

**PRODUCT SERVICE SYSTEMS APPROACH TO
DESIGN FOR SUSTAINABILITY** - Case Study of
Catering Systems for Northeast Frontier Railways, Assam.

A thesis submitted

in partial fulfilment of the requirements for the Degree of

DOCTOR OF PHILOSOPHY

By

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Indian Institute of Technology Guwahati

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Under the supervision of

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December 2014



DECLARATION

It is certified that the work contained in this thesis entitled “Product Service Systems approach to design for Sustainability – Case study of catering systems for Northeast Frontier Railways, Assam” has been carried out by me, a student in the Department of Design, Indian Institute of Technology Guwahati under the guidance of Prof. Ravi Mokashi Punekar for the award of Doctor of Philosophy and that this work has not been submitted elsewhere for a degree.

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CERTIFICATE

The research work presented in this thesis entitled “Product Service Systems approach to design for Sustainability – Case study of catering systems for Northeast Frontier Railways, Assam” has been carried out under my supervision and is a bonafide work of Mr K.K. Balakrishnan. This work submitted for the degree of Doctor of Philosophy is original and has not been submitted for any other degree or diploma to this institute or to any other institute or university. He has also fulfilled all the requirements including mandatory coursework as per the rules and regulations for the award of the degree of Doctor of Philosophy of Indian Institute of Technology Guwahati.

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Dedicated to the unknown . . .



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ABSTRACT

It is today a well-accepted fact around the world that the development paths followed by the societies in industrialised countries are unsustainable. The devastating environmental effects caused by anthropic activities of human beings on the planet are alarming. This has resulted in humans coming up with a series of solution approaches to sustainability which ranges from pollution control measures to cleaner production technologies and to environmental friendly design. Whether these approaches devised are sufficient to achieve sustainability is still under debate because the negative effects caused by humans to the environment seem to be always ahead of the solution proposed to counter it. Moreover, these problems seem to be very much towards existentialism and are complex. For sustainable solutions to be successful there is a need to move from the stagnant strategy that focuses only on the product and production processes towards a holistic approach of system design which decides the way in which consumption patterns are influenced. One promising approach for this is the Product Service System (PSS). It is observed that sustainability solutions in developed countries are more focussed towards environmental effects and its discussion which may not completely satisfy the needs of the developing nations which requires important issues like socio-ethical problems and the economic problems also to be addressed in the first hand. Public catering is a very important area which needs to be addressed in the sustainability domain as it is relevant in both the context of the developed as well as the developing nation. This research considers the Indian Railways Catering system for a system study and analyses it from a PSS perspective to find out how it scores from the three dimensions of sustainability using the Method for System Design for Sustainability (MSDS) and the Sustainable System Steering tools. A new concept is proposed which is more sustainable as the system concept is developed using the system design steering tools.

The thesis is broadly classified into four phases. In the first phase, a thorough study of the existing Indian Railway catering system is carried out through observation and interaction with the staff and managers of the pantry and base kitchen. Since not much of work had been reported in the area of Indian Railway catering from the perspective of sustainability, an effort was made to compare the existing Indian Railway Catering

system with a reference system; AkshayaPatra in this case. The second phase studies in depth the AkshayaPatra base kitchen and identifies the best practices which could be derived in the IRCS and the comparison of both the systems in terms of the three parameters of sustainability. After applying the “Method of System Design for Sustainability” (MSDS) and the Sustainability system design steering tools a new conceptual model is proposed which is perceived to be scoring high on the sustainability parameters.

The third phase discusses the issues related to the system, its stakeholders and interlink between the key stakeholders along with the perception of the passengers about the existing system. With an intention to provide a more acceptable sustainable solution to the passengers, a support tool of the Method of System Design for Sustainability (MSDS) approach was used to design a conceptual idea appropriate for the given context with brainstorming sessions. Eventually, the final specifications were formulated followed by concept generation using the SDO toolkit. The concepts were again discussed with the stakeholders to get the perceived advantages of the concept. Radar diagrams were formulated to get visual representations of the improvements of the proposed concept in the three dimensions of sustainability. The findings of these assessments and the future scope of work have been discussed in the final phase of the thesis

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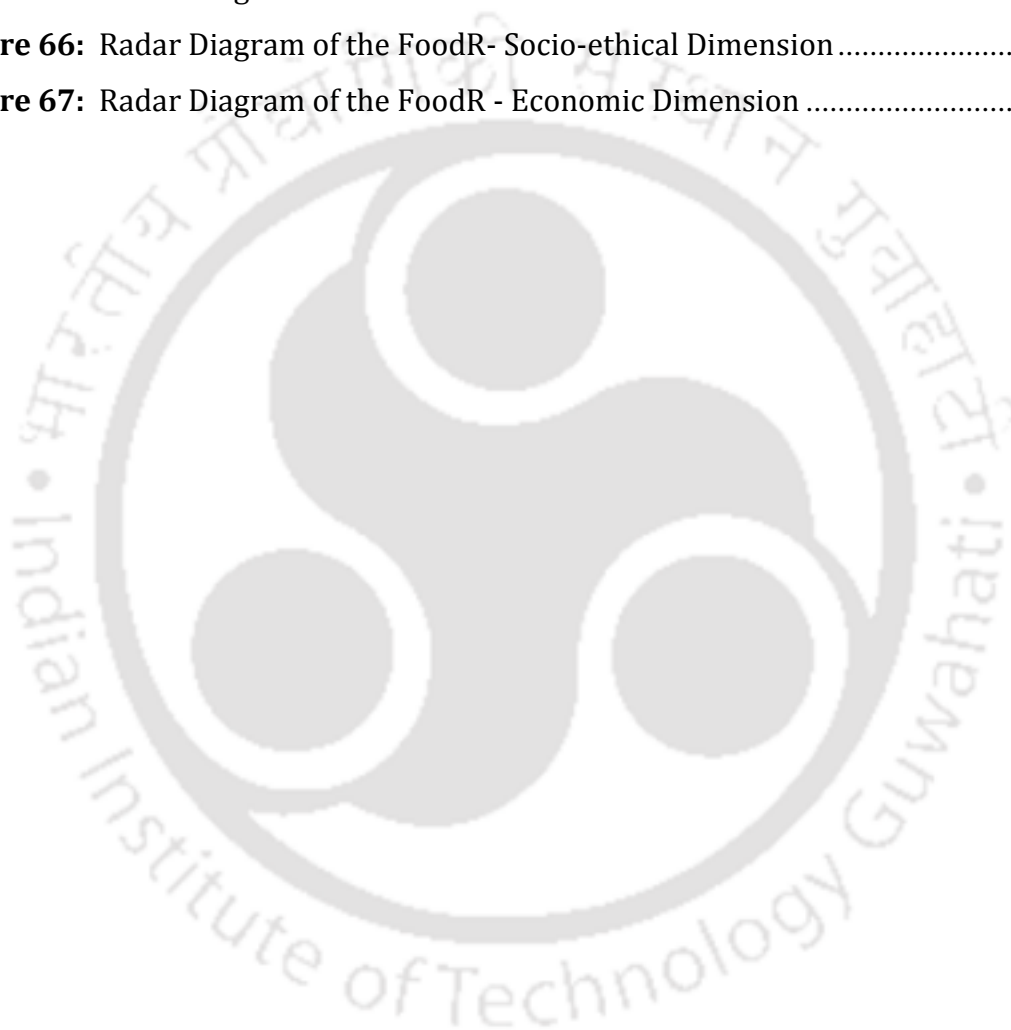


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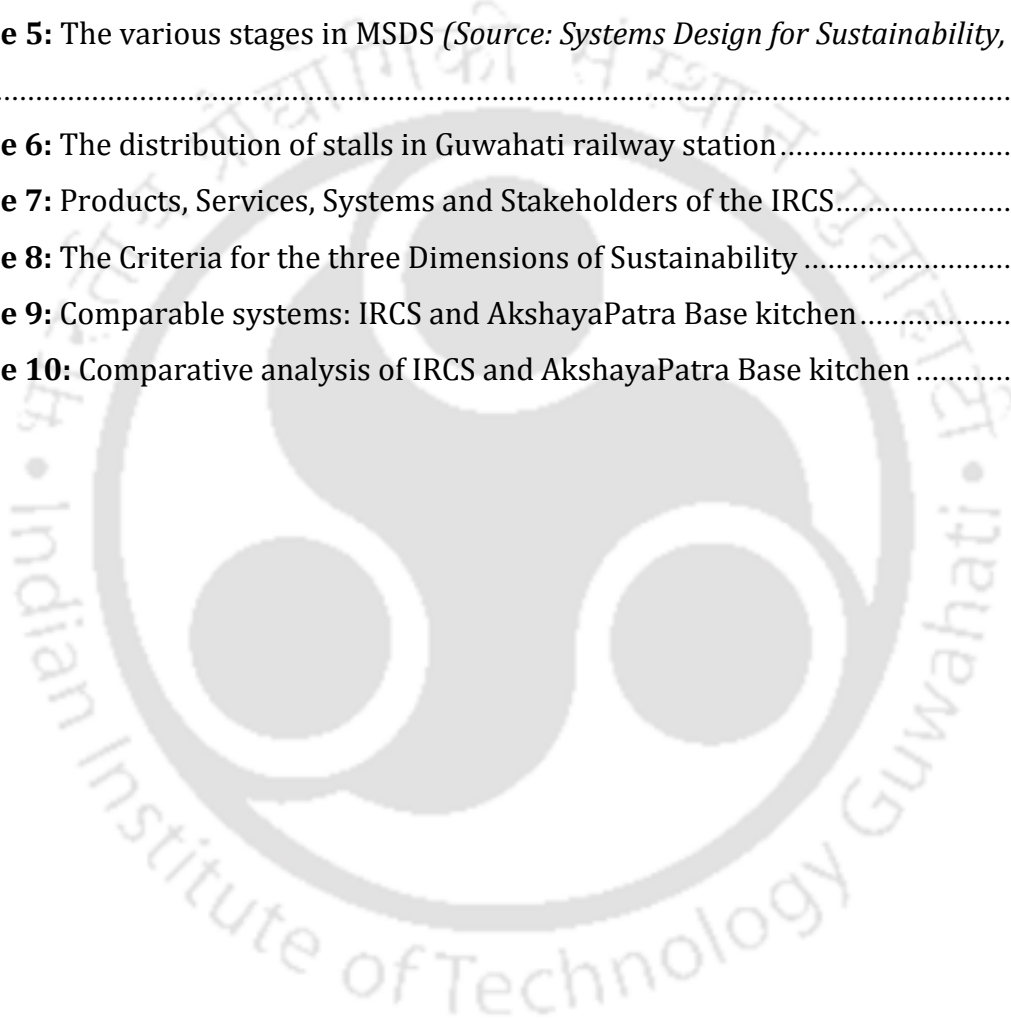
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CHAPTER 1: INTRODUCTION



Chapter 1: Introduction

Introduction

This we know, the earth does not belong to man, and man belongs to the earth. All things are connected like the blood that unites us all. Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself."

- [*Chief Seattle, leader of a Native American tribe and a prominent figure of 19th century who spoke out for land rights of the Native Americans*]

In nature, there is perfect balance in the web of life. Predators hunt, scavengers scavenge, life forms reproduce, and waste is recycled and reused. This system is very closely interconnected and is sustainable. In this system man too, is a biological being with all the activities appropriate for his survival. With his capacity to think ahead and reflect back, man has the ability to ask questions, seek answers, and build an identity. However, in the mad rush of human civilization to attain growth and development, man-made systems have evolved only by consumption of the natural resources. These developments, without considering our relationship with our natural environment, have resulted in a major turbulence in the balance of the eco system. Today, in our highly interconnected eco system, any social or environmental failure in one region threatens the entire planet (Costanza, Robert, Lisa Graumlich, Will Steffen, Carole Crumley, John Dearing, Kathy Hibbard, Rik Leemans, Charles Redman, 2007).

Let's look at some data from around the globe in order to know how humans have interacted with the rest of the nature in the past as well as present in terms of environmental degradation to understand the implications and causes for this current state of affairs. 37 million acres are deforested around the world each year. Loss of species diversity is increasing at an alarming speed and according to reports it is between 1,000 to 10,000 times more than the natural rate of extinction. The atmospheric carbon dioxide concentration has increased 18.8% between 1959 and 2003. A good portion of the carbon dioxide level increase is due to human activity. To worsen the situation, the human population seems to grow every year. The above-mentioned details give a glimpse of the enormity of the situation. The current

human population is 6.4 billion and growing at an annual rate of 80 million. Under the current trend the global population is expected to reach the 9 billion mark by 2050. This could cause a huge problem under any circumstance straining food, energy and water resources. The richest 20% of the world's population earn 86% of the world's income; consume 80% of the world's resources and create 83% of the world's waste. The poorest 20% of the world's population earn less than 2% of world's income. The population in US consumes over 25% of the world's energy production with less than 5% of the world's population, and enjoy over 30% of the world's GDP. [Source: newcommunityproject.org]

The entire world is threatened by serious environmental, socio-ethical problems and on top of it scientific evidences illustrate the rapid degradation of air, water and land and the over-exploitation of natural resources. Scarcity of clean usable water, degradation of land and a social imbalance of wealth distribution are among the most prominent issues raised worldwide, concerned with sustainable development. All these share the same characteristics because of which they have now become a global phenomenon.(Myers, 1995)

The points presented here reflect only the tip of the iceberg, and is not conclusive. This information is particularly of benefit to those people living in western countries, who are not aware that they depend on products that are produced in faraway Asian countries, and are shipped to them, which is one of the reasons for the rising environmental concerns. All the developed, developing and under developed nations share the same planet and unfortunately, we don't have an 'another earth' to move out to. Though a complete one stop solution may not be available, any effort in that direction would be like droplets helping to form a sea. This is the main reason to consider a research in the area of sustainability.

This chapter outlines an introduction to sustainability and its relevance in the global context. It discusses how important the concept of sustainability is for a developing country like India. Reflecting on a personal incident made me realize that problems concerning nature can only be solved through a collective human effort. This formed

the motivation for planning this research in the area of sustainability. Taking the case study of a public transport system like the Indian Railways the focus of the research is to examine the catering system in particular and understand how sustainable PSSs can be introduced and scaled-up and how strategic design may contribute to support and stimulate this process.

In the sections to follow below, is outlined the broad plan of the thesis, the goals of the research and the context in which this may be applied.

1.1 MOTIVATION

Recalling a small incident from a few years ago, when I was looking after the family plantation at the foot hills of Vagamon in Idukki District Kerala, India. The existing practice of agriculture was that of using chemicals as pesticides and weedicides in the crops. But in the market, the produce from farms certified as organic by Peermade Development Society (PDS), an NGO working in the field of agriculture development, would fetch better prices. Planning for a complete makeover of my farm I thought of adopting organic farming practices to gradually convert my farm to an organic certified farm. But, that year of adhering to organic farming principles, the yield was very low due to unprecedented pest attack. When I investigated this, I found that the neighbouring farms were using concentrated chemical pesticides to destroy the pests. This resulted in these pests migrating to my field and destroying the crops. I realized that if organic farming is to be done it has to be carried out at a community level where a large area has to be considered as a system and a systems level intervention is required. Consequently, a meeting was arranged with all the local farmers in that area and a group was formed to undertake collective farming using only organic pesticides, manures and supplements. The produce was to be sold to the PDS at a higher rate than normal produce. Drawing from this example one would say that dealing with the issue of sustainability, too requires a systems approach. Many researchers have attempted to establish why a total system approach (Lewis, van Lenteren, Phatak, & Tumlinson, 1997) is essential as the guiding premise on issues of sustainability and have provided arguments that throw light on how earlier attempts for change and current mainstream initiatives generally fail to follow this holistic principle. India, a developing country with its enormous population cannot afford to follow the trail of development created by the

western countries and needs to adopt a holistic approach to its sustainability goals rather than going in for quick fix solutions. This led me to consider the subject of my doctoral research topic of PSS approach to Design for Sustainability.

1.2 BACKGROUND

From a researcher's point of view, it was found that there are an increasing number of definitions for the word sustainability. It is so complex in nature with its roots extended to all fields of study. Holling (2001) discusses a few guidelines to identify sustainability indicators. International Union for Conservation of Nature (IUCN) has stated that sustainability, either in a company, region or of a species, depends on interactions amongst the internal and external factors. The internal factors being the social, political, ecological, or economic aspects and the external factors include foreign debt, global environmental problems, and social/political/economic conflicts (Arcese, Gabriella, Maria, & Roberto, 2013; Holling, 2001).

Even after many years of research, the definitions of sustainability continue to be confined to a few disciplines although its importance and impact is undisputedly applicable across many disciplines. Also, the objective mind with which humans approach scientific researches and the lookout for a universal one stop solution may not be applicable in the domain of sustainability because sustainability involves both the global and the local environment (Heller, 2003; Markussen, Kulak, Smith, Nemecek, & Østergård, 2014). The Organisation for Economic Co-operation and Development (OECD) strategies for sustainable development called for at Rio in 1992 intended "to ensure socially responsible economic development while protecting the resource base and the local environment for the benefit of future generations"(OECD, 2001a).

Another interesting point of deliberation that emerged from the literature search on sustainability was the concerns and priorities amongst developing countries as compared to developed nations. Can these be weighed on the same scale? (Ashley & Carney, 1999). In developing countries like India, economic concerns preoccupy and influence national policies. Sustainability and climate change was not an important focus of developmental policies and has only recently been included as one of the

national environmental policy objectives. (Markandya Anil, 2002). The current climate change policies at the international level have been driven by global environmental concerns, and very little attention has been given to local development and the environmental impacts of those specific policies. It is interesting to note that amongst the developing countries, even though the geographical and demographic patterns are different, they seem to follow the same trail of development traversed by the western countries. This poses a threat to sustainable development mainly because of the huge population in developing countries. For example, it is seen that in India there has been a rapid growth of population in urban India due to migration of large populations from rural areas to the cities. This needs to be carefully tackled as it presents a challenge for equitable and sustainable development. Kalam & Singh (2011) propose a model - Providing Urban Amenities in Rural Areas (PURA). Ramanathan and Parikh (1999) suggest encouraging development of infrastructure such as public transport and waste disposal more efficiently and cost effectively.

The reach of a government run public transport system like the Indian Railways (IR) is very large. Over 30 million passengers are carried daily by the Indian Railways. It forms the central network of transportation. Planning for intervention at the product, service and system level from a design and sustainability perspective and proposal for changes in this large system can have a large impact on the masses as the scope of scalability of IR is very high. To conduct a system study from a sustainability point of view for passenger amenity such as catering service would render IR the more preferred mode of public transport in the long run. An attempt to address this issue formed the basis of this doctoral research.

1.3 RESEARCH GAP

While going through the literature review, it was found that there are only few Product Service Systems (PSS) studies from a sustainability perspective, that have been undertaken in the context of low-income countries. All PSS examples are predominantly in the western context. Limited studies in the area of PSS are available for government run large systems like the Indian Railways even though the relevance of these types of organizations is immense for the masses. Literature

review suggests that the PSS that already exist in the developing countries (Manzini, Vezzoli 2001) as a consequence of economic and cultural conditions needs to be further explored. There is a need and scope for applying the conceptual frameworks of sustainability for a pragmatic application in the domain of catering system in the Indian Railways. Application of a Cradle to Cradle approach of the Catering system based on a system level study offers scope for improvement and implementation in the Indian Railways. Selecting a system which is the central network of transportation in a populous country like India gives this research a great potential to contribute in the PSS domain. This research study has been undertaken on the zonal section Northeast Frontier of the Indian Railways. It offers scope to be replicated in all the other 16 zones of Indian Railways and can impact considerably by effective implementation. Selecting a system level intervention for an organization like Indian Railways offer potential to examine and assess PSS planning and the impact it can generate for a public government run transportation system. The focus of this study is on the catering service offered on trains in the NFR zone of the Indian Railways; a subject that has not been examined and offers scope of research for this doctoral thesis. Any constructive planning and modelling of a proposal for design interventions can make an impact on the sustainable development of large systems like Indian Railways.

1.4 RESEARCH QUESTIONS

While exploring the state-of-the-art and going deep into the research background of sustainability, sustainable development and systems approach to design, we encountered many questions, which this research attempts to cover.

RQ1. How is the catering service provided by the Indian Railways performing in terms of the three dimensions of Sustainability; viz. Environmental, Economic and Socio-ethical?

RQ2. How can one identify interventions at Product, Service & System level to evolve a sustainable model for Indian Railway Catering service?

RQ3. Can intervention through a PSS model of approach help improve the existing Indian Railway Catering System (IRCS)?

RQ4. Will there be a perceptual improvement among the different stakeholders about the proposed catering system model developed by a PSS intervention?

From the research questions the Hypotheses and the Objectives of this research were formulated.

1.5 HYPOTHESES

Based on the above research questions that need to be explored in this research, the following two specific issues are being addressed:

- a) About the performance of Indian Railways Catering System (IRCS) in terms of the three dimensions of sustainability and
- b) On the possibility of a design intervention in the existing system.

Hence two hypotheses were framed as listed below.

H1. The present catering system in the Indian Railways scores low on sustainability parameters viz. economic, environmental and socio-ethical.

H2. Assessment of Indian Railway Catering Service (IRCS) following a Product Service System (PSS) approach will help identify the scope of design intervention in the improvement of the catering system of Indian Railways for the different stakeholders in the system.

For the first hypothesis the state-of-the-art was analysed and the present catering system in the Indian Railways was thoroughly studied. The data collected from different stakeholders were put together to analyse the catering system from the three dimensions of sustainability: environmental, socio-ethical and economic. For confirmation of the second hypothesis the methodology MSDS (Method of System Design for Sustainability) was adopted to assess the existing Indian Railway Catering System and exploring possibilities of design intervention domains in the

system. This study adopts a PSS perspective and attempts to put forth a proposed system developed using this methodology for the benefits of all stakeholders in the system. To coherently represent the benefits in the three dimensions of sustainability, three radar diagrams are developed from the SDO toolkit, which forms a part of the MSDS methodology.

1.6 RESEARCH OBJECTIVES

The main objectives of this thesis are:

1. Examine the existing Catering system of Indian Railways from a PSS point of view
2. Examine a comparable reference system for benchmarking, AkshayaPatra in this case, using a PSS approach
3. Comparing both the systems, identify the best practices of the reference system and to find out the scope of improvement and design intervention at a system level in the existing IRCS
4. Proposing an improved system for the IRCS using Method of system design for sustainability (MSDS) and to orientate it towards sustainability using SDO Toolkit
5. Find out the benefits of the proposed system using Radar diagrams of SDO Toolkit.

The breakdown of the study to meet the research objectives on the above hypotheses follows four phases:

Using the MSDS methodology, a detailed study of the existing Indian Railway Catering Service (IRCS) is compared against a reference system of AkshayaPatra catering system following sustainable system design steering tools is outlined under Phase I and Phase II in an attempt to seek answers for the research question viz.

RQ.1. How is the catering service provided by the Indian Railways performing in terms of the three dimensions of Environmental, economic and socio-ethical sustainability?

Phase III is a generative phase. It tries to identify the design intervention points at the Product, Service and Systems level and remodel a proposed system to achieve improvements in terms of the three dimensions of sustainability. In the process it attempts to seek answers to the other three research questions viz.

RQ.2. How can one identify interventions at Product, Service & System level to evolve a sustainable model for Indian Railway Catering service?

RQ.3. Can intervention through a PSS model of approach help improve the existing Indian Railway Catering Service?

RQ.4. Is there a perceptual improvement among the different stakeholders about the proposed catering system model developed by a PSS intervention?

1.7 CONTRIBUTIONS TO PRESENT RESEARCH

This research work attempts to provide a better understanding of the application of PSS in analysing a large system such as IRCS from a PSS perspective. It offers the possibility of implementation as a socio-technical experiment for a developing country like India. This study aims to give insights on the possibilities of re-modelling the catering system from a PSS perspective. As the proposed model mentioned here may prove to be very much context specific and is more adapted to the conditions prevailing in India, cues can be taken forward from this proposal to design similar systems in other comparable contexts as well. Prospective contributions of the study of such a large system from a PSS perspective and the proposed model could have significant applications in the study of PSS in exploring the possibilities of studying other large public systems similar to the catering system of Indian Railways in a developing nation like India.

1.8 ORGANIZATION OF THE MANUSCRIPT

Following the research objectives the thesis is outlined under the following five chapters.

Chapter 1 Introduction

This chapter introduces the research subject and the scope that exists in the study of sustainability especially in the Indian context. In this chapter, the objectives of the

study are outlined and two hypotheses are put forward which this research proposes to investigate.

Chapter 2 Literature Review

This chapter is subdivided into the following three sub sections

Section A. Sustainability an Overview: Gives an outline of the current state-of-the-art of the research on 'Sustainability' and the various definitions of sustainability, sustainable development, and sustainable design.

Section B. Contextualization in the Indian Context: Makes a comparative study of different systems in the field of education, food, agriculture and Railways. The Indian Railway Catering Service (IRCS) is selected as the system for further detailed data collection and analysis from a sustainability point of view. The scope of intervention of IRCS helps to understand how the implementation of this could lead to scalability at a macro level and the larger impact it could have on the society.

Section C. Modes of Assessment of Sustainability: It examines the various methodologies and tools for sustainability assessment from a PSS perspective.

Chapter 3 Planning of Research – Case study of NF Railway Catering System

This chapter discusses in detail the case study of the research undertaken for the Indian Railway catering system of the Northeast Frontier Railway zone, Guwahati and the AkshayaPatra base kitchen Guwahati. The actual data collected by various methods and interactions are also mentioned. This gives a complete view of the facts and figures of both these cases, list of stakeholders and the identification of problems and issues with these systems. A comparative analysis of both these systems are carried out which will help identify specific points of design intervention to make a proposal for an improved system which is better scoring in terms of the three dimensions of sustainability.

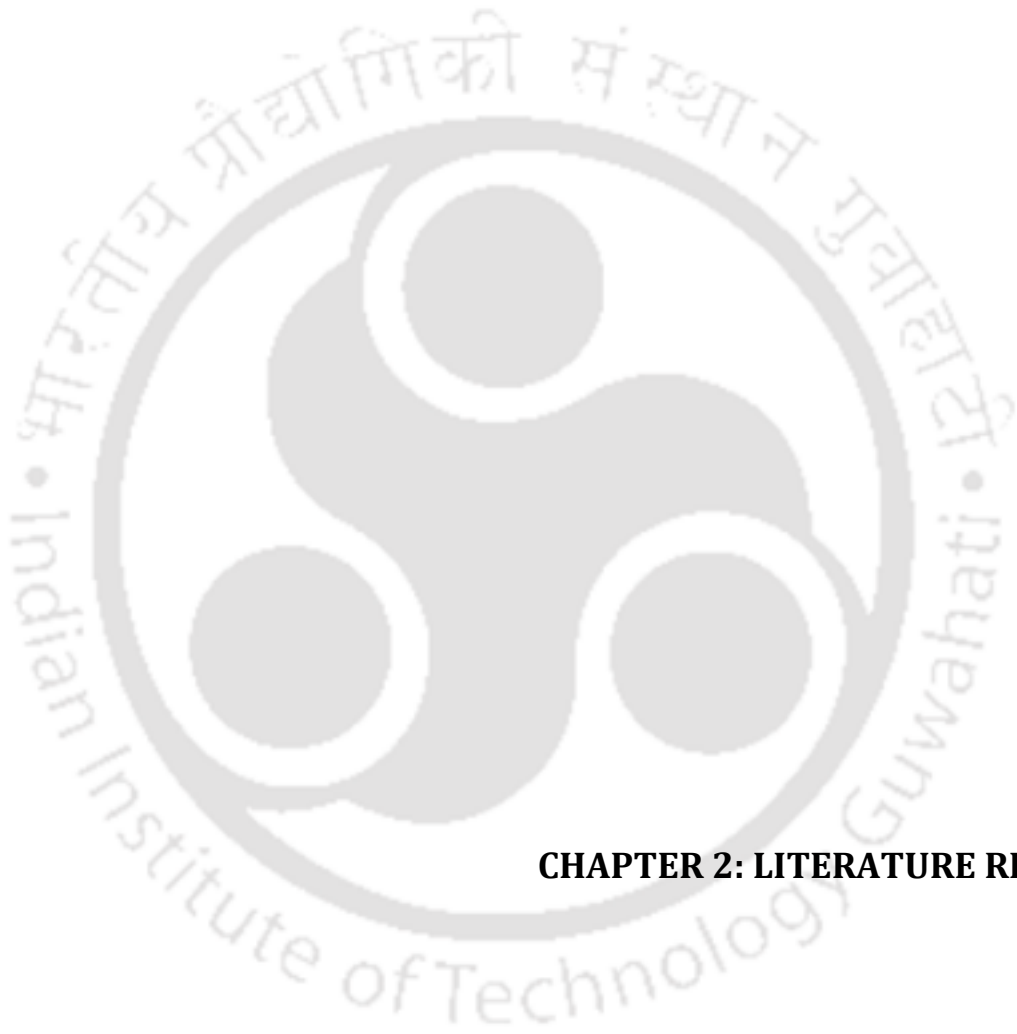
Chapter 4 Design and Analysis of the Proposed System

This chapter charts the design and development processes of the proposed system and its various sub-systems. A comparative visualization of both the systems is undertaken to present the improvements in terms of the environmental, economic and socio-ethical assessment. Finally, the recommendations, scope and strategy for implementation are also discussed.

Chapter 5 Prospects and Conclusion

Drawing conclusions from the research, this chapter outlines prospective contributions of the research on the Indian Railway Catering system and some recommendations that may be considered by the Indian Railways for implementation. The comparative results help to illustrate and validate the hypotheses. The concluding remarks suggest the future directions for further work to be undertaken for applied research of this nature.





CHAPTER 2: LITERATURE REVIEW



CHAPTER 2: LITERATURE REVIEW

Introduction

This chapter has three sub-sections:

Section 2A Sustainability – An Overview

Outlines what is sustainability and sustainable development. How they are defined? It traces the issues, concerns and developments related to sustainability and their bearing on design.

Section 2B Sustainability Contextualization in the Indian Context

Examines the relevance and importance of applying sustainable design practices for developing countries like India and the need of a detailed study on catering services for large public systems like the Indian Railways and the scope for sustainable design interventions and the impact it can have on society.

Section 2C Modes of Assessment of Sustainability

This section outlines the different assessment models that can be considered to measure sustainability as relevant to the different domains of their application.

SECTION 2A: SUSTAINABILITY - AN OVERVIEW

Sustainability, sustainable development, its definitions, the issues and concerns related to sustainability, the bearing it has on design, the role and influence of design on sustainability, the position of India and how a large public sector organization can perform in terms of environmental preservation by adopting it as a social responsibility. These are the topics discussed in the sub-sections of this chapter.

2A.1 Sustainability - Definitions, Issues and concerns

Sustainability has been defined in diverse ways. Definitions range from a precise approach that focuses on the health of rural economies (Stephen McKenzie, 2004) to environment conservation; to an all-inclusive definition that addresses multiple concerns.

The author, John R. Ehrenfeld (2008), defines Sustainability as

“The possibility that humans and other life will flourish on the Earth forever.”

Drawing from the metaphor of ‘an alcoholic man’, Ehrenfeld expresses a concern for the current patterns of over consumption. He argues that in order to preserve the earth as a self-supporting system; humanity needs to not only reduce greenhouse emissions but also change the consumption pattern triggered by the discovery of fossil fuel. According to him, replacing the overconsumption patterns with sustainable ones can help earth to keep its self-supporting system intact. Sustainability is not just about the environment or "saving the planet". He explains how humans have alienated themselves from nature and by this picked up habits that lead to un-sustainability. After each generation, the gap between the human being and his natural environment keeps building up. It is evident that current over consumption behaviour not only damages the environment and creates environmental problems but also creates unethical social problems such as disparity between the rich and the poor, child labour and hazardous working environments (Ehrenfeld, 2008; Nihlen, 2009).

Eherenfeld (2008) describes two basic types of human behaviour; "fixes that fail" and "shifting the burden". The most common human characteristic is to solve problems by a quick fix solution. This most likely has side effects and pops out new alien problems which were never thought through, eventually leading to unsustainability in the long run. We must acknowledge that nature is a very complex system, and that quick fix solutions tend to fail. Humans also tend to concentrate on the symptoms only, and forget to search for a long-lasting solution. We shift the burden to a common, easy and a customary solution. One example in this regard would be the pattern of consumption, which detracts us from our unhappiness within, so we keep on consuming and possessing more products. In the long term this is not satisfying and even becomes addictive. This is one of its side effects. Also, the society has framed itself in such a manner that people are forced to buy only those products which the manufacturers want to sell. These businessmen take the market share by selling more and more products. They manufacture only those products which sell more. Hence, individual tastes are not taken care of. For example, there has been a long list of cars sold in India. Many of these are phased off from the market even when they were selling like hot cakes. So today, if a person wants to buy the model Toyota Qualis – a model that was very popular and selling very well from 2000 to 2004- it is not in production today. It was discontinued at a time when it was the market leader in the MPV segment for promoting a new generation model, Innova. Today the market has become highly volatile and the consumer is kept in the dark about the fact that he is tricked into thinking that he has a choice.

Nathan Shedroff (2009) explains in his book, "Design is the Problem", that diversity is one strategy for resilience since it allows multiple solutions and approaches to solve or respond to the same challenge. A diverse community is more able to weather a storm, a bad growing season, a financial hardship, or a cultural crisis. Companies with diverse resources have more tools to respond to market challenges, customer whims, or corporate missions. The potential of diversity is often not valued in the society. Considering how many varieties of apples or rice have evolved- Shedroff says a whopping 7,500 varieties of apples and 80,000 varieties of rice! Before humans, these varieties helped all of nature (plants, animals, bacteria,

fungi, and so on) to respond to the hazardous changes in the environment due to weather, tectonic events, or those from space. Today, however, human societies have reduced the number of varieties of almost everything natural to just a few. The vast majority of the U.S. agriculture system, for example, is built on five to six varieties of apples, three to four types of cherries, and fewer than 20 types of grains— often without even preserving discarded varieties in case we need them in the future. It may seem like good business from a financial perspective (fewer options to choose from), but it's very bad business if you want a resilient marketplace. So here the basic aesthetics of human mind to select from larger options is reduced and has been forced with a smaller option. So the quality is replaced by quantity and people buy more and more and consume because they don't have the opportunity of more options. An example that indicates the importance of practicing diverse cultivation is the way in which farmers in the southern parts of India grow cash crops. Those farmers who run after financial profit alone seldom survive in the long run. The prices of their produces keep on fluctuating cyclically every 5 years due to many reasons. For instance, when the prices of cardamom are high there is a tendency that all farmers shift to cardamom cultivation; but by the time their cardamom grows and yields, the prices would have gone down. Then the farmers have the tendency to go after the crop that fetches the highest price at that point of time and discard other crops. However, a farmer who practices diverse cultivation that is a bit of everything always survives the price fluctuation from either one of the crops.

Ehrenfeld (2008) mentions the need of a paradigm shift which is only capable of bringing sustainability and not a gradual process of reducing unsustainability. Humankind, Environment and Ethics are the three sectors which should be indisputably included in this paradigm shift to materialize sustainability. He explains that for this to happen, a laid back attitude of expecting that the change will come from the authorities won't bring in the desired result; rather there should be a cultural shift from within. One path that could be traversed for this is to re-design our everyday equipment and appliances in order to make us more aware and steer our behaviour towards sustainability. An example mentioned is the two button toilet system where one button is for the big flush and the other button for a small

flush. This provides a choice to the user through which a sense of responsibility can be cultivated, and a responsible behaviour can be preset in the mind of people in long run. This is what is called as "Sustainability by Design".

The definition of sustainable development was first introduced in 1987 by the World Commission for Environment and Development (WCED) in the document titled 'Our Common Future'; also known as the Brundtland report, named after the coordinator of the commission Gro Harlem Brundtland. It says:

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [WCED 1987]

This definition does not mention environment conservation *prima facie*, but throws light towards the origin of a fundamental ethical principle: the responsibility of this generation to the future generations. Following the Brundtland report, various other significant international initiatives have been taken that have addressed the issue of sustainable development and have brought it to the attention of the global community. Some of the landmark events have been the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, the World Summit on Sustainable Development that took place in Johannesburg in 2002 and the Rio Earth Summit 2012.

Initially, the main thrust of sustainability was viewed from the environment aspect (Mebratu, 1998). Accordingly, a productive process was sustainable if it used resources with low environment effect. Later the concept of sustainability has often been associated with other socio-cultural orientation which promotes the importance of maintaining the stability of social and cultural systems, making them evolve towards greater equity, particularly elimination of poverty and the propagation of civil rights for future generations.

The problem of sustainability can be addressed only by attacking the root cause of it. The change must come at the level of the mind-sets of people and the societal structure. Tom Gladwin (1995) has classified twenty un-sustainable characteristics

that underlie social and individual activities in modern industrial societies. This provides a conceptual road map of where humanity stands and where it should go to achieve the goal of sustainable living. From this, it is very clear that the solution for this problem lies in a subtle level strata- the individual mind- which will spread across the masses and finally to the society. The negative change which we see in this world today is just a reflection of what has happened in the mind-set of the people over the years.

The basic mistake that humanity has committed is that it started to relate GDP of a nation with progress. McDonough & Braungart (2010) in their book, 'Cradle to Cradle', mentions an interesting relationship between activity and prosperity. Citing the example of the Exxon Valdez oil spill of 1991, it is showed that in the nearby areas where the oil spill happened registered an increase in the economic prosperity, because so many people were trying to clean up the spill. Restaurants, hotels, shops, gas stations and stores all experienced a boom in the economic exchange. This had in fact increased Alaska's gross domestic product (GDP). But can the GDP be the only measure of growth? To just imagine that we call that progress!! Absurd indeed. The fact is that the Valdez accident led to the death of more wild life than any other human engineered environmental disaster. The reason for this glitch is due to the fact that the GDP is taken as a measure of progress emerged during an era when natural resources seemed unlimited and quality of life meant high economic standards of living without bothering about the consumption patterns. If prosperity is to be judged only by increase in such activities, then car accidents, hospital visits, illness, toxic spills, cancers, are all signs of prosperity. When new hospitals are opened, is it too considered to be a development? In reality more hospitals means a decrease in the general health of the people. Exhaustion of resources, cultural diminution, damaging social and environmental effects, and reduction in quality of life – all these would be taking place and yet they are negated by a simplistic economic figure that says economic life is good. It is ironic that most countries are trying to singularly boost only their economic activity as it can increase their GDP which they see as a measure of progress.

Several authors, (Goodland & Daly, 1993; Odum & Johannes, 1975), have subsequently argued that human activities are part of a socio economic subsystem integrated into the ecosphere. Going on to emphasize that economic growth that is uncontrolled and based essentially on the intensive consumption of resources, is not sustainable in the long run, precisely because the ecosphere is finite and contains limited resources. Mahatma Gandhi has rightly said that nature can satisfy human needs and not human greed. The environment by providing raw materials and all other primary resources; also constituting a dumping reservoir to absorb and sometimes recycle waste to performing all the other irreplaceable functions for sustaining life supports human society. Hence, it was suggested that the consequences of exhausting environmental resources must be taken into serious account in the formulation of policy making. These considerations have led to the development of the concept of sustainability from an ecological view-point integrating the economic and socio-cultural aspects.

Around the world today, there is a growing body of knowledge explaining the fact that the reason for any of today's environmental problems can be traced back, directly or indirectly, to the local level – and to the lifestyles, choices, values and behaviours of local communities. Environmental problems that are becoming apparent at the global level – for example, climate change, loss of biodiversity, increasing desertification – are being tackled internationally by introducing a variety of multilateral norms, conventions and agreements amongst nations. Solving an environmental issue successfully can be ensured only if it is accompanied with strong local action, and involvement of local stakeholders. It is widely accepted that sustainable development requires community participation in principle and in practice.

In view of these considerations, sustainable development has been defined today by a few interlinked dimensions(Elkinjton, 1998). Them being:

- **The Environmental (Planet) dimension:** Consumption of natural resources should not cross the “resilience limit” of the planet; that is the ability to absorb the

anthropic perturbations without provoking the irreversible phenomena of degradation resulting in global warming, ozone layer depletion, acidification etc.

- **The Socio-ethical (People) dimension:** Conservation of resources to maintain same degree of “satisfaction” for future generations and the fairness in the “distribution” of the resources.

- **The Economic (Profit) dimension:** Use of resources for economically feasible solutions, in a more or less norms oriented market and the interrelationship of efficiency with sustainability.

2A.1.1 Sustainable Design and Sustainable Development

The establishment of a formal training program in the field of Industrial design is attributed to the Bauhaus School of Design which commenced its program in the early 1920's and subsequently to the Hochschule für Gestaltung at Ulm in Germany. It was only in 1957 that a professional body the *International Council of Societies of Industrial Designers*. (ICSID) was formally established – to protect the interests of practicing designers and to ensure global standards of design. The definition for Industrial Design at that time read as follows:

“An industrial designer is one who is qualified by training, technical knowledge, experience and visual sensibility to determine the materials, mechanisms, shape, colour, surface finishes and decoration of objects which are reproduced in quantity by industrial processes. The industrial designer may also be concerned with the problems of packaging, advertising, exhibiting and marketing when the resolution of such problems requires visual appreciation in addition to technical knowledge and experience”.

The thrust initially was towards design and it met the requirements of industrially manufactured products and design activities related to associated activities such as advertising, marketing and promotion. It was a reflection of the thrust on the profession and one that met the aspirations of an emerging modern society entering an ‘industrial era’, where mass manufacture and mass consumption of man made goods and artefacts were the order of the day. The decade of the 80's saw these

phases of marketing reach its peak in terms of mass consumption, consumerism, the use of plastics, and the emergence of throw away products.

In the early 1990's, with the emergence of the digital era and the shrinking of the world into a global village, the values and the impact of mass consumption on the environment began to be voiced. This discourse gained a critical mass and was voiced with a serious concern in the manufacturing sector, which suggested that methods should be evolved that could measure and reflect issues of sustainability at the design phase. With liberalization and globalization, the whole practice of design, manufacture, disposal and other related processes were being re-examined in the context of complete product life cycle studies as it was evident that the activities happening in one part of the globe has its effects on the other, both environmentally and economically.

Over the years, a number of designers like Buckminster Fuller, Victor Papanek, and Chris Jones, have given warnings to make changes in the design profession, and increasingly these calls are being heeded. A recent example would be the *First Things First 2000* manifesto signed by 33 leading graphic designers. This document was published in *Adbusters* in the autumn of 1999 and was also published in many design journals and forums which are in fact an updated version of a similar document published by Ken Garland in 1964, signed by 22 visual communicators then. This shows that the issues addressed in it were long-standing and were still unresolved. As the need of the hour, the concerns raised regarding sustainability were also reflected in the profession of design, and its roles and responsibilities were getting seriously impacted. In his book '*Design for the Real world*' Papanek (1985) was critical of the present practice and thrust of design profession and expressed this in his famous quote;

"There are professions more harmful than industrial design, but only a very few of them"

He was of the opinion that the present design has satisfied only the momentary wants and desires of the people by satisfying them superficially, and not attending to the genuine needs of man which have often been neglected by the designers.

A serious analysis of the economics of production revealed that every product we purchase required an average 30 times its weight in materials to make, package and ship. An automobile used twice its weight in materials to produce. By many accounts, it was clear that we have already exceeded the capacity of the earth to provide for the sustainable existence of all species, by several folds. It was argued that many after effects of this intense use of the resources in the manufacturing of products could be prevented at the design stage. In other words, designers also hold the onus of this overload of resource extraction on planet earth. The traditional approach often followed by designers to solve a problem or to satisfy a perceived need seems inadequate. Designers must rethink and revise their approaches to “problem solving” in a very novel and radically new way, if design is to take a leading role in overcoming the profound economic, ecological, and social problems the world faces today (Meyer, 2003). Without a change in thought pattern, designers will keep on adding fuel to the fire by posing problems and difficulties that arise from uncontrolled consumerism.

This is an indication towards a higher level of thinking and a more responsible outlook for the designers that needs to be the trademark of designers of this era.

The present definition of Industrial Design is:

"Design is a creative activity that aims to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles." Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange. Design is further explained as the field which seeks to discover and assess the structural, organizational, functional, expressive and economic relationships, with the task of:

- *Enhancing global sustainability and environmental protection (global ethics)*
- *Giving benefits and freedom to the entire human community, individual and collective, final users, producers and market protagonists (social ethics)*
- *Supporting cultural diversity despite the globalization of the world (cultural ethics)*

- *Giving products, services and systems, those forms that are expressive of (semiotics) and coherent with (aesthetics) their proper complexity. [www.icsid.org accessed on 11/10/2010]*

These important considerations of Design and Environment resulted in the profession updating its definition of Industrial design. Today the definition of Industrial Design has been revised, in which sustainability has been included as one of the crucial aspects. It has been updated in the context of the critical contribution that the profession is expected to make in the design and development of a new product / product system or artefacts that meets the objective of improving the quality of the life of users devoid of a toll on the environment.

In the present world, design has become the most powerful tool with which man shapes his paraphernalia, society and environment. The contribution that design can make to improve environmental performance is increasingly being recognized. Over the last few years many companies have made considerable progress in improving the environmental performance of their manufacturing operations but in many industries major impact comes from their products in use, or when disposed. Improving the performance of products through intelligent design is now a major focus of interest for designers.

The first pro environment movement started in the 1960s and 1970s. The book *Silent Spring*, (Ferguson & Carson, 1962), raised concerns for the environment from the public, by highlighting the dangers of pesticides to both the eco-system and humankind. In the decade of the 80s, the second movement to sustainability was triggered by many environment disasters including the Bhopal gas tragedy and the Chernobyl tragedy which resulted in the governments implementing more environment safety legislations that were given due importance by the media. This made the public aware of the environment that accommodates them and the importance of preserving it, which paved the way to designers creating “eco-friendly”/green products. Around the world today, business and regulatory scenarios are changing. The responsibilities of the stakeholders and the investors are widening its business boundaries beyond the products and the value chains that produce them. The nature of risks and opportunities that the companies face now

had given a new turn in their business to incorporate the environmental and social function to the design as well (Marco, Werre, 2003). It is now a question of remaining competitive in the global and local markets. The very recent incidents with many companies calling back their products and worldwide debates and protests against the toxicity of the materials used in the products have slowly triggered a new wave of regulatory frame works that deal with the product's life cycle and eco efficiency. So now, if companies want to stay in the market, maintain their goodwill and not incur loss, they have to be watchful and incorporate sustainable practices into their work culture.

The increasing importance of sustainability and sustainable development in this complex world requires integrating economic, social, cultural, political, and environmental factors (Kates, 2001). This requires an understanding of the fundamental character of interactions between nature and society. Such an understanding must encompass the interaction of global processes with the local ecological and social characteristics. It will also require fundamental advances in our ability to address such issues at the behaviour of complex self-organizing systems as well as the responses, of the nature-society. Combining different ways of knowing and learning will permit different social actors to work in concert, even with much uncertainty and limited information (Cash & Moser, 2000). Gallop (2003) asserts that when referring to the sustainability of a system it should be made clear which level of sustainability is being considered, because the implications may be quite different for each case. Sometimes, we want to sustain parts of the output but want to improve or transform the system, sometimes we want to change the system to improve some of its outputs (Gallop, 2003). The concept of sustainable development is quite different from that of sustainability. The word "development" clearly points to the idea of change, which is directional and progressive. Here, what is sustained, or has to be made sustainable, is the process of improvement of the human condition (or better, of the socio-ecological system to which humans pertain), a process that does not necessarily require the consumption of energy and materials. Humanity is going through a period of tremendous technological and economic transformation. In an attempt to ensure that the changes affecting humanity are changes for the better, the world community has

initiated the process of redefining progress which has happened till now. This attempt at redefining progress of humanity is called sustainable development (Mebratu, 1998; K.H. Robèrt et al., 2002).

2A.1.2 Driving forces of Sustainable Design

World over, different regulatory and non-regulatory bodies are beginning to form new green regulations around product sustainability. To address the social and environmental life-cycle impacts of products, these catalysts are generating attention towards the “design” function in companies as the focus of sustainability-based reforms (BSR, 2007). One of the major drivers in this direction of move towards sustainability is the regulations by the governments and the authorities.

The European Union has demonstrated that governments can and should tackle sustainability issues through product regulation (Albareda, Lozano, Tencati, Midttun, & Perrini, 2008). Directives passed in 2003 have extended producer responsibility to end-of-life management for Waste Electrical and Electronic Equipment (WEEE) and required the Restriction on Hazardous Substances (RoHS) certification in products for six chemicals so far. The Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) directive in Europe that came into effect in July 2007 is a chemical screening regulation that has the potential to extend restrictions to additional substances and product types (BSR, 2007). Another main factor is the product call backs and rejections faced by many companies. For instance, an undercover investigation by the BBC on child labour revealed shocking realities of many children being forced to work in many of the factories of garment exporters at Tiruppur, Tamil Nadu, India which had a great setback when their products were rejected and sent back by *Primark* because of these socio-ethical issues involved in making them (Bourdillon, 2010). About six years ago the Netherlands government stopped the import of Sony Play station modules when they found that the wire cables had alarming levels of cadmium. Famous toy brands in the US like Barbie also had to call back their products. Product composition audits are on the rise as product regulations are widely accepted and implemented and companies have to pay high cost for acting ignorant about environmental and social ethics.

Another major factor which initiates the move towards sustainability is the competition among the companies (Halldórsson, Kotzab, & Skjøtt-Larsen, 2009). Many companies are trying to market their products under the umbrella of “Green”, differentiating their products by labelling them as ‘eco-friendly’. So the customers have a preference to the greener products and also the supply chain has a trademark of eco-discipline, which makes sustainability an essential qualification to compete in the market. This is also a positive progress in the direction of sustainability. In terms of social sustainability, there are so many organizations that develop online resources for providing data regarding the truth of these claims. When these claims are not found credible, the companies face a threat of mass boycott of the products from the consumers. This pressurizes the companies to provide true data and never make false claims. Some examples of such websites are *www.cosmeticsdatabse.com*, *www.thegreenguide.com* and *www.epeat.net*. Lastly, many campaigns by NGOs and the media against companies that do not comply with the supply and production chain of green products have proven to be very effective. The campaign against child labour have made the whole process of garment manufacturing transparent and also the campaign against e-waste are prompting electronic companies to adopt life- cycle- impact a part of their product design process. In spite of the progress in this direction, no company can claim that they are offering a 100 cent sustainable product. It is important for the companies to realize that designing sustainably is an on-going learning process that makes flexibility and adaptability crucial to success. The most important challenge is to develop the organizational capacity to absorb these evolving insights on sustainability and to embed them into the company’s decision-making function.

There are many practical difficulties towards designing better products. For this the decision makers should be able to identify options that are more sustainable and to channelize organizational resources to pursue them. This is very difficult in a traditional company set up as no functional group is competent enough to identify sustainability options and launch innovations that are accepted by all the functions of the company. The traditional organizational structure is based on clear demarcation and distribution of responsibilities. For sustainable designs, it is not clear as to who should have the responsibilities, how people should communicate,

or work together towards sustainability. Sustainability is still a new concept; therefore successful organizations are developing more integrative product design approaches that facilitate on-going learning about sustainable design, as well as product innovations. Integrative design recognizes that sustainability is not just about modifying products, but about modifying the way that products are made (BSR, 2007).

2A.2 Design and Sustainability

Here let us examine the expanse of design activities and their pre-occupations in the field of sustainability. These include design methods and approaches in design practice that includes issues related to sustainability within the sphere of design activities. The environmental degradation and depletion of resources have led the scientists and researchers in all fields to think and adopt the concept of sustainability in their respective fields. Coming to the field of design, the new generation designers realized that design has a major role to play throughout every stage of the product life cycle (Charter & Tischner, 2001). This consciousness has led to the emergence of new areas of sustainable designs. Prof. Ursula Tischner (www.econcept.org accessed on 28/10/2011) says that the role of sustainable design goes a step beyond Eco-design, to influence the consumption and production patterns and to reach the improvement at a system level. Many design researchers are also thinking about how to design products that may influence users towards new and more sustainable behaviours (Tukker, 2004). An intelligent design applied in the manufacturing of domestic equipment would probably instil a more eco-efficient and responsible way in household practices (Jégou, Liberman, & Wallenborn, 2009). After nearly a decade of research and study of environment issues, the focus has shifted from end of pipe actions and solutions to research and innovations that aim to diminish unsustainable systems of production and consumption. The first step towards this was the selection of resources with low environmental impact. During the second half of the 90s, there was a shift from the material to the product level, designing products with low environmental impact, usually referred to as product life cycle design or eco- design. Later Vezzoli

suggested a System Design approach for Sustainability for design interventions at a systems level (Carlo Vezzoli, Asirelli, & Tacchini, 2010).

With time, the design profession has evolved much and so has the role of the designers in the world. A glance into the history would clearly elaborate the path followed by the field of design. Throughout the nineteenth century, the term 'designer' was vague and ambiguous, referring to a wide range of occupations: fine artists, architects, craftsmen, engineers and inventors (Sparke, 1983). By the twentieth century the profession of design had developed into Industrial Design as we know it today, existing in design teams and governed by management structure (Sparke, 1983).

After the industrial revolution, when the design profession took off to modernity, it was expected to give contribution only in product aesthetics and styling, and designers were considered to be creators. In the 1960s, the industrialists and designers saw a need to support the integration of design into the industrial processes and hence this profession was given a slight increase in its stature by considering design to be a part of the team along with engineering and marketing. So designers started concentrating on the entire product development process. The next decade saw the dawn of a new field of study; ergonomics, where the designer had to study the user and consider them to be most important. The whole product definition was oriented toward the user. The 80's saw the boom of Design management where in the designer got a new role as a coordinator. He created the roadmaps, and product portfolios. This trend had a slight upgrade in the next decade with a new buzz word "Branding", popping up. Soon designers had the role of a strategist where he has to think of the total experience from concept to retail keeping in mind the task of creating experiences for the customers.

In the new millennium the role of design soar to new heights, contributing to the vision with design as innovation driver. The former prime minister of India Dr. Manmohan Singh has challenged Indian scientists to unleash a "decade of Innovation" at the Indian Science Congress at Chennai on Jan 2011. The need of the hour is innovation and competitiveness (Krishna, 2012). People, cultural diversity and opportunities drive innovations and this is required to develop new products,

services, reduce cost, and improve efficiency, productivity, performance and quality. Innovations are the key to growth, problem solving and inclusive growth world over.

Recently, design research has opened a new discussion on a possible role for design in social equity and cohesion (Labuschagne, Brent, & van Erck, 2005; Carlo Vezzoli et al., 2010). Over a period of time, design for sustainability has widened its boundaries to include design for social equity and cohesion from the starting point of selecting resources with low environmental effect. It not only integrates the three pillars of sustainability - people, profit, and planet, but goes beyond simply greening products to embrace consumer needs in a holistic and sustainable way. These considerations are important in evaluating any strategy for design intervention in any man-made systems for them to be sustainable. Evolution of sustainable designs has followed these four aspects (Blewitt, 2014; Carlo Vezzoli & Manzini, 2008) as discussed below :

2A.2.1 Selection of resources with low environmental impact

Green design is a process which deals with individual environmental impacts at a material level, while eco-design goes a step further, i.e. over the entire life span of the product from cradle to grave (Knight, 2009) . Earlier researchers had identified toxicity of materials in use as the foremost issue to be tackled in sustainability concerns. This has already resulted in many regulations, but new estimates and upgrades are still being accrued. Another associated question that has raised ambiguity is the naturalness of the materials. It is often believed that natural material has by default no environmental impact whatsoever, or at least has lesser impact than synthetic materials. This argument is now considered wrong for two reasons. First: In nature toxic and noxious materials are in abundance. Second: Practically all natural materials are subjected to a series of processes in order to become usable for production and all processes have their own environmental impact. Another closely related topic which still has great magnitude among the environmental problems is waste management; especially recycling and incineration in order to recover the contained energy. In the design context, a material cannot be claimed as recyclable without designing the easy separation of

incompatible materials or their easy retrieval from the discarded products (Almeida, Rodrigues, Bonilla, & Giannetti, 2010; Hunsberger, Gibson, & Wismer, 2005). Another open debate is on the subject of biodegradability. In fact, for many products and contexts, biodegradable materials might pose a problem in a sense of premature expiration of the product (Carlo Vezzoli & Manzini, 2008). For example, the use of bamboo for a product which is to be used in humid environment. Tackling the issue of renewable resources, (both in the terms of energy and materials), it should be understood that a resource is renewable only when it is replenished by natural processes at a rate comparable to its rate of consumption by humans (K.-H. Robèrt, 2002). Only when associating renewability with the speed of recovery of resource and with the rate of utilization, can its effects be measured (Hart, 1995).

2A.2.2 Design Products with low environmental impact

Eco-design was developed in the 1990s with a focus on the redesign of existing products from an environmental point of view. The focus shifted from using environment friendly materials to assessing the effect of the whole life cycle. Eco-design is influenced more by the Life Cycle Analysis model calculating the environmental effects from the stages of ideation, raw material procurement, production, use and finally the disposal.

In this area two main concepts have emerged:

- 1) The concept of Life Cycle Thinking, i.e. from product design to the design of product life cycle stages (Heiskanen, 2002; Rebitzer et al., 2004; Carlo Vezzoli & Manzini, 2008). All the activities required to produce the raw materials, to manufacture the product, for distribution, use and disposal are considered as a single unit.
- 2) The concept of functional thinking, i.e. to design and evaluate a product's environmental sustainability starting from its function rather than from the physical product itself (Oksana Mont, 2002).

2A.2.3 Design for Sustainability starting from system innovation.

After the Rio conference in 1992, the focus has again shifted from product to a system capable of fulfilling a demand; a top down approach (Leach et al., 2012). The

stringent interpretation of sustainability has led us to work on radical changes in production and consumption models. More attention is paid on design for eco efficient system innovation (PSS – Product Service System) than for a single product. In order to be more coherent with the enlargement of the design scope from a single product to a wider system fulfilling a given demand of social needs and desires, the design conceptualization process needs to shift from functional thinking to satisfaction based thinking (E. Manzini & Vezzoli, 2003).

2A.2.4 Design for social equity and cohesion.

As the design profession evolved, a potential role of design was identified as to address the various aspects of social equity and cohesion, aiming at a “Just” society with respect for fundamental rights and cultural diversity that creates equal opportunities in all its forms and for all (Carlo Vezzoli et al., 2010).

Design for environment is in its infancy and are marked by the absence of stringent standards. It always involves trade-offs between hard and fast rules that are very difficult to find. At present the companies have developed guidelines to assist designers in designing for the environment. They are usually checklists that include: Material recovery and Re-use, Design for disassembly and simplicity, Waste minimization and Energy and material conservations. These are points that give a direction to the whole design process. Even though we say our development is human centred, it seems to be more towards the greed of the individual and not to the well-being of the whole society and mass. Such solutions can materialize only in cooperative movements like the Amul and the Warana (Kalam, 2011) which are discussed in the next chapter.

Product innovation was traditionally focused on redesigning the product itself with very less concentration on the way in which products are managed and used (Service & System) during its lifetime. Now the new trend in the industry is toward the design of products and services together often referred to as Product Service Systems (PSS) which presents an opportunity for these two possibilities to be considered and improved in tandem (Isaksson & Larsson, 2009; Maxwell, Dorothy, 2006; Oksana Mont, 2004).

2A.2.5 From Strategy of Efficiency to Strategy of Sufficiency

Environmental sustainability refers to the condition where the human activities both at the global level and local level do not disturb the natural cycles exceeding the rate of planetary resilience and do not diminish the sharable natural capital for the future generations. Considering the growing population and the growing demand for the materials in the emerging and developing economies, the current consumeristic production consumption patterns can be considered sustainable only if there is a tenfold increase in their eco-efficiency. (Carlo Vezzoli & Manzini, 2008). The domain of environmental sustainability can be approached in two ways one 'inside out' approach i.e. the strategy of efficiency and the other 'outside in' approach i.e. the strategy of sufficiency. The strategy of efficiency is founded on the basic assumption that the eco efficiency of the present technological system is increasing, so the present consumption pattern is harmless to the environment and can be continued. On the other hand the strategy of sufficiency is supported on the belief that it is necessary and possible also to have a cultural change that would regard the reduced availability and consumption of materials and products as an increase in living standards. Both these strategies seems to be extreme in nature and considering the extent of urgency of the problem, a middle path approach like a PSS which has the scope of blending both the eco efficiency of the production process and the efficiency of the consumption; seems to be the feasible way out which is discussed in the next section.

2A.3 Product Service Systems (PSS)

In nature we seldom see any isolated building blocks, but rather a complex web of relationships between the parts of a unified whole. Systems thinking have been applied in different fields of study. To approach problem situations as a whole on a holistic level requires an understanding of what a system is. According to the definition provided by the United Kingdom Systems Society (UKSS): "The concept of system embodies the notion of a collection of elements connected together to form a whole. Systems' thinking uses this concept to help understand the world. Central to the approach are the ideas of emergence and hierarchy, and communication and control. Systems practice employs systems ideas to design and manage complex

processes and artefacts for the benefit of individuals, organisations and society” (Checkland, 2000). According to Werner Ulrich (2005) “Systems thinking is relevant because all problem definitions, solution proposals, evaluations of outcomes, and so on, depend on prior judgments about the relevant ‘whole system’ to be looked at. Improvement, for instance, is an eminently systemic concept, for unless it is defined with reference to the entire relevant system, sub-optimisation will occur.” Systems are useful in relation to understanding the problems ahead; especially to understand that problems might have sub-problems which are interrelated and that a problem is a symptom of some other problem.

Sustainability means different things to different groups and individuals; which makes it difficult to define. If sustainability was to measure only climate-related issues (like carbon dioxide production) and leave the social issues for people to figure out on their own, the customers would eventually discover that the product they believed to be “better”, due to the ratings, actually had questionable social impacts (such as animal cruelty or child labour), dissipating all the trust they had on both those products and the rating system (Shedroff, 2009).

Considering the product cost, the consumption of resources and energy both have economic as well as environmental costs. A reduction in the consumption of resources is a source of saving because the waste treatment after the production also involves high costs- as they say-“Prevention is better than cure”. In the existing product system where the manufacturer produces the product and sells it to the consumers, the reduction of factor costs and emissions during use phase is not necessarily of the interest of the manufacturers. For example, a manufacturer of home appliances has interest only in reducing the resource and energy consumption during the production phase as it directly affects him. He may not have any direct economic interest in limiting the consumption during use phase or reducing waste after its useful life span. Sometimes the producer is interested in manufacturing products with a short life span so that his sales increase (Carlo Vezzoli & Manzini, 2008). The disposal of the products is not his responsibility and is transferred to the government, individual user or the social administration. Therefore, in a traditional

system, the economic interests of the different stakeholders don't match. Hence, very less eco efficiency of the life cycle system.

On the environment front, better interactions between the different economic actors, would lead to optimizing the resource and energy consumption within the entire product-consumption system and lifecycle. To overcome this, a vertical stakeholder interaction would help; a single stakeholder who is responsible for more than one stage within the lifecycle. For example, a washing machine producer who also produces washing powder and later takes care of their disposal. Therefore, the only way to approach sustainability effectively is from a systems perspective (Clayton & Radcliffe, 1996). We need to consider a wide perspective before diving into details. In design, things are inter-connected, so anything effectively requires considering what it connects to (Cash et al., 2003). This necessitates considering financial, social, and environmental issues together—at least at some point. Surely, these issues are widely different and require specialized knowledge and solutions. But no solution can be addressed effectively without considering its impact across all three areas. These constraints are a challenge for designers, not a limitation. The advent of a new thinking, PSS (Product Service System) where in the possibility of satisfying consumer needs is thought upon by more dematerialised services than the traditional material intensive production and consumption is becoming more and more popular.

2A.3.1 Evolution of PSS

Product Service System (PSS) has taken different paths of evolution during the course of the last two decades. A product service system (PSS) is a function-oriented business model aimed at providing sustainability of both consumption and production. A PSS is defined as a marketable set of products and services capable of jointly fulfilling user needs (Beella, Silvester, Brezet, Timmeren, & Bauer, 2010; O. K. Mont, 2003; Morelli, 2006a). In this paradigm, the role of designers are very important in order to strike the balance as well as solve common problems and common goals (Silvester, Beella, Timmeren, Bauer, & Quist, 2010). This process is carried out with different actors, such as companies, institutions and end users, towards a common solution. In the novel concept of PSS there is an attractive design

offering which will satisfy the requirements of all the stakeholders (Van Halen, Vezzoli, & Wimmer, 2005). Another definition given for PSS by the DFS(Design for Sustainability) group of TU Delft is – “Designing and providing *a system of products and services* (and related infrastructure) which are jointly capable of fulfilling client needs or demands more efficiently and with higher value for both companies and customers than purely product based solutions” (Tischner, Ryan, & Vezzoli, 2009). In a scenario of successful implementation of PSS, the service providers will have a major share in the market. According to the United Nations Environmental Programme (UNEP), PSS can be claimed to be a result of an innovation strategy, shifting the business focus from designing and selling physical products only, to selling a system of products and services which are jointly capable of fulfilling specific client’s needs. In this framework, the manufacturer can also make profit from minimizing resource and energy consumption, emission of waste during the use and disposal phase and are motivated to develop durable goods that require few resources and emit little waste (Williams, 2007). An extension of the product lifecycle will delay the disposal costs and the new production costs and enable the user to re-use some of the good condition parts of the discarded product thereby saving on disposal costs as well as procurement costs. Given a certain demand, the economy based on a product service system which transfers the ownership of physical goods from the user to the producer, is essentially more eco efficient than an economy based on individually produced goods (Mont & Lindhqvist, 2003a). The advantages are - more efficient resource consumption: minimization as well as selection of resources with low impact, more intensive use of products, direct interest to extend product life span and direct interest to extend material life span. Going through the literature Mont specifies a point where one pattern which is observed is the increase in the overall consumption that in turn eclipses the small benefits obtained by improving the energy efficiency of individual units. For example, the energy-efficient household appliances, which has become more and more efficient per unit of volume; ; on the other hand the increase in the appliances volume and in the number of sold appliances lead to increases in aggregate energy consumptions (Oksana Mont, 2004). The same is the case with automobiles (E E A, 2008). Once the concept of PSS became popular, manufacturers tend to put less

focus on producing products and more focus on providing more value to the customer by incorporating more of services, as services can provide value with less environmental impact without compromising the customers' needs (Yoon, Kim, & Rhee, 2012). This has brought in a new horizon where manufacturers can become service providers. An example would be the services account for 85% of the sales of GE, which historically has been a manufacturer. Dell has been a computer manufacturer but nowadays realizes greater profitability from its service operations (Fitzsimmons & Fitzsimmons, 2004). It is observed that in all the three aspects of environmental, economic and socio-ethical level, a PSS proves to be well balanced to meet all the requirements. In an economic point of view, PSS can be more viable in the market by providing more values to companies and customers (Baines et al., 2007). It also enhances opening up opportunities and new business niche even in saturated markets (Isaksson, Larsson, & Anna Öhrwall Rönnbäck, 2009). In an environmental dimension, it decouples the creation of value from only consumption of materials and energy in the current system and reduces the load on the environment. It opens up a new thinking where companies can make more profit if they meet the same customer demand by providing a total package of less energy and resource intensive product and service systems (Mont & Lindhqvist, 2003b). In a socio ethical dimension, PSS satisfies a client's needs and demands in a holistic way and provides a better quality of life for all the stake holders (Oksana Mont & Tukker, 2006).

2A.3.2 Classification of PSS

According to Prof. Tischner and Tukker,(2006) Product Service Systems can be classified into three categories:

- a. Product oriented PSS (POPSS)
- b. Use oriented PSS (UOPSS)
- c. Result oriented PSS (ROPSS)

In POPSS, the consumer owns the product and the company provides additional auxiliary services to ensure the performance, functionality and durability. For example, high tech products are added with service contract for maintenance,

repair, up keep and take back like the extended warranty. In the second type, UOPSS, the service provider owns the product and the customer buys only the function from the company through a service contract. Some examples for this would be the car sharing. In this case the company owns the product and maintains it and the customers just use it and give the charges for the usage. In the third type, the ROPSS, the customer is concerned only of the net result and not about how they are delivered. For example, some companies provide thermal comfort in the buildings and they don't sell any equipment for this. Another example would be contracts for pest free fields instead of pesticides (Brezet, Bijma, Ehrenfeld, & Silvester, 2001; Valencia, Mugge, Schoormans, & Schifferstein, 2015)

2A.3.3 Why PSS?

As summed up in the literature, the PSS approach has the advantage of the presence of the services component to include a product or a new service component marketed as a PSS innovation (Beuren, Gomes Ferreira, & Cauchick Miguel, 2013). PSS is considered in many aspects by many authors; as the combination of products, services and their relationships, as an innovation strategy to fulfil a customer demand and also as a sustainability tool seeking a balance between environmental, economic and social concerns. It is a strategic design method intended to integrate a system of products, services and communication based on new values of the organization, customers and the stakeholders, thereby creating an opportunity for changing the unsustainable consumption patterns (Shimomura, Nemoto, & Kimita, 2015). When a PSS helps in re-orienting the current unsustainable trends in the production and consumption practices it is usually referred to as a Sustainable or Eco-efficient PSS (Lindahl, Sundin, & Sakao, 2014; E. Manzini & Vezzoli, 2003). There are many examples of Eco-efficient PSS in the context of western countries from various industrial sectors like the Diddi & Gori textile flooring service, the Allegrini service added to detergent supply, the Kluber services added to lubricant supply, and the AMG solar heat selling service. Going through these examples we can observe that the component of radical innovation lies in the way how different technologies, more or less already existing and on the market, have been restructured in a novel manner. This implies new and innovative relationships

among the different social actors involved in the system, inclusion of new stakeholders and a closer relationship with customers. It is quite interesting to note the potentialities that this approach presents by producing synergies among profit, competitiveness, and environmental benefits particularly for a developing country like India where population is a huge barrier for sustainability in the aspect of material and resource consumption. If these products and services together within the framework of a system enable the user to achieve the desired satisfaction level, then customers would perceive PSS as a preferable choice which would also improve the dematerialisation strategy. As already mentioned in the introduction that developing countries should adopt new strategies of development rather than following the trail of the path travelled by the developed countries.

The benefits of the PSS are directed at stakeholders, the environment, and the larger society. For providers, the PSS increases competitiveness and improves the potential for innovation. For consumers, it lessens responsibility for such services as installation and maintenance as well as product disposal at the end of the useful life. The PSS also benefits the environment through dematerialization of products as well as planning for the life cycle of the system. Finally, society benefits in two ways: first, fewer natural resources are used, and second, new jobs are created to provide services to the products. Over the last few years, the concept of the PSS has increasingly gained attention and is growing into a dominating economic factor for many companies. Since the markets for many types of consumer goods are saturated, companies increasingly use services to differentiate themselves from competitors. These deliver benefit in providing increased value to customers.

In summation, based on the literature review in this sub-section the multidimensional dimensions of sustainability and the developments in evolution of concepts in sustainability have been examined. Further, the role of design and designers in making inclusive sustainability as an important criterion has been highlighted. In the context of the inter-relatedness of complex systems level engagements involved, it is proposed that the current developments of evolving design proposals taking into consideration a Product Service Systems (PSS) approach is being suggested as the methodology to be considered for design and design research.

In the next sub-section, we examine the relevance of these concepts and the challenges, opportunities and scope of their application to case examples in an Indian context. This will help to identify the focus of study for this research.







CHAPTER 2: LITERATURE REVIEW

SECTION 2B



SECTION 2B: CONTEXTUALISATION IN THE INDIAN CONTEXT

2B.1 Traditional Indian Practices and Sustainability

A visit to the many villages in India is an opportunity to find typical households which are truly versatile and self-sufficient units. They would grow their own food, build houses with the naturally available raw materials, manage its livestock, and have traditional Indian medicines for healthcare (Kalam, 2011). There are many indigenous conservation practices still popular in rural parts of India due to various reasons like imitation, religious beliefs or social conventions (Gadgil, Hemam, & Reddy, 1998). After going about deep into these practices, it can be inferred that the ancestors who have initiated these practices had a great quality of farsightedness and an urge to coexist and respect the nature.

Trudy Heller, president of Executive Education for the Environment, based in Swarthmore, Pa USA, recently visited India to assist in setting up an environmental management-training program at the Indian Institute of Management in Shillong, the capital of the state of Meghalaya, Northeast India. In an interview she was explaining her experiences in India where she was comparing the way the roads and pavements are cleaned in India and in America. In India, four or five women were employed for cleaning the driveway and walkways sweeping up the debris that had fallen from the trees from the previous night's rain. Each woman worked with a biodegradable sweeper made of broom grass, a locally grown agricultural product. In America the problem of removing debris from driveways and walkways would be managed with an entirely different solution. A single worker equipped with a gasoline-powered tool would be hired to blow the debris off the pavement. This solution would disturb the community with noise and air pollution, burn fossil fuel, emit carbon dioxide a greenhouse gas and provide employment only for a single individual. With sustainability as the standard, it is easy to see which one among these is the more "advanced" solution. She goes on to compare the way an average American produces four pounds of trash per day. In India, there was no trash can in rooms. She would collect trash on a shelf of her desk, and hand it to the woman who came to clean the room. This system was simplified and could be implemented in

India because of the absence of paper products that are abundant in the United States: paper cups, plastic lids, straws, tissues, paper plates, plastic spoons and forks, all manner of hand-outs and advertising fliers, brochures, schedules, announcements. Instead, Indians used "real" plates and cups that are washed and reused. E-mail worked just fine, a single copy of a newspaper was shared, and communication was often person-to-person. Measured against sustainability standards, it is easy to see which system is more advanced. If India, having 18 % of the world population as compared to the US population of 5%, starts adopting the same consumerist approach and starts to generate waste like the Americans, the 'collapse phase' wouldn't be very far for this planet. Heller is of the opinion that Indian managers should see themselves as leaders of the global green economy. People in the west have a lot to learn from them and need the wisdom of eastern traditional practices (Tirtha, 2009).

Environmental sustainability refers to the modes of life that do not depend on resources and practices that disrupt the web of life. *Community sustainability* deals with whether and how human groups and humans as a whole can meet their needs in ways that can be maintained over time while maintaining the health of the physical environment (Rist, Chidambaranathan, Escobar, Wiesmann, & Zimmermann, 2007). The sustainability-relevant values of traditional Indian cultures: Energy conservation for protection of natural resources and the respect and connection felt to the non-human creatures and world-features; a spiritual focus in which the manifested world is inherently linked to a spiritual plane; a sense of obligation to ancestors and to life yet to come; and a circular rather than linear view of time and events (Berkes, Folke, & Gadgil, 1995).

In the dominant western societies the local geography is not the centre of culture. In fact, remaking the land is valued. Capitalist economics is a dominant element which promotes commoditization of nature. They tend to look at the land, oceans, and rain only as physical features. Another segment sees humans as having the God-given right to use all aspects of the physical world purely for their own benefit. Sustainability can only be measured by the health of all natural beings and life forms. People traditionally understood and lived by the concept that it is in the

balance between the physical and spiritual worlds and the balance between earth, animals, and humans that the well-being of this world rests (Pesek, Helton, & Nair, 2006). They can tap energy from the nature, but only with care, humility, respect, and a sense of mutual obligation. Worship of nature-Sun, Moon, Earth, Air and water was not merely a primitive man's response to the fear of the unknown, but arose from the deep reverence shown to the forces of nature, which sustained and preserved human life on earth. It seems that developing such eco-centric ethics can only result in sustainability. In India there are so many examples of communities adopting an eco-friendly lifestyle approach. Auroville in Pondicherry is an example for the same (Kapoor, 2007). They as a community build ecological and sustainable living skills, learn about community and Indian culture, renewable energy systems, organic farming, teaching, medicinal use of indigenous plants and promote a holistic lifestyle. A traditional Indian household in the rural context has its own agricultural farms and animals. The wastes generated are consumed by the animals whose excreta are used as manures in the farms. This formed a cyclic web of life which had least use of plastic and generation of non-degradable wastes.

2B.1.1 India's Position in the Sustainability Arena

India's commitment towards sustainable development is reflected through a series of legislative, policy and institutional measures adopted nationally besides participating in multilateral environmental agreements, which integrate environmental, social and economic concerns (Government of India, 2011). Since the Earth Summit in 1992, Government of India has initiated many policies and programs in India to accelerate rural development, given that the majority of the population still lives in rural areas, and agriculture is the main source of livelihood. Sustainable development in India can only be achieved by full utilization of human resources. A large part of poor population of the country is engaged in agriculture, unless we increase their living standards, overall growth of this country is not possible. Debt traps in the country are forcing farmers to commit suicides. People are migrating to cities with the hope of a better livelihood but it is also increasing the slum population in the cities. Therefore rural population must be given employment and a chance to prosper without migrating to the cities (Kalam, 2011).

India could become a forerunner in the aspect of sustainability by understanding the implications of the best practices developed by the previous generations and adopting from those which are still relevant at this age.

2B.1.2 PSS in India –In the domain of Education, Food & Agriculture

In developing countries like India, many PSS already exists as a consequence of economic and cultural conditions, such as scarcity of access to products and resources, availability of large labour forces and locally focused culture and traditions (Ezio Manzini & Vezzoli, 2003) . Some examples in the domain of Food, Education and Agriculture are discussed below:

2B.1.2.1 Warana PURA Mission – A Socio-economic movement

One of the notable cooperative movements which were successfully implemented in the rural villages of India is the Warana Cooperative movement in Kolhapur district of the western state of Maharashtra. It was started as a sugar cooperative movement in the 1950s by a social leader Tatyasaheb Kore in the Warana region, an area which was socially and economically backward at that time (Kalam, 2011). It has evolved a cooperative framework which has implemented sustainable models covering a total of sixty nine villages based on the collective participation of the people in that region. Today Warana is one of the richest districts in India with a strong cooperative movement (Thadaboina, 2009). About 50,000 farmers live in 100 villages spread across 25,000 sq.km. The Warana complex is a hugely successful area of integrated rural development comprising of 25 cooperative societies, with an annual turnover of INR 6 billion. These societies are involved in the production of sugar and dairy products, poultry and construction. The main economic activity of the people here is sugarcane cultivation and sugar processing. This co-operative provides computer facilities and state of the art Information and Communication Technologies to the farmers of these villages. The main success of this cooperative movement was that it aimed at the integrated development of the whole community from the aspects of education, healthcare and economic growth. From a PSS perspective the Warana project is a sustainable model which has emerged out of the efficient design of Product and services using the state of the art ICT systems,

services and above all an effective system weaving all these features together. The environment conducive for a PSS to flourish prevalent in the context of an Indian village is the shared use of products because of the cultural norms prevalent there and the lower labour costs which are a mandatory requirement of an effective PSS for a labour intensive context. As mentioned by Manzini and Vezzoli (Ezio Manzini & Vezzoli, 2003) the critical issue for developing countries now, is to improve the social and environmental quality of PSS business in those countries. They have suggested that it is essential that the PSS projects should gain access to information and knowledge from the best and most advanced technologies, which have the potential to make these businesses really economically and socially appealing. Warana mission had made the best use of this by adopting the best available technology for its efficient resource consumption.

2B.1.2.2 Mumbai Dabbawalas

Another example of a successful PSS in the Indian context is the Mumbai Dabbawalas. They are a group of “tiffin suppliers” who have been coordinating the delivery of home-cooked lunches daily from the individual homes of office goers to thousands of Indian office goers in the city of Mumbai, for over a century. This informal sector was capable of developing an urban logistics system that was precise, reliable and affordable to a large middle class workforce in Mumbai (Baindur & Macário, 2013). The delivery system of the dabbawalas is so efficient that in 1998, Forbes Global magazine, conducted a quality assurance study on the Dabbawalas' operations and gave it a Six Sigma efficiency rating of an incredible 99.999999. The Dabbawalas made one error in six million transactions. The dabbawalas operations originated way back in 1890 when India was under British rule; a period, during which people belonging to different communities, from the different states across India migrated for work to Mumbai. During this period there were no canteens at the work place and many did not carry their lunches from home. Besides, different communities had different food habits, tastes and preferences which could only be satisfied by a homemade meal. Identifying this need, a gentleman named Mr. Mahadeo Medge started this lunch delivery service (Jampani & Dutta, 2004; Pathak, 2010). From a PSS perspective this traditional

delivery system continues to use minimum resources as the 'dabbas' used as packaging boxes are reused; Manual handcarts and bi-cycles used for transport consumes no fuel; The systems integrates the use of the existing metro train network for distribution and makes the best use of the available manpower and labour. From an environmental perspective the process focuses on reducing energy use and toxic emissions by using public transport; enhancing reuse of materials by reusing the same dabba again and again. In the socio ethical aspect the system enhances workplace conditions by providing a good place for employee development through mentorship and trust and also provide home cooked food to millions of people at the workplace in a non-disruptive manner(Nishesh Patel, Vedula, 2006).

2B.1.2.3 Amul Movement – Operation Flood

Anand Milk Federation Union Limited (AMUL), a successful dairy cooperative model through its innovative practices has made India the world's largest producer of milk. Through the cooperative mode it has simultaneously developed the producers and suppliers and have synchronised the demand and supply of the product to emerge as a successful business model (Chandra & Tirupati, 2003). It is an example of how to develop a network of firms in order to overcome the complexities of a large yet fragmented market like those in emerging economies by creating value for suppliers as well as the customers. Uniting the small scale farmers with a decentralized milk collection centres and then transporting it to the dairy became the initial mode of operation of Amul. The network grew from milk producers to Milk collection cooperatives (Village Societies) to dairy cooperatives (Union) which are all managed by the Federation members. This was the business model adopted by Amul. This gives the farmers an assurance of a guaranteed purchase of all the milk that they produce at a pre-determined price. The AMUL had also a social role in reducing the social and economic inequality in that region with its operational effectiveness. It was also successful in combining the market and social development in an emerging economy (Nalini Kumar, 1997). A coexistence strategy, in the socio ethical aspect, of ensuring that the benefit reaches a large number of people both suppliers and consumers was adopted. It also adhered to deployment of technologically advanced

resources for becoming economically independent to face the stiff competition from the market. When studied in detail, it was observed that Amul had a very significant contribution in the social as well as economic development of that region in terms of the sustainable parameters.

2B.1.2.4 AkshayaPatra Foundation & Mid-Day Meal Scheme (MDMS) in Primary School Education

Launched in 1995, by the government of India the National Programme of Nutritional Support to Primary Education which aims to provide cooked mid-day meals to all government and government aided primary school children. Today MDMS provides cooked meal to approximately 0.12 billion school children making it the largest school feeding programme in the world. This scheme requires a large system and coordination in place to carry out the preparation of food in the school campuses. The Main advantages of this system are the increase in school enrolment, school participation among girl children, curbing of classroom hunger, better performance of students and social equality when the school children from different castes and religion sit together and share a common meal (Reetika Khera, 2006). Organisational concerns are posing serious problems to the smooth operation of MDMS. For example the impracticality of providing kitchen facilities, utensils, fuel, water and manpower in all the schools and managing it is a big challenge which is pulling this whole system to perform well (Drèze & Goyal, 2003). Due to these reasons many Non-profitable organisations like the AkshayaPatra Foundation and the Adama Chetana Trust and similar organisations have come forward to help the government in accomplishing this task of MDMS. They have set up large base kitchens in different places and are distributing cooked food to the schools in specially sealed vehicles. The logistics and inventory management in these cases are being handled by professionals who give it an image of an efficient network. They are also performing well in terms of the sustainable parameters which are being discussed in detail in the third chapter.

2B.1.2.4 Indian Railways Catering System

Catering is one of the main amenities provided by Indian Railways to its passengers. Indian Railway catering Service provides food to railway passengers both during the journey as well as halts at different railway stations. Travelling by train for long distances can be very tiring; hence a constant supply of a variety of refreshment choices helps to keep the journey less tedious. On-board meal services are also provided on long distance trains.

A train journey from Guwahati in the east to Kerala in the south; can easily take about 60 hours of journey time. One can imagine the importance of the necessity of extending catering facilities during these long journeys. Such a service can result in train journey as the more preferred mode of transport for the common man in India. It can be stated that the catering service of IR has a much hidden significance and relevance in influencing the choice of travel in the lives of millions of common people in India. However, currently the catering system also has some evident problems. The present catering system in IR follows out-dated use of equipment and processes in preparation of food. It uses large quantity of non-degradable materials like plastic in serving food, which after single use are thrown to open tracks and becomes waste and pose a burden to the environment. Modes of transportation, maintenance of equipment offer scope for considerable improvement. Therefore, a systems study of the catering system has a large scope of improving the eco efficiency and aligning itself to become a more eco-friendly system.

There are other examples of small organizations working in the direction of sustainability, e.g. Cost-ford, founded by Laurie Baker and Auroville, at Pondicherry, works in the direction of sustainability in Architecture (Pereira, Aleixo, & Guedes, 2011). However among these different examples of various systems examined through the above case examples, the importance of the Indian Railways and its contribution as a means of mass transportation in the economic growth is a well-accepted fact. The reach of the Indian Railways to masses, the scope of scalability and also the possibility of policy level adaptation in other government organizations offers itself as an interesting case for further research. In a populous country like India where quantity often dominates quality, a service provider like Indian

Railways has a pivotal role in providing superior services as well as satisfying the socio ethical responsibilities. Owing to its large impact and the future potential, the problems related to the Indian Railway Catering service can be looked into and addressed. On the sustainability front, there seems little research being reported in this area and therefore offers scope of a systems level study of the Indian Railway Catering system that can be undertaken. A PSS approach can be examined considering not with only the environmental and economic but also the socio-ethical dimension for emerging and developing countries/contexts (C Vezzoli, 2010b). This research can have immense social relevance in India and amongst the developing/emerging context. This prompts us to select the Indian Railway catering system for our further study in the section to follow.

2B.2 Indian Railways - Overview

Indian Railways, abbreviated as IR, is a Department of the Government of India, under the Ministry of Railways, and is tasked with operating the rail network in India. The Railway minister heads the ministry, while the department is headed by the Chairman Railway Board. Indian Railways is not a private corporate body; however, off late IR has adopted a corporate management style which makes it more responsive to changes. It is one of the largest and busiest rail networks in the world, transporting 21 million passengers and more than 2.54 million tonnes of freight daily (Indian Railways, 2011). IR is the world's second largest commercial or utility employer, with more than 1.6 million employees. The railways traverse the length and breadth of the country; the routes cover a total length of 64015 kilometres. As of 2010, IR owns a total of 222,379 wagons, 42,125 coaches and 7910 locomotives and runs a total of 14,444 trains daily, including about 9000 passenger trains.

2B.2.1 History of Indian Railways

In 1844, the then Governor General of India Lord Hardinge allowed private entrepreneurs to set up a rail system in India. East India Company assisted in setting up the manufacturing units. Interest from investors in the UK led to the rapid creation of a rail system over the next few years which resulted in rapid growth of modern factories for the production of cotton and jute fabrics, and the expansion of

the coal mining industry to support these (Morris, 1963). The first train in India became operational on 22 December, 1851, and was used for the hauling of construction material in Roorkee. A year and a half later, on 16 April, 1853, the first passenger train service was inaugurated between Bori Bunder, Bombay and Thane, covering a distance of 34 kilometres. This was the formal birth of railways in India. In 1901 the railway board was constituted and in 1907 all private companies were taken over by the government (Srinivasan, Tiwari, & Silas, 2006).

2B.2.2 Indian Railways Today

Today IR is one of the major infrastructural building blocks of the Indian economy combining all major functions of a conventional railway system. They build and maintain infrastructure assets like track, electric traction, signalling systems, telecom network, stations and terminals etc. Apart from operating goods and passenger trains, they operate suburban trains in various metros. The IR manufactures locomotives, coaching stock, wagon and components of rolling stock like wheel and axle. They run workshops to maintain its rolling stock and are also involved in activities like catering, tourism etc. Indian railways have the manufacturing plants often called production units, located at different parts of the country. Many cities in India have their suburban railway networks to cater to huge passenger commutation (Pucher, John, 2004). At present suburban networks operate in metro cities like Mumbai, Chennai, Kolkata and Delhi. Kolkata was the first city to run a sub-terranean rapid transit system in the year 1984 followed by Delhi in 2002 which has made this a very popular mode of commutation in the city among the common masses. Apart from this, rapid transit systems are soon to begin in Kochi, Hyderabad, Bengaluru, Chennai, Ahmedabad and Mumbai.

Indian Railways makes 70% of its revenue from the freight sector. Since the 1990s, the Indian Railways have switched from small consignments to larger container movement which has helped to amplify its operations. Most of its freight earnings come from such rakes carrying bulk goods such as coal, cement, food grains, iron ore, mineral ores, fertilizers and petrochemicals and agricultural produce. Ports and major commercial areas have their own dedicated freight lines

and yards. Many important freight stops have dedicated platforms and independent lines.

2B.2.3 Railways – More scope for growth

Comparing the performance and growth of the railways in China and India we see a very disheartening attitude of neglect for the Indian Railways after the British left India. The first train in India was run in April 1853 between Bori Bunder and Thane (21 miles) while that of China was in 1876, from Shanghai to Woosung (15 miles). When India attained independence, India had 53596 route kilometres of track as compared to China which had only 27,000 route kilometres of track. But the state of affairs as of now in China has 78,000 route kilometres as compared to a stagnant 63,327 route kilometres of India (Ramnath Rangaswamy, 2008). **Table 1** below shows the comparison of Indian and Chinese Railways

Factor	Indian Railways	Chinese Railways
Route Kilometres (1947)	53396	27000
Route Kilometres (2008)	63327	78000
Freight Carried (billion MT per year)	750	3300
Passenger carried (billions per year)	6.2	1.4
Investment per year (Rs billion)	375	1500
Employees (million)	1.7	3.18
Speed Freight Trains (km/hr)	100	120
Speed Passenger Trains (km/hr)	160	300

Table 1: Comparison of Indian and Chinese Railways

India, with its wide expanse of land area, makes transportation a vital infrastructure for both economic and social development. It is critical for internal security, movement of forces in case of emergency, movement of goods and raw materials, promotion of culture, etc. The paradox of this country is that some parts of India are highly developed industrially and commercially, while there are other remote areas that are still twenty or thirty years away from our present standards of development; backward precisely. Distribution of employment opportunities are

not evenly done, which necessitates migration of labours from one part of the country to other parts. The sleeper and general compartments of the trains starting from Assam, Bengal, Orissa and Bihar towards south India are always jam packed with passengers even sitting in the vestibule area in front of the toilets throughout the whole journey of 2-3 days.

People employed in the various central government offices and PSUs all over India need to visit their families, and home town during holidays, which makes travelling a part of life. India being a religious country many people goes on pilgrimage every year to various distant holy places. All these situations demand high speed transport of goods and passengers with reasonable comfort. Indian Railway is one of India's most effective networks that keep together the social, economic, political and cultural fabric of the country intact. Be it cold, mountainous terrain or the long stretches through the Rajasthan desert; Indian Railways cover the vast expanse of the country from north to south, east to west.

Referring to the table above, during the last 50 years of Independence, we can see that the Railway sector has been largely neglected. It is well known that, from the fuel efficiency and economic point of view, rail transport is ideal for long distance movement and road transport for short distance. In reality, many times due to lack of accommodation available in trains, people are compelled to go by bus for their longer journeys. There are regular private buses from Bangalore to distant locations, such as Hyderabad, Mumbai, Chennai and Kerala. For operational convenience, the Indian Railway network is divided into 17 zones. These zonal railways are the basic operational units for planning freight and passenger services(K.V.Ramani and B.K.Mandal, 1992). The **Table 2** below shows these zones and their headquarters.

Name	Abbreviation	Headquarters
Central Railway	CR	Mumbai
Eastern Railway	ER	Kolkata
East Central Railway	ECR	Patna
East Coast Railway	ECoR	Bhubaneswar
Northern Railway	NR	New Delhi
North Central Railway	NCR	Allahabad
North Western Railway	NWR	Jaipur
North Eastern Railway	NER	Gorakhpur
Northeast Frontier Railway	NFR	Maligaon(Guwahati)
Southern Railway	SR	Chennai
South Central Railway	SCR	Secunderabad
South Eastern Railway	SER	Kolkata
South East Central Railway	SECR	Bilaspur
South Western Railway	SWR	Hubli
Western Railway	WR	Mumbai
West Central Railway	WCR	Jabalpur
Kolkata Metro		Kolkata

Table 2: Different Railway Zones of Indian Railways

IR follows a clearly demarcated hierarchy. (Refer **Figure 1**)

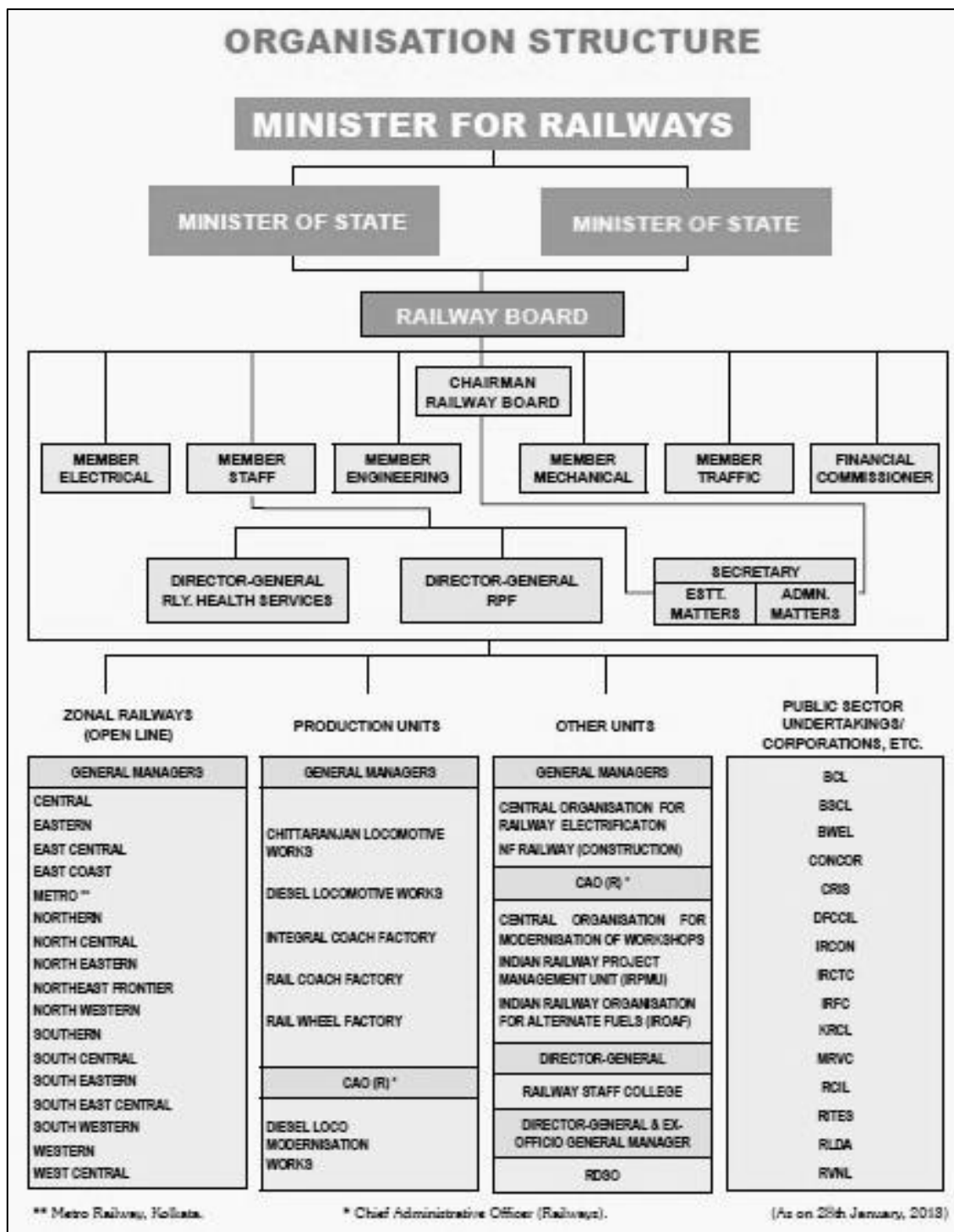


Figure 1: Organizational structure of Indian Railways

(Source: Ministry of Railways (Railway Board) CMS Team Last Reviewed on: 20-09-2013)

Since its commencement in the nineteenth century, the railways in India have been contributing a significant share to the growth of the Indian economy. The social and economic development of the country also depends to a large extent upon

the Indian railways. The Indian railways had an interesting historical turnaround in its fortunes in the recent years, largely due to the aggressive responsiveness of the organization to align itself to the strategy of striking unit cost and at the same time higher social obligations as a preferred carrier by providing affordable transport service to the masses. According to Prof. Raghuram, (2007) IR had a dark phase when there was a prediction of bankruptcy threat, as per the report of Expert Group on Indian Railways (also called the Rakesh Mohan Committee report), submitted in July 2001 which studied the IR for nearly two years (NCAER, 2001). They had stated,

“Today IR is on the verge of a financial crisis... To put it bluntly, the ‘business as usual low growth’ will rapidly drive IR to fatal bankruptcy, and in sixteen years Government of India will be saddled with an additional financial liability of over Rs 610 billion. On a pure operating level, IR is in a terminal debt trap.”

Surprisingly, IR has made a dramatic turnaround in the recent years. This renaissance was crafted due to the implementation of simple entrepreneurial practices which shows the responsiveness of the Indian Railways. Now, it is the second largest profit making PSU after ONGC. The total fund balance crossed Rs 120 billion in 2005-06 which was an all-time low of 1.49 billion in 1999-2000. The determinants of this turnaround as the total earnings of Rs 71.2 billion could be attributed to

- (i) goods earnings of Rs 55.09 billion (17.9% increase on a base of Rs 307.78 billions),
- (ii) passenger earnings of Rs 10.13 billion (7.2% increase on a base of Rs 141.13 billion) and
- (iii) Other earnings including parcel, catering, advertising etc. of Rs 5.99 billion (24.2% increase on a base of Rs 24.79 billion)**

In 2005-06, out of the total earnings, goods constituted 67%, passengers constituted 28% and others 6%. During 2009-10, IR carried 7246 million passengers as against 6920 million in 2008-09 thus registering a volume growth of 4.7%. Passenger earnings increased by Rs 15.47 billion, a 7.1 % increase in comparison with 2008-09

(Indian Railways, 2011). It is against this challenging backdrop that IR has achieved a turnaround even while maintaining its social responsibility as a national carrier. The then railway minister Mr Lalu Prasad Yadav played a vital role in leading the IR for this fantastic comeback (Raghuram, 2007). The implementation of the various strategies depended significantly on the leadership style of Mr Yadav. Initiatives of market oriented tariffs; asset utilization and competition in container movement, all goes to his credit.

Indian Railway's operations are characterized by mixed traffic –both passenger and freight trains share the same track and infrastructure. Passenger trains constitute nearly 70% of the trains run but contribute to less than 35% of the revenue earned, while freight trains constituting only 30% of the trains, make up 65% of the revenue. Even though earnings through goods are more, on track passenger trains are given priority. In fact, it can be fairly stated that in the post-independence period, being the backbone of the country's transport system, the performance of Indian Railways has been assessed more in terms of success in achieving the social objectives set for them by politicians, rather than profit earning (M. Q. Dalvi, 1995). According to researches carried out in several cities of the world, most commuters express their level of dissatisfaction with the quality of services provided or supplied. Indian Railways are not an exception either. This is highly attributed to the rapid urban population growth resulting in a rise in the demand which various transport systems are unable to meet efficiently and effectively (Ngatia, Okamura, & Nakamura, 2010). Catering for the Indian Railways is one of the most important passenger amenities which determine customer satisfaction in long distance trains. The Indian Railways has realised this and have incorporated their responsibility in the 'Citizen's Charter on Passenger Services in Indian Railways'. The charter promises catering services through mobile and static units (Indian Railways, n.d.). To go about the research on the IRCS, the nearest railway zone was selected, which is the Northeast Frontier Railways.

2B.2.4 Northeast Frontier Railway (NFR)

Since this research deals with a systemic study of the existing catering system in the Indian Railways, the zone selected is the Northeast Frontier Railways

headquartered at Guwahati as it is accessible, since the location of its headquarters at Maligaon is close to the IIT Guwahati Campus. The approach adopted is 'Literature Search supplemented by findings from Field Visits and Surveys'.

History of Northeast Frontier Railway

The Northeast Frontier railway was formed on 15th January, 1958 with an aim to stimulate the development of the Northeast region with its headquarters at Maligaon, Guwahati. The N.F. Railways is the smallest railway zone in the country. The N.F. Railways serves as many as ten north eastern states, besides providing interchange facility with Bangladesh and serves as railhead for Nepal and Bhutan. With the completion of the Saraighat Bridge, the first rail-cum-road bridge over river Brahmaputra in the year 1962, a modern era of rail transport had dawned in Assam and northeast India, opening a new horizon of progress and development.

The Departmental set up at the head quarter level & divisional set up in the field, assists the general manager for running the railways. Various departments namely, engineering, mechanical, electrical, signal & telecom, operations, commercial, safety, accounts, security, personal & medical- headed by a senior administrative grade/ higher administrative grade officer- provide technical and operational support to the divisions in train operations. Northeast Frontier Railway has five divisions namely, Tinsukia, Lumding, Rangiya, Alipurduar & Katihar. At field level these divisions are directly responsible for train operations and reports to the general manager. Each of these divisions is headed by a Divisional Railway Manager (DRM), a senior administrative grade officer of the rank of the joint secretary to the government of India. **Figure 2** below shows the organizational structure of the NFR.

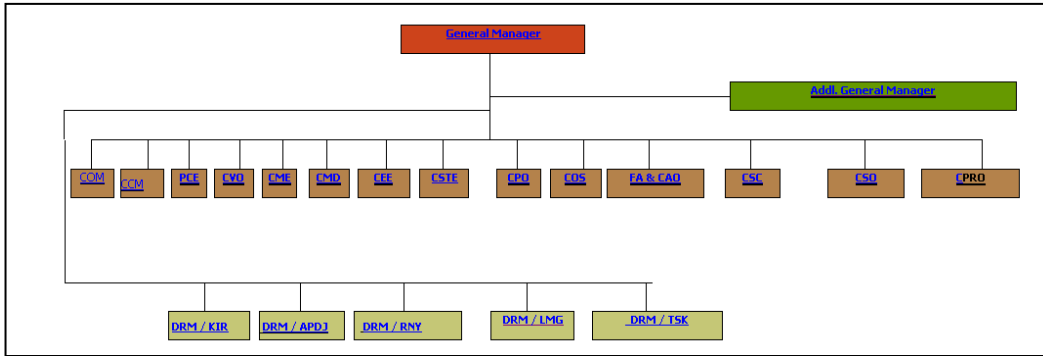


Figure 2: Organizational structure of NF Railways (Source: NFR website)

2B.3 Catering Services of the Indian Railways

Catering started in 4th millennium BC in China, to provide food for soldiers on trade routes, Christian pilgrimages to Rome and other travellers. During the middle ages, catering spread throughout Europe and evolved to entertainment purposes for the upper classes. Catering and food services became so popular in the 14th and 15th century that Germany was the first country to put laws in place regulating the quality of both food and beverages. The term “catering” was first coined by the Merchant Marines. Merchant ships were among the first vessels to employ catering officers. Their duties consisted of the purchase of goods, food preparation, and service of meals and drinks to officers, crew, and passengers. They were also responsible for various other duties related to the ship's function. During the 19th and 20th century many more technical innovations, improvements in transportation, and growing populations helped catering become an important part of the national economy. Today catering has evolved from simply providing food for travellers to presenting exotic food in a visually appealing atmosphere (University of Connecticut, 2009).

Earlier, IR was providing catering and tourism services on its own, which was growing to quite a responsibility. So, as a part of Indian Railways’ wider organizational reforms to strengthen its marketing and service capabilities in the areas of rail catering, tourism, hospitality and passenger amenities, a corporate entity Indian Railways Catering and Tourism Corporation Limited (IRCTC) was formed in the year 1999. The Corporation was given the mandate to stimulate PPP in hospitality industry which they have successfully done in the areas of food plazas

and internet ticketing. The IRCTC was responsible for managing and supplying the entire catering services for the railways. It is a Public Sector Enterprise under the Ministry of Railways, which was incorporated on 27th September, 1999 as an extended arm of the Indian Railways to upgrade, professionalize and manage the catering and hospitality services at stations, on trains and other locations. The corporation also works towards the promotion of domestic and international tourism through the development of budget hotels, special tour packages, information & commercial publicity and global reservation systems. IRCTC has also made a significant mark in its passenger services oriented business lines like setting up of food plazas on railway premises, 'Railneer', Rail Tour Packages and 'Internet Ticketing' bringing a great deal of professionalism into the operations. In addition to the above, IRCTC is managing On Board Catering Services in Rajdhani, Shatabdi, Duronto, Mail Express Trains and Static Catering Units such as Refreshment Rooms, AVMs, Book Stalls, Milk Stalls, Ice Cream Stalls, Petha & Peda Stalls etc. across the Indian railway network.



Figure 3: Inside View of Pantry Car kitchen

In the year 2005, after a cabinet decision, the whole catering business of Indian railways were progressively transferred to the IRCTC through the catering policy. But now, IR is going to modify the policy because of the poor public image created

by IRCTC for the food in trains and the increasing number of complaints received from the passengers about the food provided in the trains and platforms. (Refer **Figure 3** above). The IR realized a need for modification to improve the quality of their services to the passengers through mobile catering and static catering services on railway premises and platforms (Verma, 2010). According to the new catering policy 2010, all existing major and minor catering unit contracts will be given to the zonal railways, except Food Plaza, Food Courts and fast food units. All such contracts presently being managed by IRCTC, on expiry of the contract period, will be given to the zonal railways. The IRCTC will not renew any contract required to be handed over to zonal railways on expiry of the contract. According to (Ashima Goyal, 2008) Indian Railways as a service provider is not performing well in respect to maintaining quality and servicing the poor as a public railway service.

Railways shall progressively take over management of all mobile catering services including base kitchens and mobile catering through departmental catering in phases. The Railway Board shall determine the menu and tariff for the standard meals, breakfast, tea, coffee and catering charges for meals, etc., which are included in the fare. Zonal Railways will determine the menu and tariff for all other items including a-la-carte items and Jan Ahar outlets. IRCTC will only be primarily responsible for running Food Plazas, Food Courts and fast food units within the ambit of this policy.



Figure 4: Platform sale of food in 1945

(Photo Courtesy: Hensley Photo Library, at the Digital South Asia Library of the University of Chicago From scenes en route Howrah to Madras, summer of 1945)

The Indian Railways serve both vegetarian as well as non-vegetarian food on board. It also takes care of the religious values of the passengers, for which they firstly inquire about the preferences of food before serving them. Most of the long distance trains contain a pantry car facility till recently where a decision has been made to phase out Pantry cars in trains and promote Base kitchen catering due to the increasing number of fire accidents reported in the recent years (Ministry of Railways, 2010). Meals, snacks, coffee, tea (chai), cool drinks etc. are served in the train through the pantry. The pantry staff moves around the train with the supply. The food served is hot as it is prepared in the pantry car of the train. A variety of snacks are also available in the trains for the commuters en route. Vendors too ferry periodically in the compartments with packaged foods, mineral water, cold drinks, tea and coffee (Refer **Figure 4** above). A variety of snack bars and refreshment stalls that operate at platforms and stations offer a variety of hot and cold food products. A taste of the local flavours push in to the meals of travellers when hawkers sell their eatables when the trains halt at the stations. Anything is available for sale inside a train and at a station platform. From toys to bed sheets to fruits to shoe polishing service to dried fruits, everything is available at your seat. Majority of the vendors may not be approved by the Indian railways. Indian railways have now made the platforms a cooking free zone. So in major stations the stall contractors would have a base kitchen located nearby and would prepare food and snacks there and transport it to the platforms. When a train reaches a station the vendors come to the windows carrying and shouting what they have to sell. A train is a super market on the move. They are the part and parcel of the system. The food provided by the Indian Railways is fairly tasty, filling, and cost-effective but needs better quality control and stability. IR needs to develop a comfortable contemporary ambience with good quality, multi-cuisine and moderately priced food.

Though the earnings through catering are low, the increase in the passenger earnings is partially due to the improvement in the services of the catering. Catering and food service though, accounts comparatively less in earnings as compared to goods and passenger earnings, and is a huge generator of waste to the environment. On long-distance routes, the trains have a pantry car, and tray-full of fresh hot meals served in first, second, third AC compartments and the sleeper classes. When

finished, empty trays are collected by the porters and taken to the space between the bogeys, where there is a small opening to the tracks and the trash – leftover food, plastic bags, aluminium containers, plastic cups – are dumped from the moving train, littering all the way. The dust bins on trains, one at either end of the bogey, have a very small capacity. They quickly fill and overflow; and spill onto the floor, encourages the passengers to throw in more trash in the track.

2B.4 Income distribution from Catering services

The challenges faced by the IRCTC are, to provide catering services to more than two and a half million passengers daily maintaining the uniformity in food quality, better service, maintenance of pantry car equipment and provision of catering services during the late running of trains (www.irctc.com). The total number of static catering units in the year 2010 is approximately 11580 and 285 pairs of trains through pantry cars. Apart from this in the same year on 25th Jan, Aahar outlets were commissioned to provide low cost wholesome food and regional cuisine at affordable prices.

Table 3 below gives key statistics, including earnings from catering. As evident, there has been an increase share of private participation and the consequent earnings from license fees.

Catering Statistics	2001-02	2002-03	2003-04	2004-05	2009-2010
Total no of pairs of trains catered	228	231	234	250	285
Pairs of trains continuing as departmental	43	39	38	12	05
Static catering units	3152 stations	3152 stations	3152 stations	9270 units	11580 units
Sales turnover of departmental units (Rs billion)	1.96	2.02	1.72	1.91	1.5006
License fee (Rs billion)	0.23	0.26	0.29	0.59	2.0530
IRCTC income (Rs billion)	--	0.37	0.42	0.76	

Table 3: Earnings from Indian Railway Catering services (Source: indianrailways.com)

A recent study carried out by the Central Pollution control board on the Delhi railway station reveals the following facts. Delhi has three major railway stations (H.Nizamuddin, Old Delhi and New Delhi Railway Stations), which cater to the maximum commuters of National capital Region (NCR). In all, about 522 trains originate from Delhi stations. The total number of passengers served at these three stations are 725000 per day i.e.; the passengers served annually are about one fourth of India's population. There are about 42 platforms, 146 vendors at these stations to meet the passenger's requirement. About **6758 kg/day** of plastics waste is generated in these three railway stations, of which 30% of the waste comes from the value added plastics of the catering units, like the water and soft drink bottles (Board, 2009). Rag pickers, collect only value added plastics waste such as pet bottles etc. However, plastic carry bags and low quality plastic less than 20 micron do not figure in their priorities, because collecting them is not profitable. This is primarily because the effort required to collect them outweighs the reward they get. This leads to plastic bags and other packaging materials to grow into a major threat to the environment (Narayan, 2001). More over the major concern for this waste stream is that these are non-biodegradable and remain in the environment for several years. Clogging of drains from plastic waste is a common problem in railway premises.

Various scholars have identified the attributes that passengers use to evaluate the service quality of Indian Railways as reliability, assurance, empathy, tangibility and responsiveness. It was identified that among these employee behaviour was the most important determinant of passenger satisfaction (Geetika, 2010). According to the Census survey of India, 2001 about one third of the population are illiterate and about 37% of people are living below the poverty line. For these masses, Indian Railways are the only affordable mode of transportation. In the absence of a competitor, IR has become a monopoly and can afford to neglect aspects such as quality of service and customer satisfaction. In the paper by (Geetika, 2010) it was identified that the service of the Indian railways can be divided into three broad categories; ticketing, on-board services, and facilities at platforms. The IRCTC has made improvements in ticket dispensing by introducing computerized reservation system in large number of stations. It is also noted that the railway enquiry counters

also play a major role in passenger satisfaction. The way in which the passenger queries are answered, the time taken for addressing them, and the rush near the counters, how clear and legible the information are displayed etc. But the Indian Railways enquiry system is not very efficient at present in this regard. In their paper, the authors have identified that services at platforms are most important as passengers have to spend more time in the platforms and waiting halls when trains get delayed. It is a common scene in the Indian railway station platforms that the passengers sleep on the floor when the train is delayed by long hours. No such measures are taken keeping in mind this unanticipated scenario. This aspect is neglected by the researchers and they have selected this as their topic of research in the paper published in the journal of public transportation. In this paper a study has been attempted to determine customer perceptions of satisfactory service quality at railway platforms. The results provide statistical evidence to support identified determinants of customer satisfaction as refreshments, safety and security, basic facilities, information system, and behavioural aspects of service quality.

The aspect of refreshments includes the availability, quality, quantity and affordability of food available to the passengers on railway platforms. Passengers consider refreshments as the most important aspect of satisfaction with service quality of Indian Railways. The aesthetics involved in refreshment is not only the customer satisfaction but also the environment effect involved with this factor as they generate more trash which is thrown to the tracks. In an environment point of view a system which caters to millions of passengers in the scale of its operation, the catering system commands all respect to be treated more seriously in both planning and execution. (indianrailways.gov.in)

This research attempts to study the Indian Railways Catering systems from a sustainability point of view. In the catering sector, sustainability development has two aspects; the conceptual views and the pragmatic views. There has always been a conflict in the communication between the policymakers and the catering managers regarding the smooth execution of these two aspects in the catering industry. Adopting organic food or slow food for achieving the sustainability targets have been a common process followed by the authorities but whether organic food or

slow food is the best alternative from a sustainability point of view is always in conflict (Anna Post, 2011). The importance of seeing catering as a food system is also critical in terms of the assessment from a sustainability perspective (Dahlberg, 1993). Food supply chain is seen as a linear pathway of only simple connections where as a food system has a more complex interconnection with a feedback loop towards all the stakeholders. A system study of the catering system would involve the complex challenge of identifying the human activity and the communication involved in these systems (Yakovieva, 2009). This research identifies that very few literatures are available which has carried out a holistic study of the catering systems from a cradle to cradle approach. This makes our research more relevant in the context of a socially relevant system like the Indian Railways. This needs a comprehensive sustainable system design tool and assessment technique to assess the system from all the angles.

In sub-section 2C to follow, we will explore the different tools for the assessment of sustainability to help identify the one that is suitable for this research.





CHAPTER 2: LITERATURE REVIEW

SECTION 2C



SECTION 2C: MODES OF ASSESSMENT OF SUSTAINABILITY

2C.1 System Design and Sustainability Assessment

In the area of sustainability and sustainable development, the main three questions usually asked are: what is to be sustained, what is to be developed, and the intergenerational component. The identified three areas to be sustained are nature, life-support systems and community (Parris & Kates, 2003). This is furthermore derived into three ideas which are to be developed: people, society and economy. Lastly, the intergenerational component is critical because specific sustainability goals must explicitly express the time-horizon for which the goals are to be achieved (Kasemir, Jaeger, & Jäger, 2003).

Defining sustainability is not simple because it must be applicable to many ecological and social situations. It is considered as a system property (Gaziulusoy, 2015). Definitions of sustainability usually end up as a list of preferred characteristics, most often pertaining to the global socioeconomic system in the context of its ecological life support system. For example, most definitions of sustainable development contain elements of: (1) a sustainable scale of the economy relative to its ecological life-support system; (2) an equitable distribution of resources and opportunities between present and future generations; and (3) an efficient allocation of resources that adequately accounts for natural capital (Robert, Costanza, Bernard, C., & Patten, 1995).

As the topic of sustainability has gathered immense importance in the last few decades, scientists, researchers and organizations are placing more emphasis on how sustainability is measured. Using sustainability as a metric generally means an expansion of the traditional system to take into account the social and environmental performance in addition to economic performance. These three key principles should be measured, but they do not, themselves, provide a measurement system. Therefore, many organizations are developing organization-specific or industry-specific measurement tools and best practices to help them achieve the appropriate balance across Social, Environmental and Economic principles.

2C.2 Classifications of Sustainability Assessment

Both qualitative and quantitative research methodologies are popular in the field of sustainable development. It is often considered that the quantitative approach and indicators-based tools are extremely valuable for measuring sustainable development. But the problem with these type of quantitative assessment is that it fails to bring into question the nature of the human relationships, including the interweaving of the objective and the subjective, that go into creating a community on sustainable terms (Gasparatos & Scolobig, 2012; Hacking & Guthrie, 2008; Scerri & James, 2010; Shaffer, 2013).

Sustainability assessment approaches can be categorised based on numerous factors such as the temporal characteristics, the focus area and the integration of nature –society systems. The temporal characteristic is whether the tool evaluates after the development or whether it is used to predict the future. Classification according to the focus area shows whether the emphasis is at the product level or at the policy level and integration of nature society system which sees to what extend the tool fuses environmental, social and economic aspects. The classification of sustainability Assessment tools as explained by (Ness, Urbel-piirsalu, Anderberg, & Olsson, 2007) is shown in **Figure 5** below.

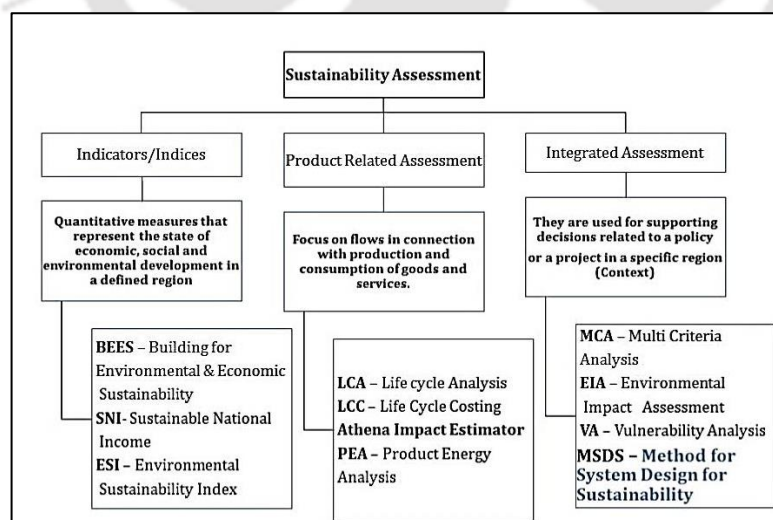


Figure 5: Classification of Sustainability Assessment (modified) (Courtesy: Ness, Barry, et al 2007)

The indicators/Indices are more of retrospective in nature while the integrated assessment tools are more of a prospective in nature. According to Gough (1998) many of these integrated assessment tools are based on systems analysis approaches and integrate nature and societal aspects. There are many examples of integrated assessments of major environmental problems, but also established tools such as Multi-Criteria Analysis, Risk Analysis, Vulnerability Analysis and Cost Benefit Analysis that do not necessarily pertain directly to sustainability issues alone, but can be extended to a variety of other problem areas across disciplinary thresholds (Ness et al., 2007).

OECD has developed social indicators, which provide objective measures of the conditions in which people live, the factors shaping these conditions and the actions taken by governments to preserve and improve them. These are grouped under four broad policy objectives: enhancing the self-sufficiency of individuals, promoting equity in social outcomes, improving the health of populations, and securing social cohesion (OECD, 2008).

The existing tools and methods available to the designers are only fit to control a product or manufacturing based design process, where the main components as well as the process can be clearly defined. But the design process in case of a PSS focuses on the system and is dependent on a network of stakeholders and social actors. While the development of the tangible features of a product is based on the dimensional, aesthetical technological and physical characteristics of the product, the service components in PSS introduce new variables. The new variable includes the dimension of the interaction between people, and other hidden dimensions related to cultural mind-sets and social habits of people. This requires methods and tools which will help in the design of the system from a sustainability point of view.

In dealing with complex issues, the systems approach can offer a perspective more useful than other analytical approaches, because the systems view is a way of thinking in terms of connectedness, relationships, and context (Gallop, 2003). The other thing to consider is to assess the goals so as to know how much the transition is towards sustainability. This has posed important challenges to the scientific community in providing efficient and reliable tools to measure sustainability.

Sustainability assessment has become a rapidly emerging area (Devuyst, 2000). The numbers of tools that claim that they can be used for assessing sustainability have increased. Sustainability assessment is defined as “...a tool that can help decision-makers and policy-makers decide which actions they should or should not take to make the society more sustainable” (Devuyst, Hens, & De Lannoy, 2001).

2C.3 Various Sustainability Assessment Tools

‘Indicators’ are an important part of these available tools and relate mainly to the various parameters that can be measured to depict the trends in a particular condition. It is important to distinguish between those tools used for measurement (identifying variables measuring sustainable development and collecting relevant data), and those used for assessment (evaluating performance against criteria), as well as those tools that can be used to catalyse a move towards sustainable development by changing practice and procedures. (Levett-Therivel, 2004).

According to Stevens (2005), the Organisation for Economic Co-operation and Development (OECD) has included sustainable development reviews of countries based on indicators structured according to various issues like reducing emissions of greenhouse gases, reducing air pollution, reducing water pollution, sustainable use of renewable and non-renewable natural resources, reducing and improving the management of waste, ensuring sustainable retirement income policies and improving living standards in developing countries. The selection of indicators for monitoring sustainable development tends to vary from country to country depending on their natural attributes, industrial structure, and political and social variables (OECD, 2001). An example of one such indicator is the Environmental Pressure Indicators (EPI) developed by the statistical office of the European communities (Eurostat)(Carlo Vezzoli, Kohtala, & Srinivasan, 2014). These indicate the present performance of a nation in terms of deforestation, waste dumping in landfills etc. These indicators provide comparisons of various countries in terms of their performance in these areas. There are also indicators that integrate the nature society systems like the Environmental sustainability index (ESI) and The Human Development Index (HDI) which take into account the environmental conditions and the quality of life of the people. The ESI measures the overall progress towards

environmental sustainability which is developed for 146 countries (University, 2005). These indicators permit comparison across a range of issues like Environmental Systems, Reducing Environmental Stresses, Reducing Human Vulnerability to Environmental Stresses, Societal and Institutional Capacity to Respond to Environmental Challenges and Global Stewardship. The main purpose of ESI is to get a comparative data and help in decision making in environmental strategies. The HDI is used by United Nations Development Programme (UNDP) for evaluating social and economic progress in different countries. It takes into consideration three parameters- longevity, Knowledge and standard of living.

The other classification is the product related tools that focus on flows in connection with production and consumption of goods and services. This type of tools focus on evaluating material and energy flows in relation to various products and services instead of regions or nations. They evaluate resource use and environmental impacts along the production chain or through the life cycle of a product. (Ness et al., 2007). These tools do not integrate social aspects as they are mainly focussing on environmental aspects (Sousa & Miguel, 2015). The most established tool in this category is the Life Cycle Assessment (LCA) which was invented around 1970 at the Midwest Research Institute in United States (Klöpffer, 1997). LCA attempts to measure the total environmental effects of a product "from cradle to grave" (Duda & Shaw, 1970). LCA is also represented as tool for environmental product management. There is an international standard for LCA (i.e. ISO 14040 1997) that lists following applications: identification of improvement possibilities, decision making etc. (Sharma, Saxena, Sethi, & Shree, 2011). For example, LCA in building can be used to measure the effect of buildings on various environmental categories, i.e., GHG emissions, energy use etc. The key factors for energy use in buildings are transportation, building material production, construction, during the pre-use life cycle phase; electricity use, HVAC, manufacturing and maintenance, water use, waste generation, natural resource consumption during use (operational) phase; building demolition and recycling, during end-of-life phase.

Even though LCA is considered to be most reliable method for calculating environmental impact, it has certain limitations. LCA is a model used for inventory

analysis and impact assessment and this may not be sufficient to describe the entire spectrum of environmental impacts nor can they be adapted to all applications. Another emerging tool which is following biomimetic approaches is the Cradle to Cradle (C2C Netherlands) The C2C certification is a non-governmental eco label that the MBDC (McDonough Braungart Design Chemistry) defines as “a multi-attribute, continuous improvement methodology that evaluates products across five categories of human and environmental health. However, Some literatures have questioned the feasibility of the eco-label approaches and suggests that C2C certification could not be always distinguishing environmental preferable products (Bakker, Wever, Teoh, & De Clercq, 2010; Bjørn & Hauschild, 2013; Reay, Mccool, & Withell, 2011). The C2C concept promotes an infinite economic and production growth however, there are some limitations regarding the bio capacity of the planet.

Apart from these, there are at present several methods available and in use for the evaluation of environmental impacts of buildings and urban developments (Levett-Therivel, 2004). Few examples are Building Research Establishment, Environmental Assessment Method (BREEAM UK), ENVEST (UK, an offshoot of BRE's assessment method), Leadership in Energy and Environmental Design (LEED (USA), Building for Environment and Economic Sustainability (BEES (USA), and ATHENA (Canada). The factors covered by these assessment tools are mainly related to the exhaustion of energy, materials and land along with the pollution impact of buildings and urban settlements. Integration of social and economic impacts into assessment is missing in these tools (Xing, Horner, El-Haram, & Bebbington, 2009). As a result, existing tools cannot be described as integrated sustainability assessment tools. Many of these tools mentioned above measure sustainability of the built environment and have been developed to determine any possibility that exists for further development, or whether the present development is sustainable, or whether any progress is being made towards sustainable development.

BEES measure the environmental performance of building products by using a life-cycle assessment approach specified in the ISO 14040 series of standards. BEES was developed by the US National Institute of Standards and Technology with support from the US Environmental Protection Agency's Environmentally Preferable

Purchasing Program (Lippiat, 2007). BEES include environmental and economic performance data for nearly 200 building products and allow environmental and economic performances to be aggregated into a score for overall performance of the building using priorities defined by users. Even though in a different context, the best-known sustainability assessment tools in the USA are the Leadership in Energy and Environmental Design Green Building Rating System (LEED) which was developed by the U.S. Green Building Council (USGBC), the popularity of this tool has created awareness in the minds of people about sustainability while building environments (LEED, 2002).

Many companies are now reporting on their environmental performance as well as their financial position, but increasingly there is an expectation that organisations need to account for the performance of their interaction with the staff, the local communities and other stakeholders. Therefore to become a sustainable corporation the sustainable philosophy needs to be reflected in financial, environmental and social responsibility through mission statements, policy, strategy, organisational culture and action. As per Stevens, (Stevens, 2005), the most challenging task ahead of the scientists and researchers is to measure the social dimension. There are large differences across countries as to how they interpret social sustainability: from concerns about poverty in the developing world, the health consequences of environmental change, issues relating to gender inequalities, to standards of living. The diversity of concerns and lack of a common focus is one of the hurdles to identifying suitable measures for the social aspect. Boks (2006) emphasises that there must be a variety of sociological, psychological, emotional and perhaps intangible factors on an organisational level along with the environmental considerations which will make the industrial practice more effective. It has been suggested that such socio-psychological factors be referred to as the “soft side of eco-design” to illustrate the contrast with ‘hard’ design and engineering aspects. The third classification as explained in **Figure 5** is the integration of nature society system which fuses environmental, social and economic aspects. While considering a system which has many actors the integrated one is suitable as it takes into consideration the nature society aspect which is explained in the next section.

2C.4 Method and Tools for System Design for Sustainability

Study carried out on the various assessment tools shows that the suitable approach for System Design for sustainability is to link the quantitative and qualitative method, which will account for sustainability to all stakeholders in the system by facilitating participation and engagements aimed at agreeing upon what the system will require (Mayyas, Qattawi, Omar, & Shan, 2012; Scerri & James, 2010; Shaffer, 2013). This also has the advantage that the gap between planning and execution phase is minimised by incorporating the design process by side by side so that the inputs from various stakeholders are included into the whole process.

The most important responsibility of the designers for Designing for Sustainability is promoting and facilitating system innovation resulting in eco-efficient and socially equitable/cohesive enterprises/initiatives offering a mix of products and services based on a structured network and locally based model (C Vezzoli, 2010b). The important skills required for this is to design the stakeholder configuration which should create and promote novel ways of interaction and partnership among the stakeholders.

These tools, mostly used by system engineers and designers, may help to a certain extent in covering areas of the design process characterised by a complex systemic structure (Morelli, 2006). While thinking of the assessment for Indian Railways Catering system it is intended to carry out an assessment technique which integrates the food production chain, the production systems, consumption, waste handling and the supporting networks. The methodology to be adopted here should not only be concerned about the performance of an individual company but the overall performance of all the companies and stakeholders in the food chain (Moll & Uiterkamp, 2003). Our interest in this research is in the PSS approach of design for the Indian Railway Catering System. It has to be noted that not all PSS innovations results in environmental benefits or economic advantages. For example, there could be hidden costs involved during the implementation of these novel ideas. Thus it should be kept in mind that even when well designed, some PSS changes could generate unwanted side effects, referred to as rebound effects (C Vezzoli, 2010b; Yoon et al., 2012).

For designing a PSS innovation, the requirement for the tool is that it be an integrated one which can steer the design process towards the development of sustainable PSSs, which can analyse and assess strengths and weaknesses, which can support creativity and idea generation, assess the sustainability improvements and facilitate co-design process (CESCHIN, 2012). The basic requirements for these kinds of innovation are that it should hold a:

- Satisfaction-system approach – Not designing a single product but a combination of products and services associated with the fulfilment of a given demand of satisfaction.
- Stakeholder-configuration approach – Focussing on innovative types of interactions and partnerships between appropriate socio-economic stakeholders while responding to a demand for satisfaction.
- Customer –oriented approach – A co-creation process where the final users play an important role in the design process.
- System Sustainability approach – Model from the point of view of the whole system.

Many PSS design tools have been developed over the last many years to design sustainable and eco-efficient PSS. These were all developed by the European research projects namely, SusHouse (Strategies towards the sustainable Household 1998-2000), ProSecCo (Product Service Co-Design 2002-2004), HiCS (Highly Customised Solutions 2001-2004), MEPSS (Methodology for Product Service System Development 2002-2005), SusProNet (Sustainable Product Development network 2002-2005) and MSDS (Method of System Design for Sustainability which started from MEPSS) (CESCHIN, 2012). Table 4 below shows a comparative representation of the specific focus of each tool for PSS innovation.

	Methods focussed on Innovation Development in general	Methods specific for PSS innovation	Methods to develop PSS for specific sectors
Methods covering only Economic and Environmental Dimensions		Kathalys PSS innovation scan for Industry PSS Methodology	PSS innovation Workbook Sustainable Home services
Methods covering Economic, socio-ethical & Environmental Dimensions	HiCS (Highly Customised Solutions) SPSPD (Sustainable Product Service Development)	DES Design of Eco-efficient services methodology MEPSS Practical guide for PSS development Modular Design for PSS MSDS (Method of System Design for Sustainability)	

Table 4: Comparison of various tools for PSS innovation (Source:(CESCHIN, 2012))

While going through the various PSS design tools (Refer **Table 4**), it can be seen that some of them are focused on innovation in general and can also be used to develop products, services and partnerships while some others are specifically aimed at only PSS development while some are used to develop PSS for specific sectors. Moreover some methods focus only on the environmental and economic aspects, while some others cover all the three dimensions of sustainability including the social dimension. MSDS was found to be such a tool which takes into consideration the economic, socio-ethical and environmental aspects and particularly aimed at the PSS development. The main advantage of this assessment methodology is the ease of analysis of complex systems and also that they are a combination of both design and assessment. In the context of a developing country, the importance of the societal aspect is unavoidable so the preferred route would be to design and orient the system keeping in mind the role of the various actors and then to assess its improvements with possible iterations. It also includes direct involvement of stakeholders in decision making and marking their interaction in the design process. One direction in which the literature review is guiding us in selection of an assessment methodology is about the assertion that the quality of decisions will be improved by the direct involvement of stakeholders in the process

(Salter, Robinson, & Wiek, 2010) which leads to socially informed designs where the stakeholders (who could hinder the development) feel that their views and perspectives are valued by the designer (Goodfellow, Wortley, & Azapagic, 2014).

2C.5 MSDS - Method for System Design for Sustainability

The methodology of MSDS was developed by the research unit system Design and Innovation for Sustainability (DIS) in the INDACO department of the Politecnico di Milano. This method aims to support and orient the entire process of system innovation development towards sustainability (C Vezzoli, 2010a; Carlo Vezzoli et al., 2010). The basic structure of MSDS as discussed below consists of five stages and is shown in the **Table 5**.



MSDS Methodology		
Stage	Aim	Process
Strategic Analysis	To obtain the information needed to facilitate the generation of sustainable ideas and scenarios for system innovations	Analyse project proposers and outline the intervention context
		Analyse the context of reference
		Analyse the carrying structure of the system
		Analyse cases of excellence
		Determine priorities for the design intervention in view of sustainability
Exploring opportunities	To make a catalogue of promising strategic possibilities available, or in other words, a sustainability design-orienting scenario	Generate ideas oriented towards sustainability
		Outline a sustainability oriented design scenario (visions, clusters and individual ideas oriented towards sustainability)
Designing system concepts	To determine one or more system concepts oriented towards sustainability	Select clusters and single idea
		Develop system concepts(constituting of one or more product and service mixes that characterize the offer; the relative interaction systems between the actors involved; potential environmental socio-ethic and economic improvements)
		Environmental, socio-ethical and economic appraisal
Designing (and Engineering) a system	To develop the most promising system concept into the detailed version necessary for implementation	Detailed system design
		Environmental socio-ethical and economic assessment
Communication	Draw up reports to communicate the general, and above all sustainable characteristics of the system designed	Draw up the documentation

Table 5: The various stages in MSDS (Source: *Systems Design for Sustainability*, C.Vezzoli)

The method is organised in different stages, processes and sub-processes. It is characterised by a flexible modular structure so that it can easily be adapted to the specific needs of designers /companies and to diverse design contexts and conditions. This flexibility gives the method an edge in our context of IRCS. The advantages of this tool with regards to its flexibility are that it can be easily adapted to specific needs of designers/companies and to diverse design contexts and conditions. The selection of different stages can be done according to requirements of a particular project. This method takes into consideration the three dimensions of sustainability independently which gives the designer the freedom to choose them individually.

2C.5.1 Strategic Analysis

The first stage of Strategic Analysis targets the collection of all the background information necessary for the generation of a set of potentially sustainable ideas. This paves way for understanding the existing situation and finding out more about the project proposers, the socio-economic context in which it operates and the dynamics (socio-economic, technological and cultural macro-trends) that influence the context. For defining the context various information are needed to be collected like demand to be met by this system, the key areas of expertise of the project promoters, their main strengths and weaknesses, the main stakeholders and the relationship between/among them, the main environmental, socio-ethical and economic problems associated with the value chain and the value for the client and/or end user. For further analysing the context, certain other information are also required like the structure of the entire production and consumption chain, the main actors (public and private) and their respective interests, the technological, cultural and regulatory dynamics influencing, or of potential influence to, the characteristics of the production and consumption chain, the main competitors, their offers and how these differ from those of the project proposers etc. (Carlo Vezzoli et al., 2014). Next it is required to analyse for any case of excellence for sustainability (best practices) of a reference system and finding out their advantages in the three dimensions of sustainability. After this it is required to analyse sustainability of existing system and determine priorities for the design intervention

in view of sustainability. This requires finding out how the existing system is performing in terms of the three dimensions of sustainability mainly the environmental socio-ethical and the economic dimensions.

2C.5.2 Explore Opportunities

The aim of the second stage is to identify possible orientations for the development of promising systems. This takes place through a participatory process whereby the various actors in the current system generate ideas. Here it must be stressed that the aim of this idea-generating process is not to come up with incremental improvements at product or service level, but rather to come up with possible innovations at system level, characterised by radical improvements from an environmental, socio-ethical and economic point of view. This step comes up with a set of system ideas with their environmental socio-ethical and economic sustainability characteristics. This requires finding out the satisfaction unit to be met by the design, the actors who might potentially be involved in the satisfaction system and the potential product and service system capable of bringing radical improvements from environmental, socio-ethical and economic point of view.

2C.5.3 Designing system concepts

Starting with the scenario (with its visions, clusters of ideas and single ideas) elaborated previously, the aim of this stage is to select the most promising clusters and single ideas through a participatory process whereby the actors involved are called to express their opinions. The clusters and single ideas selected are sorted into various groups, each one representing a system concept in an embryonic form (Carlo Vezzoli et al., 2014). These groups of ideas are then developed in greater detail, defining the set of products and services that make up the offer, together with the actor system that produces and delivers it, and the potential environmental, socio-ethical and economic improvements it offers are assessed. The most promising ideas from an environmental, socio-ethical and economic stand point are selected and combined through a participatory process, possibly supported by purposefully designed tools which are discussed in the coming sections. The next step is to assess the potential improvements that the system concepts could

generate from an environmental, socio-ethical and economic (Planet, People, Profit) point of view. This process is fundamental in order to understand whether there are still any unresolved critical points and also, if more than one concept has been developed, to decide which one is the most promising. The result will be a description, for each concept, of the potential improvements offered (for every criterion of each sustainability dimension); a visualisation of these improvements by means of a radar diagram; and a visualisation of the interactions that illustrate improvements.

2C.5.4 Designing (and Engineering) the system

This step develops the system concept in detail, defining: the set of products and services that make up the offer; all the actors (both primary and secondary) involved in the system together with their roles and interactions; all the interactions between actors and client/end user that occur during the delivery of the offer; all the elements (both material and non-material) required for delivery of the offer and who will design/produce/deliver them. All the intricacies in the design are dealt with in detail which again is developed by a participatory approach.

2C.5.5 Communication

The communication stage, which works across all the others, aims to communicate the general characteristics of the solution designed, and above all those regarding sustainability, to the outside world. The basic aim is to provide a document indicating the design priorities for sustainable solutions, the general characteristics of the product-service system, the sustainability characteristics of the product-service system and not just communicate the new system to the clients and stakeholders with respect to how the system operates, it is also to convince the clients and/or service provider to accept the newly designed Sufficiency PSS.

2C.6 Strategic tools for system design under MSDS

MSDS method consists of various support tools which can be classified into two groups:

- **Sustainable system design steering tools**
- **Stimulus and support tools for the generation of ideas**

Sustainable system design steering tools: The sustainable system design steering tools consists of tools developed to steer the system design process towards environmentally, socio-ethically and economically sustainable solutions. They are discussed below.

2C.6.1 Sustainability Design Orientating Toolkit (SDO)

This tool orients the design process towards sustainable system solutions. The process followed includes four phases namely; setting sustainability priorities, analysing best practices, using sustainable design-orienting guidelines, and checking and visualising the potential improvements in relation to an existing reference system. The purpose of the tool in the first step is to define the design priorities for all three dimensions of sustainability (e.g. for the environmental dimension, to ascertain whether it is more important to optimise the life of the system, or to reduce resources, etc.). This is done by using checklists to analyse the existing system (SDO section: 'Set Priorities'). In the next step the generation of ideas for potentially sustainable systems is stimulated. This is done by using design criteria and guidelines oriented towards sustainability (SDO section: 'Orientate Concept'). In the third step, assessment of the potential improvements or any worsening, associated with the three dimensions of sustainability compared to the existing system is carried out. This is done by using checklists to compare the designed solution and the existing system, and radar diagrams to visualise the results of the analysis (SDO section: 'Check Concept' and 'Radar')(Carlo Vezzoli et al., 2014). Figure 6 below shows the basic interface of the SDO toolkit.

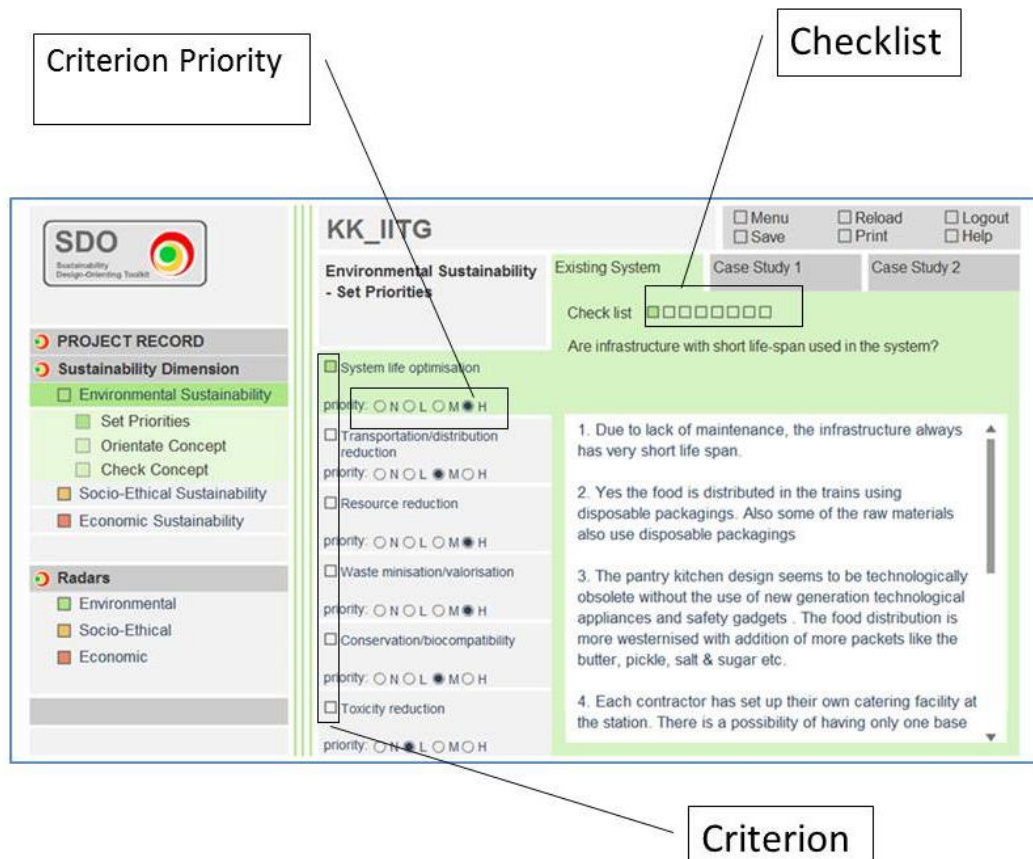


Figure 6: Basic Interface of SDO toolkit (<http://www.sdo-lens.polimi.it>)

The criteria considered for the various dimensions are given below

Criteria for the environmental dimension:

- Life optimisation
- Reduction in transport/distribution
- Reduction in resources
- Minimisation/valorisation of resources
- Conservation/biocompatibility
- Non-toxicity

Criteria for the social-ethical dimension:

- Improvement of employment/working conditions
- Justice and equity on the part of stakeholders
- Enabling of responsible, sustainable consumption
- Fostering and integration of the weak and marginalised

- Improvement of social cohesion
- Reinforcement/valorising of local resources

Criteria for the economic dimension:

- Market position and competitiveness
- Profitability/added value for businesses
- Added value for clients
- Long-term business development
- Partnership/cooperation
- Macro-economic effect

These criteria under each dimensions of sustainability are used both as a way of assessing a given system and also as a way of steering the design process, and each in turn materializes a series of guidelines. This is essentially a qualitative tool applicable to complex systems. This tool is dealt with in detail in the context of Indian Railway Catering System in the next chapter.

2C.6.2 Sustainability Interaction story board

The Sustainability interaction story board is a co-designing tool for visualisation purpose.

Its purpose is to illuminate effectively, the salient elements of a product-service system in relation to given objectives (e.g. how the solution designed achieves certain environmental and socio-ethical aims). It is basically an Interaction table focusing only on specified interactions. The tool requires the use of graphic image processing software and slide show software (e.g. Microsoft PowerPoint) for the visualisation.

Stimulus and support tools for the generation of ideas

2C.6.3 Stakeholder System Map

The System Map supports the (co)-designing and visualisation of the system structure, indicating the actors involved and their interactions. It is basically a graphic representation showing all the socio-economic actors involved in the system as well as the different interactions between the various actors in terms of material and/or product flows and those of information, money and work. This uses

different legends for the material exchange, finance, communication and the people movement across different sub-systems, people, actors, and stakeholders which are all represented visually. The tool requires the use of graphic image processing software and slide show software for the visualisation.

2C.6.4 Satisfaction System Map

The Satisfaction system map is a support tool for the generation of system ideas. The purpose of the tool is to identify and visualise the potential socio-economic actors who could be involved in the satisfaction of a given demand for well-being. This visualisation is used during the ideation process as a stimulus to understanding which actors could potentially take part in the satisfaction system.

2C.6.5 Offering Diagram

The Offering diagram is a static representation of the system functions; it can be used both as a design and a visualisation tool. The tool is useful to the design team for defining in ever-increasing detail the functions that the system delivers to the user. It is basically a graphic representation, made up of images and text elements. It represents the core function, the basic functions, the added value functions (Value addition) and the sub-functions, which describe the way in which the functions will be delivered.

2C.6.6 Polarity Diagram

The Polarity diagram is developed to identify and explore the possible and promising directions in which the current systems may evolve. It is a part of an ideation process which is used, in particular, at the start of the designing process to define and visualise what we call a sustainability design-orienting scenario, i.e. the set of possible and promising reconfigurations that a system may take.

The tools mentioned here require the use of slideshow software (e.g. Microsoft PowerPoint, or the equivalent in Open Office). With this software it is possible to define and modify the actor map using a standardised set of purpose created icons which facilitate the involvement of all participants in the project in the designing process and speeds up the exchange, modification and presentation of the various

steps in the evolution of the solution. These tools are dealt in detail in chapter 4 when it is applied in the context of the Indian Railway catering system.

2C.7 Summary

In this chapter, we have undertaken literature review to understand the broad definitions of sustainability and its present concerns with a systemic and holistic assessment of its parameters for any meaningful design intervention. While going through the literature review, it was also apparent that most PSS examples were predominantly in the western context. It was suggested that the PSS that already exist in the developing countries (Ezio Manzini & Vezzoli, 2003) as a consequence of economic and cultural conditions needs to be further explored to fit the developing countries. It was also found that very few studies have been undertaken following a PSS approach in the context of low-income countries. In the Indian context, studies in the area of PSS are not available for government run large systems like the Indian Railways even though the relevance of these types of studies for such organisations is immense. Selecting a system which is the central network for public transport in a populous country like India offers immense potential to contribute in the PSS domain. There is a need and scope for applying the conceptual frameworks of sustainability for a pragmatic application in the domain of the catering system in the Indian Railways. Application of a PSS innovation for the Catering system based on a system level study offers scope for improvement and implementation in the Indian Railways. It can have large implications and impact in the perception of the common man when implemented successfully.

Also the various approaches to sustainability assessment and their comparison are carried out along with a specific comparison of tools pertaining to PSS innovation. It was finalised that for PSS approach the MSDS is the suitable approach which can design as well as assess the PSS innovation from a sustainability point of view. The design steering tools along with the stimulus and support tools were also discussed.

This research study on the Catering system is limited to the Northeast Frontier Railways Zone of the Indian Railways. It identifies the research gaps and examines Indian Railway Catering system from a PSS perspective. Following the MSDS

methodology, when scaled up, it offers scope for replication and implementation across all the other 16 zones of the IR.

The research design and the methodology followed along with the application of these tools in the context of the IRCS are carried out in detail in the next chapter.







**CHAPTER 3: PLANNING OF RESEARCH - CASE STUDY OF NF
RAILWAY CATERING SYSTEM**



Introduction

In the previous chapter we have been able to establish through the Literature Review, the developments in the discourse on sustainability and the different modes that have evolved in its measurement for analysis. Further we have considered the relevance of a study of sustainability in the domain of catering services for the Indian Railways following a PSS approach.

After considering different approaches to the study and measurement of sustainability parameters in the previous chapter, the MSDS methodology was adopted as the one that was considered most suitable to undertake an integrated assessment of the catering system of the Indian Railways.

As per the guidelines of the MSDS methodology, the study involves the following four phases as seen in **Figure 7** below.

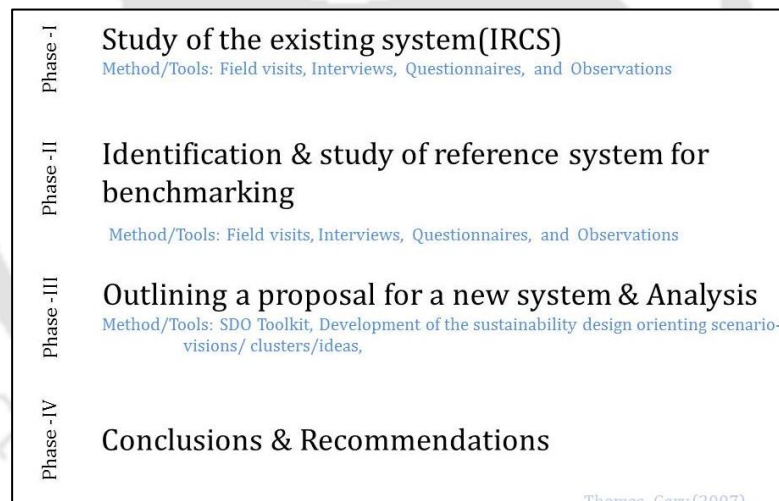


Figure 7: Four phases of this research

The outcome of the study carried out under

Phase – I: Study of existing IRCS.

Phase – II: Identification and study of a reference system for benchmarking which will help to assess and draw insights to answer the first two research questions viz.

1. How the catering service provided by the Indian Railways is performing in terms of the three dimensions of Sustainability viz. Environmental, Economic and Socio-ethical
2. To identify interventions at a Product, Service System level and to propose a sustainable model for Indian Railway Catering service.

The outcome of the intervention under Phase III and Phase IV will result in planning a new systems level sustainable model of the catering system for the Indian Railways. It will thus verify the research questions viz.

3. Whether an intervention through a PSS model of approach would help to improve the existing Indian Railway Catering Service?
4. Whether there is an improvement on the perception among the different stakeholders about the proposed catering system model developed by a PSS intervention?

In this chapter we will outline the detail plan for the research study following the MSDS methodology.

In Phase I, a detailed case study of the existing Indian Railway Catering system in the northeast frontier division was done. Under Phase II, the AkshayaPatra Base kitchen Guwahati as the reference system was examined. A comparative study and analysis of the IRCS will be made with the reference system. Based on the comparative analysis of the two systems, insights will be drawn to conceptualize an alternative proposal for a more sustainable model for the IRCS. The study mainly deals with the practices adopted for the catering system by the NF Railway Division of Indian Railways as a case study. The research planned is to consider a PSS approach and to go with the literature review supplemented by findings from field visits and surveys.

Guwahati Railway station being the 'Gateway to the Northeast', an important terminal station in the Northeast Frontier Railway zone is selected as the focal point for undertaking the research. In addition, it being located in the proximity of the IIT Guwahati campus, it offers easy access to the zonal Railway office for gathering data for the case study and having direct access to the base kitchens located in the city.

With the above aim, a thorough investigation on available official documents by Indian Railways and IRCTC (Indian Railway Catering and Tourism Corporation), reports, published papers, and newspaper articles was carried out to understand the policy level initiatives and provisions of the Indian Railways. Study was planned for the existing catering system in the Indian Railways (both on-board and base-kitchen catering), through multiple field visits to the railway stations, Static catering units, Base kitchens, pantry cars, GMC Garbage disposal area, PWWC and rag picker centre. To understand the perception of the various stakeholders about the existing system, survey using questionnaire were carried out with different stakeholders including passengers, base kitchen managers, railway officials and pantry staffs. In the following sections, a detailed study of the catering system for the Northeast Frontier division of the Indian Railways is presented.

3.1 Phase – I: Study of Existing System

Under phase I, a detailed study of the existing catering system in the Indian Railways (both on-board and base kitchen catering) was undertaken to identify the various actors and stakeholders involved in the catering system. Interactions are held with them to assess their perception about the system and identify the problems that exist in the present system in terms of environmental, socio-ethical and economic parameters of sustainability.

The methodologies adopted for data collection were field visits to Guwahati Railway station and meetings with the Additional General Manager, Chief Public Relations Officer NFR Maligaon. A study of the Base kitchen in Guwahati city which is outsourced to JK Ghosh on contract basis was also studied. Field visits were undertaken to study the system from a PSS perspective. The Prevalent Waste management system in the existing system was studied by visiting the rag-pickers sorting yard, Plastic Waste Management Centre (PWMC) Borgaon (Banglagarh), Hajo circle, Guwahati. Train journeys were undertaken to study catering service on the following trains: Poorvottar Sampark Kranti Express (12501), Rapthi Sagar

Express (12512). A study of Jabalpur Railway Station stalls and kitchen in Jabalpur railway station were also undertaken.

Method of Direct Observation in person by the researcher was carried out at all the above mentioned venues and detailed interviews were carried out with the Catering Manager at JK Ghosh Base Kitchen Guwahati, Manager of Agrawal Caterers, M/S Vrindavan Food products on train No.12512, 12 Pantry staffs in both stalls in the railway station platforms and in Pantry kitchen in trains. To infer the perception of the passengers on the present Indian Railways catering system and the food provided in trains and stations, a survey with questionnaires were carried out for 150 passengers in various trains.

3.1.1 Guwahati Railway Station

Guwahati railway station plays a very important role in the transport and communication system of the entire north eastern region of India. Guwahati city is the gateway to all the north eastern states. All who travel to other eastern states have to come to Guwahati city for their onward journey. Guwahati is a strategically important station, well connected with the rail network to other parts of India by the Rajdhani, the Shatabdi and the Express trains. This railway station has more scope for development as many new rail projects and networks are in the pipeline. It is awaiting a major revamp as the authorities have plans to convert this railway station into world class. Extensive field visits were carried out to collect facts and figures on the Guwahati railway station.

This railway station falls under the category "A" (NO.COM/RTI-ACT" 05/14/146). In the commercial importance classification scheme, non-suburban stations with annual passenger earnings over INR 60 million is a Category "A" station. Guwahati Railway station handles about 32766 passengers in terms of booking and reservation tickets. This number excludes the numbers of train travellers who arrive in the station daily from different arrival trains to Guwahati. It has a total of seven platforms and is located in the heart of Guwahati city. There are a total of 399 passenger trains, both starting from and passing through Guwahati railway station every week. This heavy flow of passenger traffic results in the generation and

accumulation of wastes and the absence of an accurate system of waste disposal adds to the agony of the situation. A visit to the railway station premises gives us a glimpse of the way in which the catering system has been put in place. In particular, waste management undertaken at present, reveals the lack of a proper system in place to collect, segregate, transport, treat, re-use and dispose plastic wastes. As the passengers using this railway station are considerably increasing day by day, so is the plastic waste. This huge quantity of waste generation becomes a burden to the environment due to the lack of a proper waste disposal channel in place. Catering service which includes both vendors on the platforms as well as pantry cars in trains has a major role in waste generation.

3.1.2 System study of Indian Railway Catering System at NFR Guwahati

Stakeholder is any group or individual who can affect or is affected by the achievement of the organization's objectives (Freeman, 2010; Mitchell, Agle, & Wood, 2009). According to Carroll (2013) rightfulness and influence are two factors which help us in identifying stakeholders. Catering facilities are essentially public amenity services. Indian Railways need a well-managed catering system to supply tasty and wholesome food at reasonable prices to the passengers. Indian Railways provide catering services through refreshment stalls at stations and in nominated long and medium distance trains through pantry cars. The history of the catering of the Indian Railways has on the whole been inconsistent marked by irregular and frequent changes in principles and policies governing it. Right from the beginning, catering services on the Indian Railways have been managed by private agencies as well as departmental catering divisions. Since 2010, IR's have adopted a new catering policy to provide better catering service to the passengers on running trains. Accordingly IRCTC will now be only responsible for running food plazas, food courts, fast food units and all other catering services will be managed by the IR catering division.

Given the vast variety of cuisines and culinary preferences across the country, regional cuisine is being encouraged and the zonal railway divisions have been given the authority to design the menu.

According to Indian Railways (Indian Railways, 2005) Catering/vending services on Indian Railways consists of following facilities:-

- (i) Refreshment rooms, restaurants, fast food centres/snack bars, tea stalls, fruit/fruit juices stalls, cold and hot beverage dispensers, miscellaneous curio goods stalls, ice-cream parlour etc. at railway stations.
- (ii) Integrated on-board catering services on Rajdhani and Shatabdi Express trains.
- (iii) Services through pantry cars on selected long and medium distance superfast/mail and express trains.
- (iv) Base kitchens to provide ready-to-eat meals for on-board catering.
- (v) On board catering/vending services through static units (trains having no pantry cars) Catering system at Railway Station Premises

Field Visits

Field visits were undertaken to the Guwahati Railway station and the Base kitchen at Paltan Bazar Guwahati to understand the catering services provided on Guwahati Railway station. Visits were also made to the NFR Headquarter at Maligaon, the waste collection centre, waste segregation centre and the PWMC (Plastic waste Management Centre, Guwahati) to gather information on aspects of waste management on the railway station premises. Direct observations were undertaken on different trains starting from Guwahati railway station to observe the operations of the pantry and their staff to see first-hand, the complete logistics of collection from the base kitchen, its mode of transport to the railway station, loading and distribution and serving food on trains during train journey. Detailed discussions were held with the pantry staff, train officials and passengers during these trips to understand the various problems and identify the check points that were critical to catering service. One of the main complaints of the contractors and the staff about the Indian Railways is about the lack of adequate infrastructure support for the preparation and distribution of food. Extreme working environments at the work

place in the pantry and the lack of maintenance was very apparent. The need to provide facilities of modern and international standards that would help the caterers provide quality food seemed critical here.

3.1.3 Classification of Indian Railway catering system

The catering system of IR can be broadly classified into two types:

Base kitchen catering (Static Catering)

On-board catering

3.1.3.1 Base Kitchen catering

Once the contract for running is awarded by the IR to a contractor through a tender, it is the responsibility of the contractor to set up the base kitchen either in the railway station premises or in the vicinity of the railway station. As per the terms of the contract, it is the responsibility of the contractor to employ his staff, and set up infrastructure, equipment and transport required for catering services including preparation and supply of food to the static stalls in Guwahati railway station platform stalls and in selected trains. In Guwahati railway station, there are mainly four food catering contractors who also manage the pantry car services in the various trains that start from and pass through Guwahati railway station. They have set-up their own individual base kitchens not far away from the railway station and they prepare food for the platform stalls, as well as for the Shatabdi trains. These contractors are based in Delhi, Howrah and other faraway places and the logistics of daily operations are executed through their respective supervisors and managers.

Guwahati railway station has 7 platforms and 35 food stalls distributed across all the platforms. The food stalls can be classified as:

Big stalls (Restaurant) – They extend catering services including Breakfast, Lunch snacks and Dinner. They have a full-fledged kitchen, storage and dish washing facility. People take their food standing and keeping the plate on a waist high table. These stalls consume large quantities of water and have high electricity consumption.

Medium stalls (snack bars) – Employ around 5-10 staff who work in two shifts between 9.00 am to 11.00 pm. Only snacks and beverages are served here. Snacks like samosas, sandwiches and *pakor*as are prepared and supplied from the base kitchen located nearby. They serve these in paper plates and plastic glasses.

Small stalls –These stalls sell only branded packed food items and beverages.

Trolley stalls – These are small push cart stalls that sell only packet foods, water, fruit juices and *Pan*.

The distribution of these food stalls in the platforms are shown in **Table 6** below

Platform No.	Big stall	Medium stall	Small stall	Trolley stall
1	2	6	2+1hpmc	0
2&3	0	4	1(Amul)	0
4&5	0	7	1	0
6&7	1	4	1hpmc	5
Total	3	21	6	5

Table 6: The distribution of stalls in Guwahati railway station

The schematic layout of the placement of the catering stalls in Guwahati Railway station is shown in **Figure 8** below.

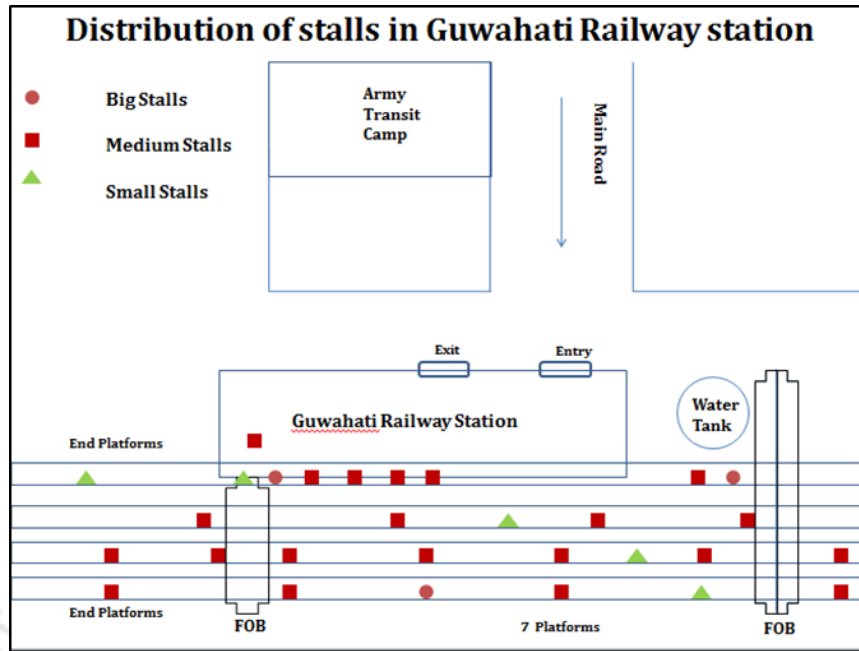


Figure 8: Schematic layout of catering stalls in Guwahati Railway station

It can be observed that the medium stalls cater to the requirement of the passengers for snacks items including samosa, bread pakora, puffs (*pattiz*), cream roll, chicken roll, egg roll, cream cake, plain cake, cake roll, alobonda, boiled egg, sweet parotta, bread sandwich, momos, biryani packet, packet foods, cold drinks, hot beverages and mineral water.

Figure 9 below shows a medium and a small stall in platform No. 1.



Figure 9: (a) Medium stall

(b) Small stall

The Big stalls usually located at the end platforms, serve freshly prepared food from the kitchen. They require large infrastructure to operate. The menu usually includes

Masala Dosa, Idly +Vada, Plain Dosa, Roti Dal, Puri-sabji and Jan Aahar Food Menu. Small stalls sell only branded packed food items like the *haldiram* snacks, *lays* chips, toffees, biscuits, cakes, aerated cool drinks, fruit juices, packed water, tea, coffee etc.



Figure 10: (a) Big stall (b) Jan Aahar

The Jan Aahar (common man's food) run by IRCTC, is a chain of food outlets that provide affordable food (starting from Rs. 10 per meal) for the passengers in the sleeper class and general class passengers. The branding of these stalls is quite impressive and the interiors of these stalls follow a consistent colour scheme. (Figure 10). The Jan Aahar has its head office at Kolkata.

These self-service-food joints cater to about 2000 passengers daily in Guwahati railway station alone. Unlike the other stalls that use paper plates and plastic glasses, these food outlets use only steel plates and glasses which are washed and reused a number of times. This is one of the reasons for being able to provide food for the passengers at such cheap prices. The use of paper plates and packaging adds up to the price of the food being served which makes it unaffordable to passengers travelling by sleeper and general class. Since Guwahati is a major station, trains halt here for at least 20 minutes. This is the time when the second class and general passengers avail this facility of food at affordable prices from Jan Aahar. They also have the state of the art packaging machine using which food is packed in a plastic moulded plate and laminated by a thick plastic sheet on top for which an extra Rs 9 is charged. (Figure 11)



Figure 11: Lunch being packed in Jan Aahar Guwahati

The snacks prepared at the base kitchen have to be transported to the stalls in between as and when required. Platform vendors are the major users of plastic packaging for the supply of food materials to the passengers at the platform.

Issues in Waste management

After the consumption of these food items, the plastic packaging are disposed as plastic wastes either in waste bins or, more often, are littered on the platforms and the railway tracks. Pantry cars use large quantities of plastic material for packaging food. Superfast trains like the Rajdhani, Shatabdi and the Duranto have a relatively better maintained pantry car and waste collection system within the trains while the express, superfast and mail trains lack a proper waste disposal system and are the main reason for littering of plastic wastes on the railway tracks. This has resulted in a network of rag-pickers who board the trains from various stations to collect this waste and contribute to the recycling ecosystem. The absence of a well-designed and well maintained waste disposal system and the careless attitude of the large number of passengers travelling by train are resulting in a major reason for worry for the IR.

In India large efforts are taken to start new ventures and establishments but seldom are the desired importance given to their maintenance and upkeep. The same attitude is reflected in matters pertaining to the environment as well. In large

organizations like IR maintenance plays a very crucial role in smooth operation, customer satisfaction, and image building.



Figure 12: The Dump yard at the Guwahati Railway Station Premises

The disposal of the wastes generated from the Guwahati Railway station premises are collected daily by the staff of the local Guwahati Municipal Corporation (GMC) who dumps it in the open dump yard situated adjacent to the railway station. These are then carried to the municipal corporation dump yard situated at Boragaon 12 kilometres from Guwahati city.

As per the information gathered from NFR headquarters, approximately 850 kilograms of wastes are generated in Guwahati Railway station daily. These comprise of organic wastes, paper, glass and plastics. This doesn't cover the wastes being thrown directly on to the tracks and the open environment. This waste collected at the railway station premises are not segregated and it is estimated that about 40% of the wastes generated in railway stations are of plastic materials (Rana, 2011).

Indian Railways have set-up its own base kitchens at Howrah, Patna and Delhi. These kitchens cater food in superfast trains including the Rajdhani and Duranto Express trains that pass through Guwahati railway station. All the stalls in Guwahati railway station platforms sell IRCTC packaged drinking water **Rail Neer**, A few of

the contractors also use other brands of packaged drinking water like Bisleri. The supply of Rail Neer comes from IRCTC factory located at Danapur in Bihar. The other two bottling plants are located at New Delhi and Palur in Kancheepuram district, Tamil Nadu.



Figure 13: a) Supplies to the Jan Aahar b) Push-cart trolleys

Branded packed food snacks are delivered locally by a distributor directly on the stalls at the platform with the help of a hand cart (**Figure 13**). The supplies are loaded to the push cart goods carrier from outside the station and are brought to the stalls at the platforms and then delivered.

On Island platform No.6 and end platform No.7 there are 5 push cart trolleys. Refer **Figure 13**. These are stalls which sell only packet foods, packaged drinking water, cold drinks and “pan”. These carts are mobile and can be pushed to different locations depending on the passenger traffic.

Most long distance trains on IR have pantry car facility for on board cooking. The pantry car serves meals, snacks, coffee, tea, and cool drinks at the passenger seats. However medium distance trains don’t have pantry cars in the trains. Instead, they load packed food from the base kitchen and store it in hot cases that are then distributed to the passengers.

Let us examine a case example of a typical routine of catering service for a train journey.

Field visit was undertaken to M/s J.K Ghosh Base kitchen. In Guwahati railway station among the catering contractors, M/s JK Ghosh has an ISO 9001 certified base kitchen located at Manipuri Basti, close to the railway station. This base kitchen caters to the following important trains: the Guwahati-Jorhat and the Jan-Shatabdi Express (Refer **Figure 15**). Breakfast is loaded from the Guwahati base kitchen early morning at 6.00 AM in packed containers. They are stored in the hot case facility available in the coaches and later served hot to passengers. The total time of travel for this train is 8 hours one side. The same contractor has a base kitchen at Dimapur in Nagaland from where the lunch is loaded when the train reaches there at 10.30 AM. On the return journey the dinner is loaded from Dimapur base kitchen when the train reaches there at 4.30 PM. The base kitchen system enables the passengers to have food packed in paper containers and are served hot. For Jan-Shatabdi Express (Train No.12067), after preparation from the base kitchen, the food is packed properly and stored in casseroles and trays and are transported to the train in covered auto rickshaws. It is then stored in the hot case in the train compartments. A common complaint from the catering staff is that the hot cases in the train compartments don't work and require proper maintenance which the railway authorities usually fail to provide.

The breakfast is prepared early morning based on estimates. For lunch the staffs takes orders from the passengers in the train and communicate the numbers to the base kitchen at Dimapur, from where lunch boxes are loaded. The maximum capacity at the Guwahati base kitchen is around 3000 meals at a time. The menu is basically vegetarian, although egg omelettes are also served. Chicken curry and other non-vegetarian meat dishes are available at the stations for Rs. 100 per plate. Prices are slightly higher for the food than the local restaurants charge, but the quality of the food is pretty decent for an express train.



Figure 14: Waste collecting chutes at the Base kitchen Guwahati

The Base kitchen at Guwahati is managed by a manager and has 25 staff members under him. The superfast trains under this contractor in NFR are: the Jan-Shatabdi Express, the Poorvottar Sampark Kranti Express, the Lohit Express, the Kanchenjunga Express and the Saraighat Express.

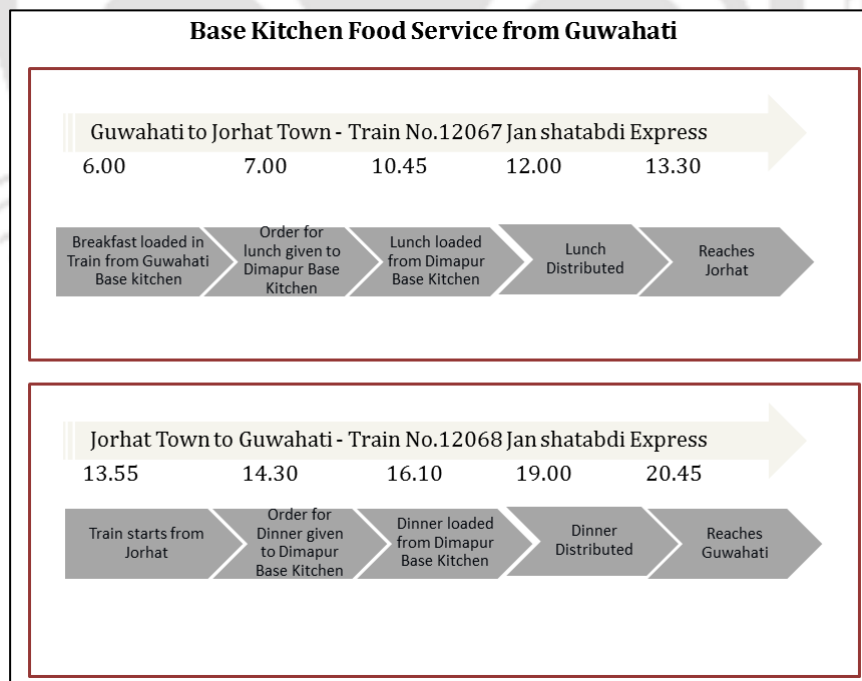


Figure 15: Journey schematic Diagram of Train No. 12067

The base kitchen has the facility for storage of raw materials for the pantry cars. From here provisions and groceries are transported to the railway station and loaded to the pantry cars of the trains. The base kitchen is the nodal point for all the activities pertaining to the catering at railway stations. Snacks are also prepared in the base kitchen here and taken to the platform stalls.

3.1.3.2 On-board catering

Providing food on time in trains is the biggest challenge for any pantry team. The railways have given this contract through tenders to different contractors who have proven their track record and good performance for the last few years in food catering. The pantries in trains are run by different contractors.

The Indian railways have provided them with very basic facilities to run the pantry car, which always remain inadequate and the contractors themselves arrange for more facilities like the vessels, extra LPG gas cylinders etc. From the originating stations all the required stock and vessels are loaded in the pantry car. All the long distance trains except the Jan-Shatabdi have a pantry car in the train. There are about 30-35 staff members in the train pantry car including two managers. The pantry staff work continuously for about three months and then go for a few days on leave. Availability of kitchen staff in NON-AC pantry cars during the summer is very difficult as the conditions inside the pantry kitchen are unbearable because of the excruciating heat and humidity. They have to pay special pay packages to attract workers for the summer. The nature of work of the staff is hectic as they have to start with their work early morning and continuously move around in the train and supply food and beverages to the passengers.



Figure 16: Pantry team waiting in the platform for the train

According to the railway circular regarding the cleaning of Non AC pantry cars, they have to fully vacate the pantry coach before the train is taken for pit line maintenance at the cleaning yard. Usually the cleaning yard is situated a few meters away from the platform. Before the train is taken for cleaning, the pantry workers evacuate the pantry car and take out all the utensils, gas cylinders and raw materials and keep it in the platform and wait there for the train to arrive ready for departure after cleaning. Then, they have to load everything again to the pantry car. This process consumes much time, space and energy and creates a chaos in the platform while other trains arrive. **Figure 16** shows the pantry team waiting with all the utensils and appliances in the platform ready to load when the train arrives from the cleaning yard. This consumes a lot of space in the platform creating hindrances for the smooth flow of passenger traffic.

3.1.4 Passenger Perception on IRCS – Surveys of Train Passengers

Passenger surveys were conducted to obtain information on the perception about the catering system among train passengers to understand the passenger's expectation of catering services on trains during journeys. The methods adopted included Personal Observation, and insights drawn from Interviews and Questionnaires. Feedbacks were taken from 150 passengers during train journeys in the following trains: Guwahati-New Delhi Poorvottar S Kranti Express; Guwahati-New Delhi North East Express, JBP-CNB Chitrakoot Express, and at Guwahati and Jabalpur Railway stations respectively.

The profiles of respondents were: Youth–65% in the age group of 15 to 30 travelling in sleeper class. Of the passenger's surveyed majority of them were males. **Figure 17 to Figure 20** below shows the results of the survey.

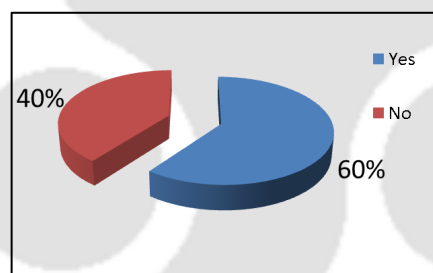


Figure 17: Low Quality of raw materials used for the preparation of food

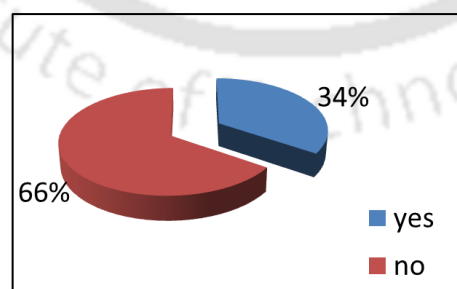


Figure 18: Cost of food served in train is too high

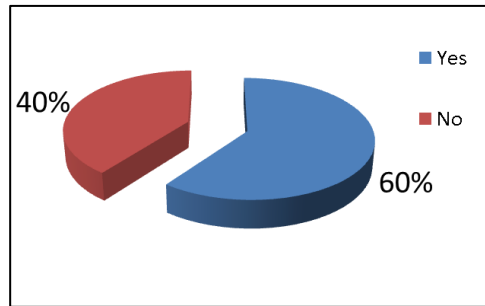


Figure 19: lack of food quality and hygiene in the pantry car

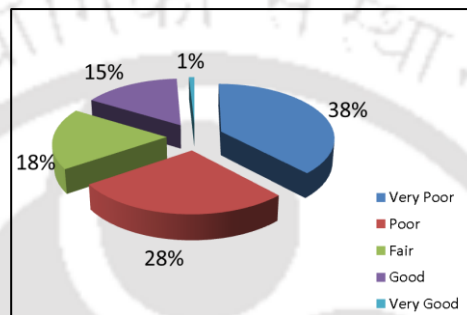


Figure 20: Present waste management system

3.1.5 Results and Analysis

The Questionnaire responses were thoroughly analysed. The main components of the existing Indian Railway Catering service were re-examined. The goal of the survey was to find out the perception and the expectations among the passengers about catering service provided by the IRCS.

From the results it was observed that passengers perceived the quality of the raw materials used in the preparation of the food in trains as poor. The price of the food was not a major issue with passengers, but Hygiene conditions in the train compartments were a major concern for the passengers. About 60% (90 out of 150) of the participants responded that they did not prefer train food and opted for other sources due to the very poor hygiene maintained inside the train compartments and pantry car. The present waste management system was perceived as ineffective by most of the respondents. They felt that if the food is being served in a clean ambience then it will be perceived as more hygienic and healthy. The passenger feedback clearly points out that the system lacks a proper waste disposal

mechanism. (Refer **Figure 17** to **Figure 20**) The summary of the survey showing the order of importance of the factors to the passengers from least to most important is furnished as **Figure 21** below

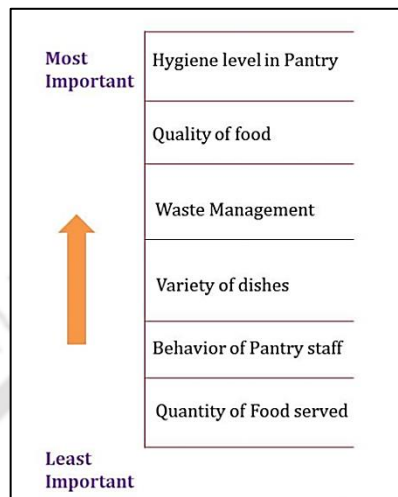


Figure 21: Order of Importance for passengers - Factors in the catering system

3.1.6 Formation of System Map and Stakeholder Interaction

In the first phase an investigation was carried out aiming to identify the various stakeholders of this system, understand the relationship between them and also to gain insights from stakeholders on the PSS that needs to be improved.

The existing Indian Railway Catering System (IRCS) is bifurcated into Products and Services which together form the whole system. The Operations of the base kitchen at Guwahati is awarded to a contractor based on an open tendering process for a fixed duration of time. It is the responsibility of the contractor to run the base kitchen and render catering services to select food stalls and select trains as per the terms of the contract. Employment of the catering staff, installation of the catering equipment and the maintenance of equipment, modes of local transport from the base kitchen to the railway premise, procurement of supplies, electricity and cooking gas are the responsibility of the contractor.

A thorough analysis of the existing system identifies all the stakeholders involved in the whole system. The full list of the products used, services offered and the whole

system and various subsystems of the Indian Railway Catering System are given in the **Table 7**.

Products	Services offered by Base kitchen	Sub-systems of Base kitchen
6 LPG gas Burners	Preparation and Distribution of Food & beverages in trains	Raw material procurement
LPG Cylinders		
Bread Toaster		
Air-curtains & Waste chutes		
Vegetable chopping boards		Food preparation
Water Purifiers		
Hand Driers		
Water Heaters		
Deep Freezers	Preparation and Distribution of Food & beverages in railway station platforms	Food Distribution
Refrigerators		
Mixer Grinder		
Electric Chimneys		
Pre-preparation utensils		Cleaning & Upkeep
Preparation Utensils		
Transfer utensils		
Disposable Packaging		
Weighing machines		
Crates for transporting		
3 Goods Pick-up trucks and Auto rickshaws		
Fire Extinguishers		
Rodents Trap		
Stakeholders		
Railway Officials	RPF	Hawkers & Rag Pickers
Municipality	Passengers	Suppliers
Electricity Board	Contractor	Manufacturers
Railway staff	Pantry Staff	Transporters
Water Authority	Platform Vendors	Hawkers & Rag Pickers
Quality Assessment Agencies	IRCTC	

Table 7: Products, Services, Systems and Stakeholders of the IRCS

Food is prepared at the base kitchen for about 10000 passengers daily.

The catering process can be divided into four stages:

Pre-preparation

Preparation

Distribution and

Disposal (Refer **Figure 22** below)

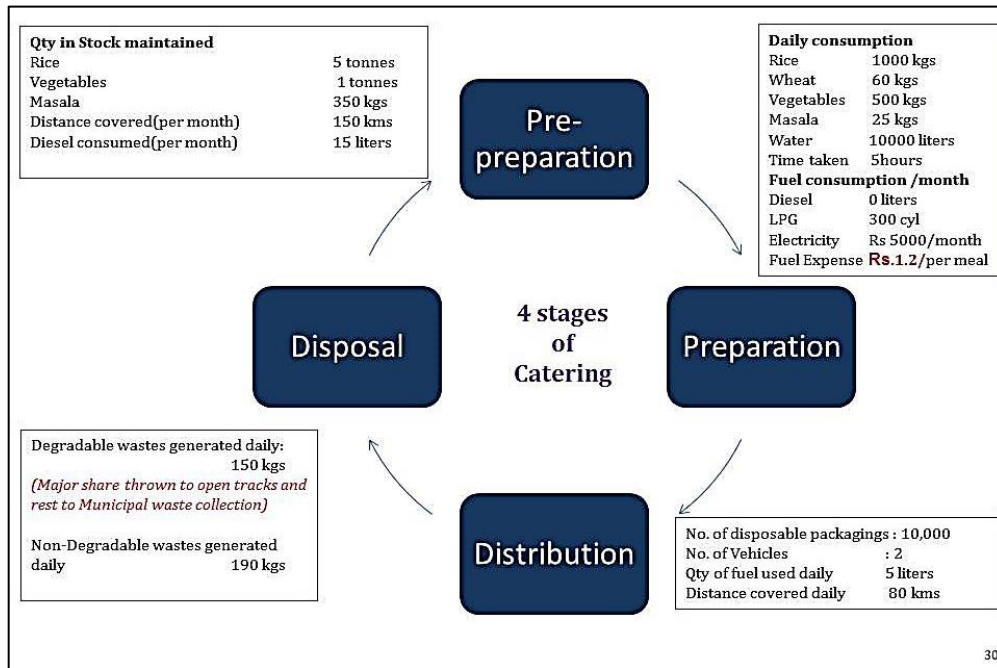


Figure 22: Data in the four stages of catering in IRCS

A typical order of quantities involved during catering operations in the different stages daily highlight the patterns of the following:

1. Quantity of raw material stock required to be typically maintained at the base kitchen
2. Daily consumption pattern of food grains including rice, wheat, spices, and fresh vegetables in cooking and the corresponding consumption of fuel including LPG, Diesel, Electricity etc.
3. Packaging consumption for the distribution of prepared food and expenses incurred towards local transport for delivery and procurement.
4. Quantum of waste generated during operation in meeting the catering requirements

The material and energy requirements for each stage are calculated. The base kitchen is solely dependent on fossil fuels for energy. It consumes about 300 cylinders of LPG per month which makes it to Rs 1.2 per meal as fuel expenses. The other main thing to be noted is the quantity of waste generated which amounts to 150 kilograms of degradable wastes daily of which the wastes generated at the Base kitchen premises are collected by the Guwahati Municipal Corporation (GMC). The use and throw packaging used for distribution of food packets forms a huge burden to the environment as there are no waste collection methods in the trains. They are thrown directly to the tracks. Calculating as 19 grams for each meal packaging, a total of 10,000 meals daily would produce approximately 190 kilograms of non-degradable wastes which are thrown to the open environment daily from the food prepared from a single base kitchen which amounts to massive figures when the whole catering system is considered all over India. This is really a concern for the environment.

The various stakeholders, their interaction, communications, transactions etc. are mapped in a layout called system map. This gives an overall picture of the whole system its operations, the mode of communication between the different stakeholders and their interactions in terms of money, material and information. The system maps of the existing IRCS (both Base kitchen and on-board catering) are shown in **Figure 24** and **Figure 25** below. The legends used in these system maps are shown in **Figure 23** below. The square headed dotted lines are used for information flow, the round headed dotted lines are used for financial flows while the normal arrow headed lines are used for material flows and the square headed lines used for labour performances between stakeholders/centres in the system.

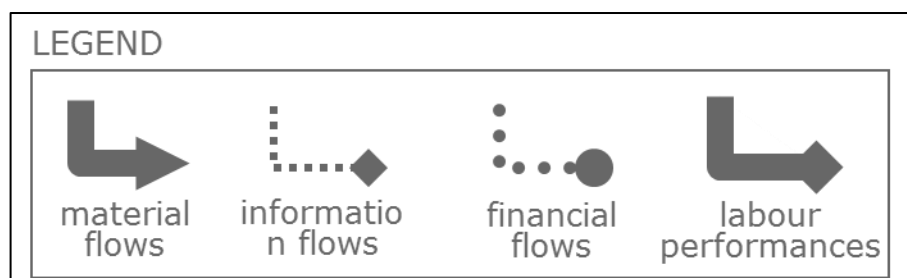


Figure 23: Legends used in System Map

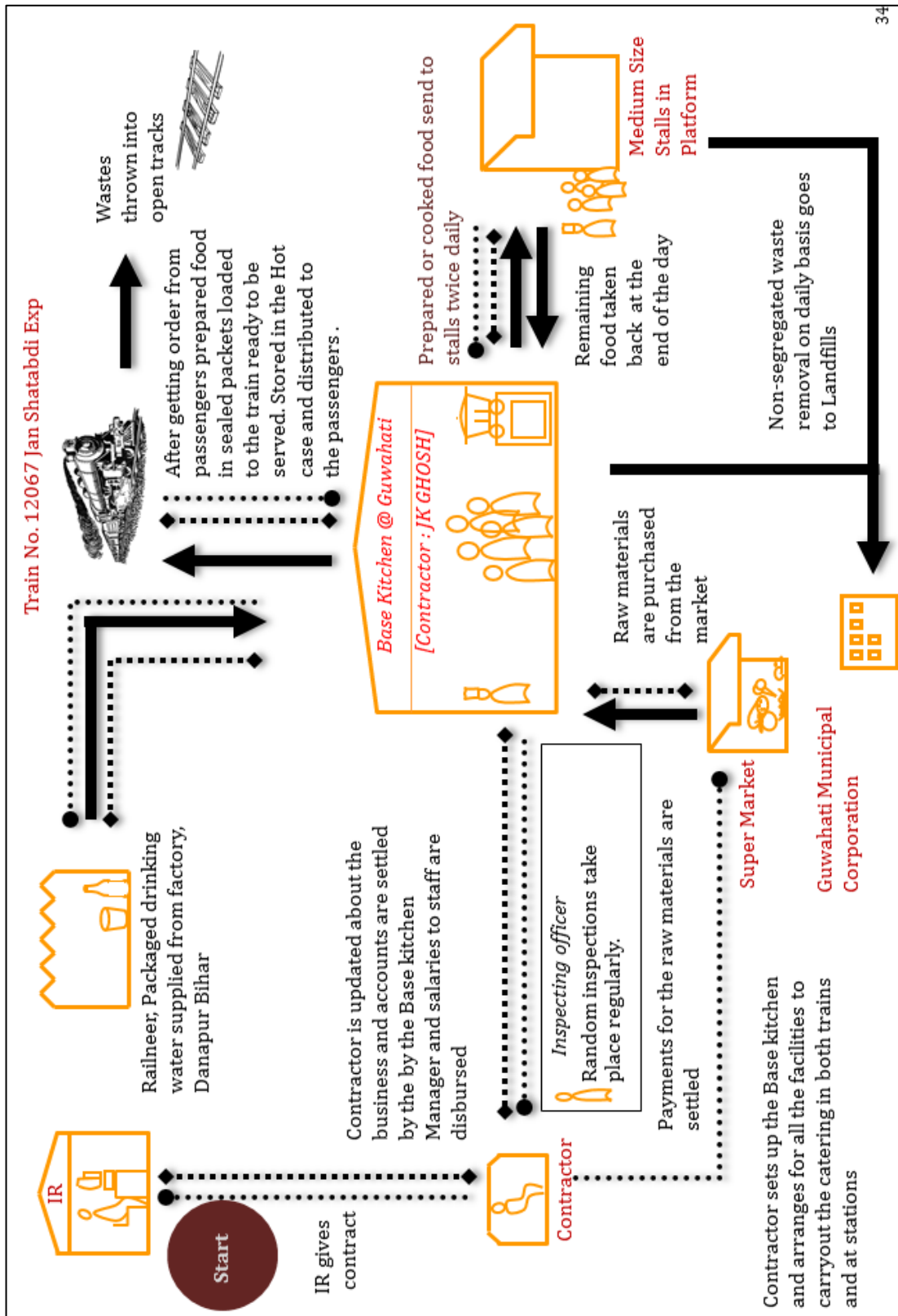


Figure 24: The existing system map for Base-Kitchen catering.

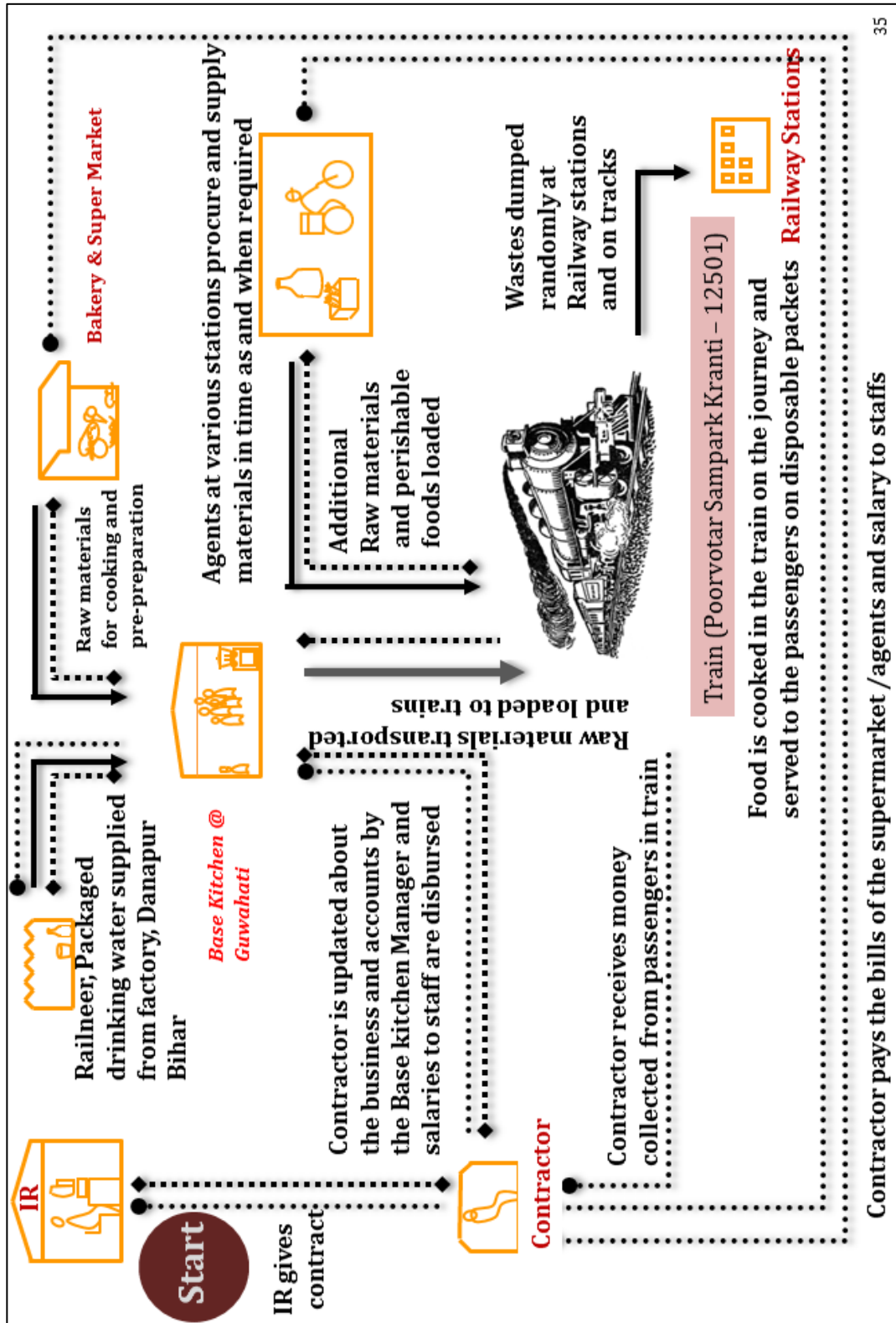


Figure 25: The existing system map for On-Board catering

3.1.7 Various Sub-systems of the existing IRCS

3.2.1.1.1 Raw Material Procurement

Raw material supply for the Base kitchen catering depends on the conventional supply chain of retailers. The raw materials are stored in the base kitchen for many days in advance depending on the perishability of the items. Vegetables are procured every alternate day from the Pan Bazar wholesale market nearby. There are also tie-ups with the retail chains in the vicinity for raw material procurement. Approximately 1 tonne of rice is used in the Guwahati base kitchen daily. About 5 tonnes of rice are always kept on stock. The spices and condiments are supplied on the spot by distributors. For on-board catering raw materials like groceries are procured and stored in the base kitchen which is then loaded in the train pantry. For perishable items the contractor has assigned agents in stipulated stations where these perishable items will be loaded in the trains. These raw materials are produced in faraway places; then collected, transported by road, stored in warehouses and handed over to the distributors and then to the retailers. This takes a long journey exhausting large amounts of fossil fuel before getting to the end user. For a transportation provider like the IR, utilizing the possibility of in-house transportation facilities could be a direction to think for optimization. Packaged drinking water comes from the *Railneer* plant from Bihar. These are also stored in the base kitchen and are loaded in the pantry car before the train leaves the originating station.

3.2.1.1.2 Food Preparation

The base kitchen has a well-protected environment for the preparation of food and has an ISO 9002 certification. Vegetarian and Non-vegetarian dishes are cooked and utensils washed separately in the base kitchen. There are also separate storage, pre-preparation, packing and dispatch areas for both veg and non-veg food. The food is cooked using LPG which is stored in a storage room and is then supplied using pipelines. The base kitchen has air curtains at all the openings and sufficient numbers of flying insect killers installed. The wastes from the base kitchen are collected and sent to the Guwahati Municipal Corporation. This base kitchen caters to certain trains where food prepared from base kitchens are loaded from the

railway stations and then distributed to passengers, directly selling at platforms to halted trains and also to food stalls at Guwahati Railway station. This base kitchen does not follow a linear flow of food preparation system due to space constraints. Food is prepared and packed and are continuously sent to platforms and also to trains depending upon the order. Refer **Figure 26** below for the space layout of the Base kitchen at Guwahati.

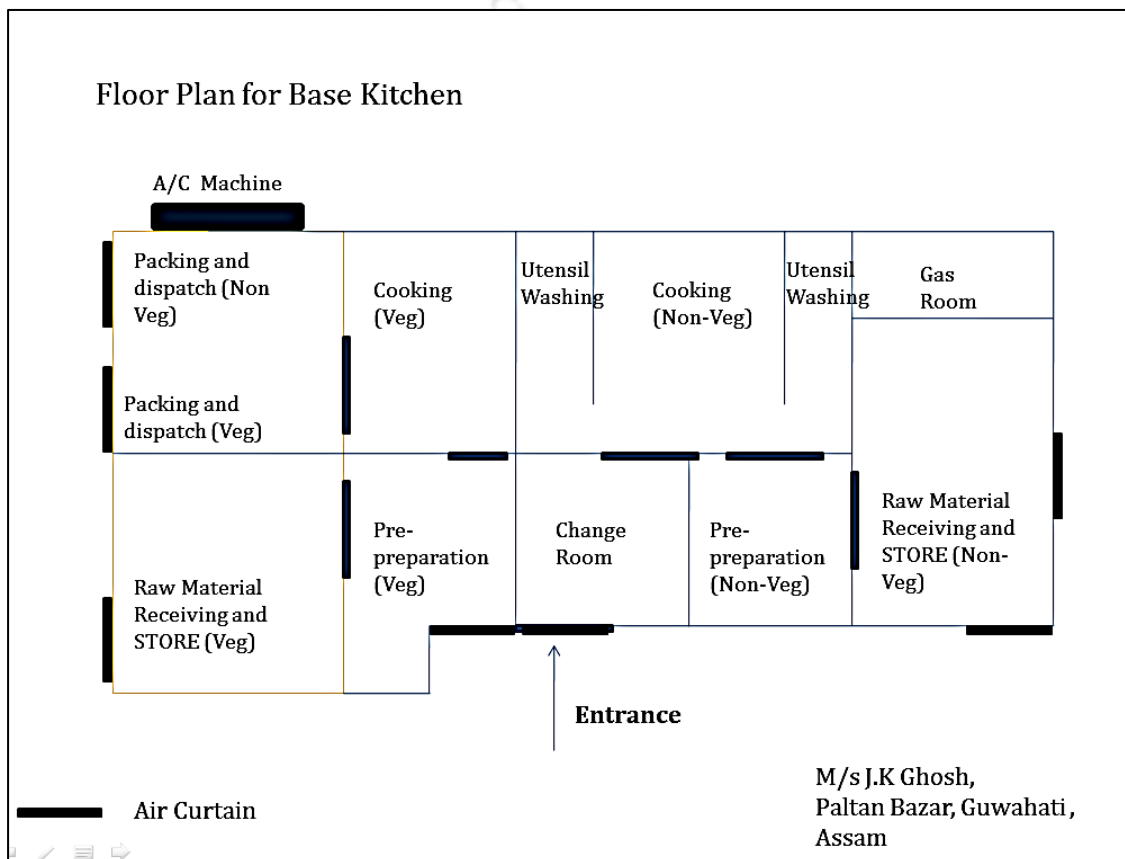


Figure 26: Floor plan of Base Kitchen Guwahati

For on-board catering the raw materials are loaded from the originating station and are topped up depending upon the demand in between the journey with pre-preparation starting as early as 4.00 AM. The pantry car is the area which is more prone to unhygienic environment. Food is prepared in the pantry cars in open burners using LPG. They are prepared, packed in disposable boxes, kept in plastic trays and are distributed manually in the compartments. There have been an

increasing number of complaints about the food prepared in the pantry cars. Refer **Figure 27** below for an inside view of the Pantry car kitchen.



Figure 27: Food preparation in Pantry Car

3.2.1.1.3 Food Distribution

For the Base kitchen catering, the prepared food is packed in disposable food boxes, kept in plastic crates and are transported to trains and platforms in covered auto rickshaws. In the railway station the food crates are kept on a trolley and are moved to the pantry compartment to be kept on the hot case. They return the crates to the base kitchen.

In on-board catering too, the prepared food is packed in disposable boxes and then kept on trays and are distributed manually in the compartments. (Refer **Figure 28** and **Figure 29** below) This is a laborious process as the staffs have to carry these trays from one end of the train to the other. Trays are provided only in the AC compartments which are usually positioned close to the pantry car while for the

sleeper coaches they carry these food packets in plastic crates. Once the food is consumed by the passengers they collect back the trays and throw the wastes and other packaging on the tracks or in waste bins. If it's a Rajdhani express train, it has a dedicated waste disposal system on board.



Figure 28: Food packing in Pantry Car



Figure 29: Food distribution in AC train compartments

3.2.1.1.4 Waste management

Large quantities of waste are generated on railway stations and trains consisting of disposable packaging wastes (both paper and plastic) and food wastes. Effective waste management should include assessment of garbage generated, provision of infrastructural facilities, arrangements for the collection of waste, their segregation and disposal complying with the rules and regulations. Report No. 6 (Indian Railways, 2007) mentions that a review of the waste management in railway stations and trains of various zonal railways revealed many inadequacies in the waste management policy. The first step to solid waste management is the assessment of the quantum of garbage generated at stations and in trains. This essentially provides the basis for assessing the infrastructure required for the collection and disposal of waste. The Indian railways did not have any mechanism to realistically assess the quantum of garbage generated at any of the stations. Moreover, only a few railway stations even have the mechanism to segregate biodegradable and non-biodegradable waste. All kinds of garbage recyclable and non-recyclable were collected in the same bins violating the rules.

In reality the waste from the pantry is thrown in to the dustbins placed at various platforms and also to the tracks. All the waste recyclable and non-recyclable are mixed together which pose a huge difficult task of segregation afterwards. There lies the need of separate disposal channels for degradable as well as non-degradable wastes from the pantry. The empty plastic bottles of the packaged drinking water, amounts to the major chunk of recyclable waste. The rag-pickers are involved in the collection, transportation and disposal of plastic waste from the railway stations. Majority of the rag-pickers are children of the age group of 5-18 years and they collect drinking water and soft drink bottles from railway tracks, platforms and train compartments and sell them to the *kabaddis* (scrap dealers). The rag-pickers would collect only value added wastes like plastic bottles, soft drink bottles; other materials like aluminium and copper and don't attend to the rest of the waste that are scattered around. So rag-pickers can only be considered as scavengers only for a small portion of the total waste generated. Around 50 -70 rag pickers including children are there in Guwahati railway station to collect value added wastes from

the platforms and tracks. Families of these rag pickers are engaged in this business and they send their children to collect these waste plastics from an early age. The dynamics goes like this: the more number of children, the better the collection of these rags. So these families have about 7 to 8 children in each family who grow up in the platform and tracks. They collect these bottles and other valuable wastes at one place and segregate it and pack them in nylon nets or in jute bags and sell these to the *kabaddis* (scrap dealers) located at a place named *Fatasil* about 4 kilometres from the railway station. (Refer **Figure 30** below) From here the sorted and crushed plastic bottles are sold to the bulk recyclers and then to organisations like the Plastic Waste Management Centre (PWMC) at Borgaon (BANGLAGARH), Hajo circle, Guwahati where it is used as raw material, to make buckets and mugs from recycled plastic. From a socio-ethical perspective of sustainability, keeping these sectors unorganised promotes the illegal activity of child labour and responsible public institutions like the IR should be able to curb this happening in their domain. One direction through which this could be tackled is to make schooling of their children more attractive to parents by disbursing subsidies, which will help these families in the long run (Ravallion & Wodon, 2000). There lies the opportunity for more value addition to this waste collected which could be made possible by forming an organised loop of rag pickers for the IR. This not only builds a case for economic sustainability but also has the socio-ethical dimension where these many families are rehabilitated by employment generation by the IR.



Figure 30: Plastic bottles collected from Guwahati Railway station

Kabaddis and rag pickers form an important network for the collection and disposal of plastic wastes from the railway station premises but this is confined only to the

value-added plastics and other materials. Anything that we deposit in the incorrect place is litter. This may be anything from a Toffee wrapper, soft drink bottle or a cigarette butt. Litter is not only unpleasant and often smelly; it can also be dangerous and injurious to people. Litter is also one of the most noticeable forms of environmental pollution. Indian railways, though has served the people of India for a long time, meeting their travelling needs, is also a major source of litter. On long distance, trains that have pantry cars, serve food to different class travelling passengers. When the finished meals are collected by the pantry staff, the trays are taken to the space between the bogeys, where there is a small opening to the track, and the trash – uneaten food, plastic bags, aluminium containers, plastic cups etc. are dumped from the moving train to the open tracks.

In railway stations the plastic carry bags and the wrappers which are thrown to the tracks, clogs the drains and causes flooding and overflow during rains, becoming a breeding ground for mosquitoes and rodents. The Indian railways have neither developed any standards for cleanliness activities nor a cohesive action plan detailing milestones or roadmaps to achieve them.

Multiple departments were involved in cleanliness activities; unfortunately leading to the lack of coordination among them and rendering the cleanliness efforts ineffective. The Railways are yet to adopt any standards or performance indicators (i.e. the expected quality of the outcome) for any cleanliness related activity carried out in stations and in trains against which the actual performance could be judged. Standards for supervision were also not prescribed for any cleanliness related activities on stations and in trains. The sources of the trash in Guwahati Railway station can be mainly classified as

- Authorized Vendors
- Unauthorized vendors
- Passengers
- Halted trains

Authorized Vendors sell various products with plastic packaging in the platforms as well as on trains in the station. They keep trash cans near their stalls which come within the loop of waste disposal by the Guwahati municipal authorities. Usage of this trash can is confined to the passengers who are using it in the vicinity of the

stalls. However, for passengers who buy things from here and spread out to the trains or some other platforms, the chances of using the stall trash cans are remote. In 21 medium snack stalls and the 2 restaurants, a lot of organic waste is generated which unfortunately are not segregated and are mixed with the other plastic wastes which afterwards pose a nearly impossible task of segregation. The GMC clears of the trash cans placed near the stalls and dumps it in the dump yard located at the Railway station premises twice daily.

The unauthorized vendors present in the station premises, who sell tobaccos, cigarettes, *gutka pan* etc., are also a source of trash as they are selling things with plastic packaging. However they are found more in moving trains than in platforms. In trains moving towards the Howrah side, it is a common experience as it is packed with unauthorized vendors who are like moving super-markets with all the goods available from fancy items to electronic goods and food & beverages. During this span, the pantry staffs are nowhere to be found in the compartments except for when they take orders for lunch and dinner and deliver them at the scheduled time. The reign of these hawkers are made possible in trains because the boundaries of the railway stations are not sealed like the airports which restrict unauthorized trespassing and entry to airport premises. Also the pantry staffs narrated incidents of rivalry and mob attacks they had to endure when they opposed this forceful entry of outside hawkers. As a result it is very difficult to quantify the waste generated from these hawkers. The number may vary from time to time and also they are mostly littered in the trains or else scattered in the railway tracks. In moving trains, the unauthorized cleaners, who pose as dedicated cleaning staff also, board; who sweeps and cleans the compartment and just pushes all the collected trash to the tracks again adding to the environmental degradation. Passengers or the visitors to the railway stations also bring plastic packed materials from home or other shops outside the railway station and discard it in the station premises which are also very difficult to quantify or the source be earmarked.

After collecting the data from the field, it was found that there are many other challenges faced by the stakeholders in carrying out the catering service both in stations and in trains. The Indian Railways (IR) network connects places across the

length and breadth of the country. The passengers travelling in a single train represents the cross-section of the whole Indian population. Due to the vast diversity of the country, food taste and cuisine changes as the train travels from one part to another part of the country. The main challenge the caterers face is to provide a menu which will be appreciated by the majority of passengers travelling by trains. Now the next step is the analysis and insights of the IRCS using the SDO toolkit. This will help us understand the parameters that require immediate attention. Setting priorities gives us an idea of the sustainability parameters in which the system scores low.

3.2 Analysis and Insights of the IRCS

Following the MSDS methodology, from the detailed study of the catering system of IRCS, the systems map were generated for a comprehensive mapping of the catering operations at the base kitchen and for on-board train catering service. The interaction direction comprehensively helps to visualize the operation from the point of view of material flow, economic activities during operations, communication exchange and the human dimension of engagement in making the operations feasible. From the system map it is now possible to assess the system for the three dimensions of sustainability viz. Economic, Socio-ethical and environmental impact using the SDO tool kit.

3.2.1 SDO Toolkit – Setting Priorities for sustainability assessment

The SDO toolkit orients the design process towards sustainable system solutions. This helps designers in: setting sustainability priorities; analysing best practices; using sustainable design-oriented guidelines; and checking and visualising the potential improvements in relation to an existing reference system. This tool is flexible in nature as it can be used as a whole or in part depending upon the nature of the selected project. In the first step the priorities are to be set in all the three dimensions of sustainability namely; Environmental, socio-ethical and economic. This is done to know which criteria is scoring low and hence needs to be prioritised and needs more attention. This helps in steering the decision towards more potentially sustainable solutions. For each dimension of sustainability the system is assessed by answering a series of checklists grouped under six different criteria. For

each criterion there is provision to write replies and comments in the field provided. After making a modified checklist (Response sheet) as the question bank with a Likert scale answering mode, it is discussed with the various stakeholders depending upon their role in the system; design priority for each criterion is assigned. (0 - 0.49 - No Priority, 0.5 – 1.49 - Low Priority, 1.5 – 2.49 - Medium Priority, 2.5 – 3.0 - High Priority). In the response sheet there are 25 questions for the Environmental Dimension, 19 Questions for the Socio-ethical Dimension and 23 Questions for the Economic Dimension which are colour coded depending upon the sustainable dimensions.

SDO Toolkit for assessment of IRCS catering system

Following the above methodology, response was gathered from the following stakeholders and experts:

- a) M1 – Catering Manager at Base Kitchen Guwahati
- b) M2 – Pantry Manager, On-board Catering, Train No. 12512
- c) S1 - Pantry Staff Static Catering Unit, Guwahati Railway Station
- d) P1 - Passenger, Train No. 12501
- e) R1 – Research Scholar in the field of Sustainability
- f) R2 - Industrial Designer.

The response sheets for each respondent were slightly modified accordingly to illustrate the response required from the subject respondent. For example, the questions were drafted based on the questions asked in the Set priorities tab in the SDO toolkit. The SDO toolkit allows slight modifications of the questions depending on the context. As in this case the main purpose was to understand the whole system from the three dimensions of sustainability. The questions were translated to regional language Hindi so that the pantry staffs can read and understand the questions in addition to a one to one discussion. A person to person interview using

the question bankcard by the researcher was carried out and the responses were marked after detailed discussion.

The following six criteria for all the three dimensions of sustainability were set and are all put together in the **Table 8** below:

Environmental	Socio-Ethical	Economic
System Life optimization	Improvement of employment/working conditions	Market position and competitiveness
Reduction in transport/distribution	Justice and equity on the part of stakeholders	Profitability/added value for businesses
Reduction in resources	Enabling of responsible, sustainable consumption	Added value for clients
Minimization/valorisation of resources	Fostering and integration of the weak and marginalized	Long-term business development
Conservation/bio-compatibility	Improvement of social cohesion	Partnership/cooperation
Non-toxicity	Reinforcement/valorising of local resources	Macro-economic effect

Table 8: The Criteria for the three Dimensions of Sustainability

3.2.2 Defining Design Priorities – Environmental Dimension for IRCS

Using the SDO toolkit and the full data on the Indian Railway catering system procured from the field studies and data collection as the foundation, the design priorities for the 6 criteria of environmental sustainability were identified. For each design criterion a series of checklists and questions were answered in Likert scale in the space provided. These answers gave a clear picture of how the system is performing for each of the selected criteria of that particular dimension of

sustainability and the overall impact on the environmental effects of the current Indian Railways catering system. This in turn gave insights to prioritising the design interventions required for the system. The Screenshot of the SDO toolkit showing the assigning of Design priorities is shown in **Figure 31** below:

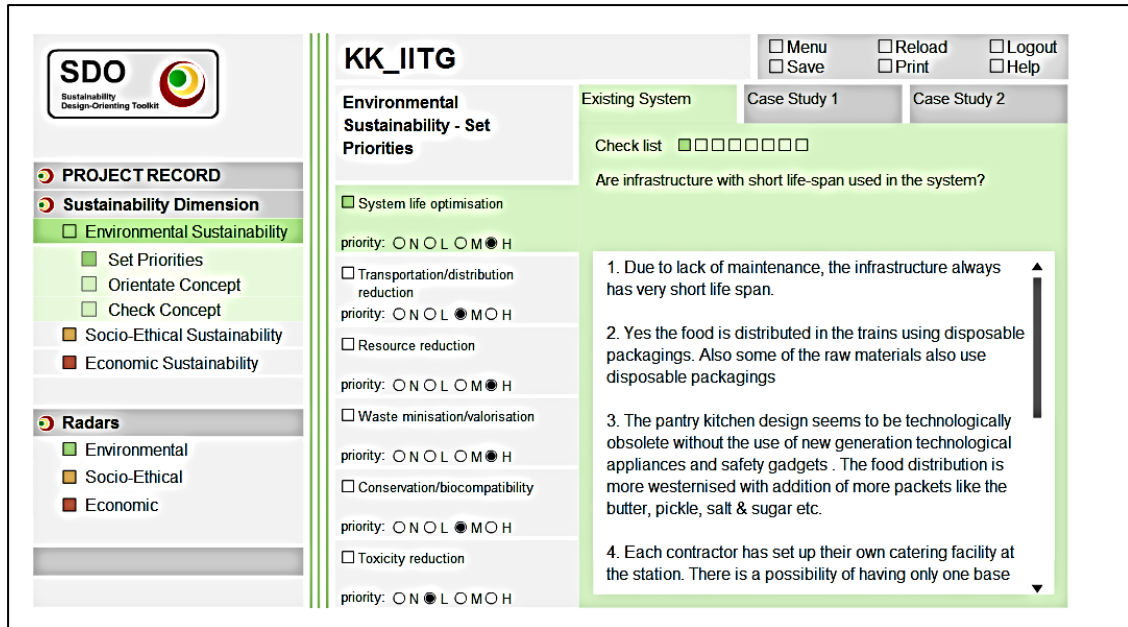


Figure 31: Assigning Priorities in the SDO Toolkit

3.2.2.1.1 System life optimization

The first criterion under the Environmental dimension is the system life optimization. Before assigning priorities the task here is to find out whether there is any infrastructure in the current system which has a short life-span. The study of the current system reveals that there exist many infrastructures with short life-spans. For example, the pantry kitchen water tanks have rapidly degenerated and have become ineffectual due to severe leakage problems. Other examples were that; the refrigerator and the hot case have gone down for a few months' time and the gas cylinder holder too seemed feeble. The burners provided by The Indian Railways are not at all sufficient which forces the contractor to carry their own burners. Even the electric fan that pushes out the smoke inside the pantry kitchen had gotten stuck. The trays used to carry food to the passengers are made of low quality plastic

which tends to get scratches easily making it look unhygienic. These problems are shown in **Figure 32a** below where the electric fan is used to dry clothes and **Figure 32b** shows a pantry staff filling water in large containers from a station as the overhead water tank cannot be used due to severe leakage. Therefore the pantry infrastructure seemed to score low in terms of sustainability and needs to be prioritised as HIGH to orient the solution towards solving this problem. Lack of proper and timely maintenance seems to be the reason for many of the infrastructures having a short life span. Another point which popped up was the possibility of base kitchen sharing with other stalls in the platforms and even trains for maximum utilization of the infrastructures.



Figure 32: Infrastructures with short life-span

The next checklist question was whether disposable product packaging and support products were used in the system. The Indian Railway catering system consumes a lot of disposable packaging. The food in trains are served in disposable containers, the water is served in plastic pouches, all of which are thrown directly into the tracks thereby creating a huge environmental threat. This littering is seen more in the non-ac compartments as the windows are open. This is in addition to the snacks and beverages sold in the Railway station premises. In Guwahati Railway station alone, around 850 kgs of wastes are generated daily which goes to the landfills without segregation. (**Figure 33** below) This non-segregated waste may also

contain plastic non-degradable as well as toxic materials. Therefore this seemed a HIGH Priority.



Figure 33: Waste generation due to disposable packaging

On whether parts of the catering system tend to be technologically, culturally or aesthetically obsolete; the pantry kitchen which is commonly in use in the train at present is technologically out-dated with open burners and more heat loss. The pantry design has not been updated since years and it lacks modern efficient kitchen equipment like a chimney, hot cases, pest traps etc. and thus lacks hygiene. There are many reforms the Indian Railways are planning to implement in pantry kitchens of the trains in the near future. As an attempt to curb incidents of fire that originate in the pantry cars, Northern Railway has decided to do away with the conventional resistive coil burners and gas cylinders. Revamping the pantry cars, the Delhi division of the Northern Railway has introduced induction-based cooking stoves (Priyanka sharma, 2013). Until then this would remain a criterion that needs to be put on HIGH priority.



Figure 34: Obsolescence of Pantry Kitchen

Whether the system facilities are shared efficiently: Guwahati Railway station itself has three Base kitchens by different catering contractors. The kitchens are utilized only to half of its capacity. This underutilization of the base kitchens could be limited by planning accordingly and could be shared so that its usage is optimized. This was given MEDIUM priority.

3.2.2.1.2 Transportation/Distribution reduction

The base kitchen is situated away from the Railway station and vehicles need to be shuttled many times between the railway station and the base kitchen to transport prepared food and return their packaging. Since the base kitchen premises have limited storage facility, raw materials need to be transported frequently to the kitchen. The excess or the left overs are returned back to the base kitchen before sending them to the landfill sites. A proper segregation at that stage could have been more helpful in avoiding excessive transportation of wastes. The transportation means in this case is not fully used as the base kitchens are located at different parts of the city. A centralised base kitchen, a strategically located base kitchen or a base kitchen on the Railway station premises could have been considered to reduce the excessive transportation associated with this model. Also, a point observed was that the food is packed in separate food packets which need to be again carried from one compartment to another. A suitable trolley design can considerably reduce the food distribution overload from the pantry staff. After getting responses from the subjects, this parameter was assigned MEDIUM priority.

3.2.2.1.3 Resource Reduction

The base kitchen neither uses any non-conventional sources of energy nor natural ventilation and lighting. Adopting this could have reduced the consumption of energy and resources. In pantry cars the open burner design makes the fuel consumption high due to cross winds which sweep in through the openings of the pantry kitchen while the train is in motion. The system is consuming high quantities of natural resources due to the lack of use of natural energy for heating, pre-heating, lighting and ventilation. Moreover, the systems promote the use and throw culture which consumes more resources. Even the lack of timely maintenance results in the usage and wastage of more resources like water. The packaging in which the food is distributed, aluminium foils, plastic bottles, spoons etc. are material intensive when compared with the number of cycles of use (Hocking, 1994). In the Indian context, where there are cheaper modes available for washing utensils for reuse, using reusable containers and plates can reduce resource consumption. This is assigned HIGH priority.

3.2.2.1.4 Waste minimisation/Valorisation

The major portion of the wastes generated do not end up in landfills and are littered through the tracks and pose a threat to the environment by clogging the drains and mixing with water and other natural resources. As discussed in section 3.2.8.1.4, this parameter is assigned HIGH priority.

3.2.2.1.5 Conservation/Biocompatibility

The energy used throughout the system is produced from exhausting resources. Non-conventional sources of energy are not used in the system. Less green materials used and fewer considerations given for conservation of eco systems. This parameter is given MEDIUM priority.

3.2.2.1.6 Toxicity Reduction

In this system, the processed resources are not toxic or potentially toxic for the workers during distribution. In the overall system the cheap quality plastics used for serving warm food could be harmful to the users (Schuler, 2008). As the utensils

used in the kitchen are made of food grade stainless steel, toxicity is of not much concern. However, the vegetables used may be the one treated with chemical pesticides. This parameter is given LOW priority.

For the dimension of Environmental sustainability, the average of the responses obtained from the respondents was noted and is summarised below.

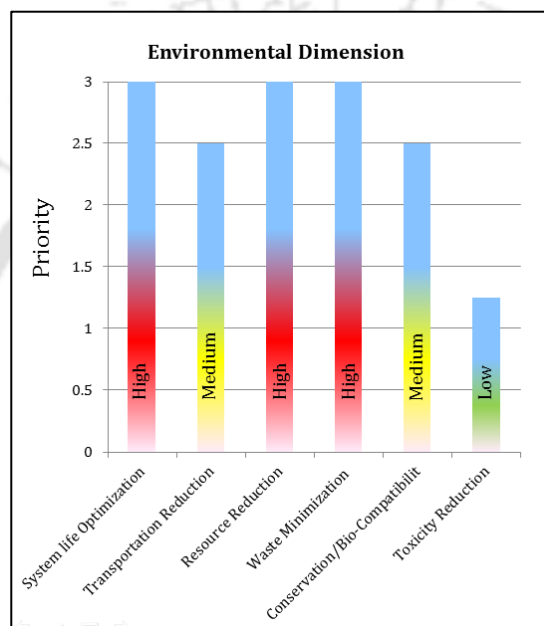


Figure 35: Priority for Environmental Dimension

As shown in **Figure 35**, it is evident that for the environmental dimension, only the parameter of toxicity reduction has low priority assigned while the parameter conservation, bio-compatibility and transport reduction is given medium priority. Three of the six parameters are given high priorities. The inference obtained from SDO toolkit denotes that the parameter which is given high priority means that it is scoring VERY LOW in that concerned parameter. The parameter which is given medium priority means it is scoring LOW in that aspect of sustainability and Low priority means Scoring MEDIUM and If no priority is given, it represents it is scoring HIGH in that parameter in the aspect of sustainability. The priority Index is shown in

Figure 38. For the existing IRCS, 5 out of 6 parameters are showing low or Very low scores which make it conclusive that the existing system is scoring low in the dimension of Environmental Sustainability.

3.2.3 Defining Design Priorities – Socio-ethical Dimension

For socio-ethical dimension, the six parameters considered are as follows:

3.2.3.1.1 Improve employment and working conditions

There are a few problems related to health and safety at the work place. Due to extreme temperature especially in the summer, the working conditions in the kitchens are unbearable to the kitchen staff and also, the distribution staffs has to carry the food crate through long distances from one end of the train to the other. Most of the time the compartments will be crowded which makes the movement of the supply staff difficult. Moreover, the working hours for the pantry staffs are very tiresome due to lower number of staffs and also due to extended working hours. The LPG cylinders are loosely strapped and not secured properly which makes it unsafe to be used in moving trains. This parameter is given HIGH priority as this needs to be addressed in the proposed system.

3.2.3.1.2 Improve equity and Justice in relation to stakeholders

To a certain extent the stakeholders are criticising the system. The pantry contractor criticizes the Indian Railways for not providing adequate support in terms of maintenance, upkeep and upgrade. The passengers criticise the caterer for various reasons like quality and price of food delivered. This was given MEDIUM priority.

3.2.3.1.3 Enable responsible and sustainable consumption

To enable responsible and sustainable consumption, all the stakeholders should be made aware of sustainability in general and specifically in their expertise and area. Passengers travelling have the awareness of a responsible sustainable behaviour. This was reflected in their response on sustainability and waste management of Indian Railways. The contractor, pantry manager and staffs should be made aware of the unsustainable patterns in the current production and distribution system so

that they can acknowledge the degree of unsustainability present in the existing system. This parameter is given HIGH priority.

3.2.3.1.4 Favour/integrate weaker and marginalised strata

There is no direct indication that the system creates obstacles or limit access to people with weaker social status. In fact with the outlets like Jan Aahar, IR has made accessible and affordable food to people with lower income. This parameter gets a LOW priority.

3.2.3.1.5 Improve Social Cohesion

The labour involved, the working hours and timings, of the present system makes this system not suitable for ladies. There seems to be monopoly of men present in the system. However, there isn't any intra cultural or intra-generational exclusion. This parameter is given MEDIUM priority.

3.2.3.1.6 Empower/ valorise local resources

It is observed and discussed that the current system is impoverishing the local cultural values and identities. The traditional way of cooking and serving food is not encouraged by ignoring the regional menus. The westernization of food is very evident. The middle men and traders take the lion share of the profit and the local producers are not uplifted resulting in the local population shifting to new avenues for a better living. The support that a national agency like the IR can provide to uplift the local population is not fully exploited. This parameter is given MEDIUM priority.

For the socio-ethical dimension of sustainability the assigned priorities are compared and discussed with the respondents and is summarised below.

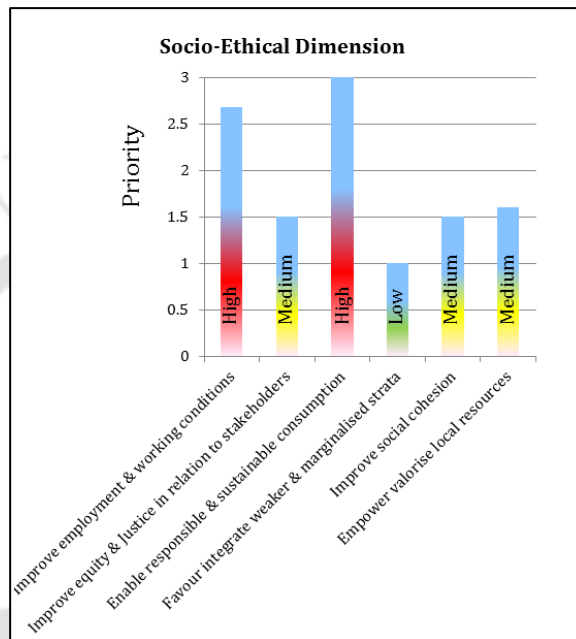


Figure 36: Priority for Socio-ethical Dimension

As shown in **Figure 36** above, it is evident that for the socio-ethical dimension, only the parameter of Favour/integrate weaker and marginalised strata has low priority assigned while the parameter Empower/ valorise local resources, Improve Social Cohesion and Improve equity and Justice in relation to stakeholders are given medium priority. Two of the six parameters are given high priorities. The inference obtained from the SDO toolkit denotes that the parameter which is given high priority means that it is scoring VERY LOW in that concerned parameter. The parameter which is given medium priority means it is scoring LOW in that aspect of sustainability and Low priority means Scoring MEDIUM and If no priority given represents it is scoring HIGH in that parameter in the aspect of sustainability. With reference to the priority index shown in figure 37, in the socio-ethical dimension of

sustainability the existing IRCS, 5 out of 6 parameters are showing low or Very low score which makes it conclusive that the existing system is scoring low in the dimension of socio-ethical Sustainability.

3.2.4 Defining Design Priorities – Economic Dimension

3.2.4.1.1 Market Position and Competitiveness

Even though IRCS is a monopolistic governmental organisation, it does not have a strong market position due to the competition from various private players in the area of catering. The passengers always look out for other options. The increasing number of complaints from the passengers reveals that there is a lot of scope for improvement of the system in terms of quality, quantity and value proposition. At present there are a number of threats and competition from private players like *comesum* and *dial a meal*. Considering these factors, this parameter is given MEDIUM priority.

3.2.4.1.2 Profitability/Added values for the companies

The profitability for the current system is not low as the statistics shows (discussed in section 2.5.7). Also since IR has commitment towards the society, providing good food at reasonable prices has been their motto from the beginning. The platform vendors provide other meal options to the passengers. But the quality of such food distributed is not monitored. So many passengers are not relying on food from the local suppliers. It can be seen that in the AkshayaPatra mid-day meal scheme for school children, they prepare large quantities of food with strict monitoring of the quality at reduced expenses which is a value addition to be highlighted. Similarly for the IR, providing good quality, organic healthy food could be an area of value addition. In trains you will find many vendors wearing similar uniforms as the pantry staffs and are trying to make use of this opportunity. Considering all these this parameter is given MEDIUM priority.

3.2.4.1.3 Added Values for Customers

There are many complaints from the passenger's side regarding value for money. It seems that they are expecting more from the IR. There are a lot of materials being used as packaging and energy being spent for preparing each meal. If this can be

reduced there could be more value addition in terms of the pricing to the customers. More than one meal options should be offered to the users as some passengers may be ready to pay more to get more value or variety or service. There are many unauthorised vendors providing low cost meal options to passengers which may not be of good quality and prepared under hygiene conditions. This trend is growing due to the inability of the IR to provide good food to the passengers. Had the competitors been able to provide an assurance of quality along with the affordability then it would have been the preferred menu for many passengers. At present there are guidelines that have been issued to all railway zones to provide special meals on demand to diabetic and heart patients among passengers travelling on premium trains like Rajdhani and Shatabdi trains. This parameter is given HIGH priority as value addition is one of the best reforms in the positive direction which can bring in more revenues and goodwill to the IRCS.

3.2.4.1.4 Long term business development and risk

There are possibilities that in the long run many unauthorised private payers may make use of this deplorable situation of the IRCS and mint money. This trend if not done as an initiative with opening doors to authorised private players may result in bringing more disgrace to the IRCS. The IR can plan for long term as the passengers' need for this service is not going to disappear. This factor is given MEDIUM priority.

3.2.4.1.5 Partnership/Collaboration

Due to many reasons, a major share of users turns to other sources and also there is a bad impression about railway food among the passengers. Many of them even had some bitter experiences. New partnership seems to be a promising direction in which the IR can think of its future collaborations because of the missing competencies internally as it is required for today and for the future. This is given MEDIUM priority.

3.2.4.1.6 Macro-economic Effect

Even though the IR has a monopolistic structure, it shows the trait of a very flexible structure which is open to changes and adoption of good practices. This parameter is given LOW priority.

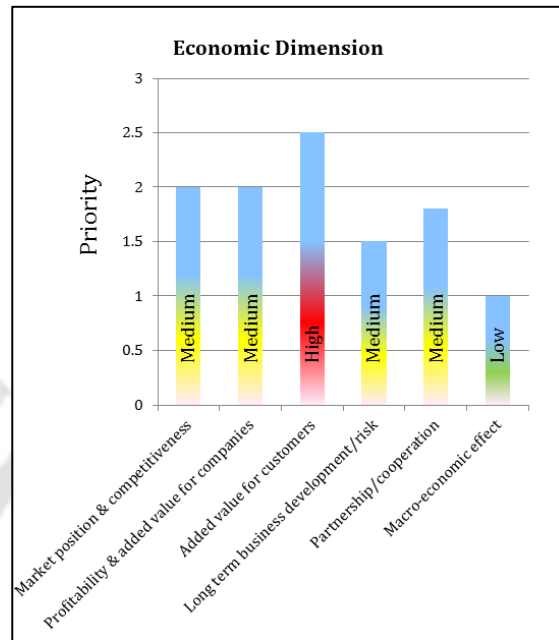


Figure 37: Priority for Economic Dimension

Priority:	No	Low	Medium	High
Sustainability Score:	High	Medium	Low	Very Low

Figure 38: Priority Index applicable to all three dimensions of sustainability

For the economic dimension there is only one parameter which is scoring high i.e. added values for the customers. All the other parameters are having low score (Medium Priority) in terms of the sustainability parameters. (Refer **Figure 37**). The similar results for all the three dimensions of sustainability shows that the existing system is scoring low in terms of the three dimensions of sustainability namely Environmental, Socio-ethical and Economic. This elucidates the first hypothesis (H1) which states that the present catering system in the Indian Railways scores low on sustainability parameters viz. economic, environmental and socio-ethical.

3.2.5 Problem Identification and Insights of Existing IRCS

After the interaction with various stakeholders of the system, and analysing through the response sheets, many problems were identified with the existing system. Under the environmental tab the problems identified can be listed down as:

- Life-span of the Infrastructure is low and not sufficient
- Use of large quantities of disposable product packaging creates large waste generation.
- Inefficient waste management system.
- Dependency on Energy from Fossil fuels.
- Inadequate Conservation of Natural resources

These are the points to be kept in mind while outlining the improved system. Similarly for socio-ethical dimensions, the problems identified are:

- Pathetic and unbearable working conditions in the pantry kitchen.
- Tedious and laborious distribution system of food packets in trains for the workers.
- Need for protecting the interests of the contractor from unauthorized vendors
- Scope of introducing procurement of raw materials from local farmers by including them as a stakeholder
- Less employment for women folks

For the economic dimension the problems identified are:

- No goodwill for the Railway Food as only 33 % passengers' avail food prepared by IRCS
- Less variety of food options available in Railway food
- Tenders are not transparent (No e-tenders)
- Scope of revenue from waste valorisation
- Conserve Natural resources like water by rain water harvesting natural ventilation etc.

The issues listed above give an idea of the problems with the existing system, which would be helpful while outlining the system when the reference system is analysed to identify the benchmarking practices to be drawn to design the proposed and more sustainable system.

The results obtained from Phase – I are the system maps of both the base kitchen catering and on-board catering of the existing Indian Railway Catering System (IRCS), the passenger survey results, through SDO toolkit the problems with the existing IRCS, the priorities to be assigned in terms of the three dimensions of sustainability namely environmental, socio-ethical and economic and the interaction between the various stakeholders.

3.3 Phase – II: Study of reference system - AkshayaPatra

The Method for System Design for Sustainability (MSDS) demands an analysis of cases of excellence that could act as a stimulus during the generation of ideas. This compares the offer in each case of excellence, interactions with the user, the offered producers and providers, and its sustainability characteristics.

The aim of this phase is to thoroughly study the reference system, identify its stakeholders and their interactions, identify the best practices and the improvements of the reference system in terms of the three dimensions of sustainability, generate the system map and to identify those practices which are considered better in terms of the three dimensions of sustainability that can be adopted in similar systems.

As discussed in section 2B.1.2, there are many case examples like Warana PURA Mission, Mumbai Dabbawalas, Amul Movement, and AkshayaPatra Foundation & Mid-Day Meal Scheme (MDMS) in Primary School Education which could be considered for a detailed study to be picked as the reference system. However, in this case the AkshayaPatra Base Kitchen was short listed as a reference system for benchmarking as it was a model system in scale which can be compared (Refer **Table 9**) with the catering system of IRCS. For data collection purpose, AkshayaPatra Base kitchen is selected which is comparable with the IRCS of NFR in Guwahati.

Indian Railway Catering system		AkshayaPatra Mid-day meal program	
No. of meals served per day (All over India)	0.52 million	No. of meals served per day (All over India)	1.3 million
No. of meals served per day (in Guwahati)	10000 (Base kitchen) 1000 (Onboard single train)	No. of meals served per day (Guwahati Base Kitchen)	50000
Quantity of rice for each meal	150 gms	Quantity of rice for each meal	Lower primary school: 100gms Secondary School: 150 gms
Menu	Rice, Dal, Sabzi, Roti, curd, Pickle	Menu	Rice, Dal, Sabzi

Table 9: Comparable systems: IRCS and AkshayaPatra Base kitchen

The APF Base kitchen, Guwahati and the IRCS at Guwahati Railway station are comparable scenarios if not exactly the same; in terms of nature of business, quantity handled and also goals to be achieved where in both have the scope of scaling up. Both these systems have the common factor 'mobility' involved in it. They both prepare food at the base kitchen and transport it to the place where it has to be served. They have similar menus and are also dealing with perishable items as the prepared food has to be consumed on the same day. There is also similarity in the consumption pattern of both these systems. The logistics, the communication

systems, the technological support and the manpower are also comparable in these two cases which render the AkshayaPatra to be chosen as the reference system. .

Even though Indian Railways were started long back it can be seen that modernisation has been introduced only during the last quarter of the previous century. Till then services like catering were directly done through the department and staffs. In 1999, IRCTC, a subsidiary to handle the catering and ticketing was constituted which has given way to the introduction of the PPP model in Indian Railway catering. This has, to a certain amount reduced the inertia for change which IR had before the modernisation. Now it can be seen that IR is also following the path of transformation to a zealous system for change. On the other hand AkshayaPatra foundation is recognised as a successful organisation formed in the year 2000 which is feeding poor schoolchildren at lunchtime. This also functions by the PPP model and are very open to the change and technological advancements happening around. Moreover, these two systems have a very crucial social role to play. While the IR is providing affordable food for the middle class and lower middle class train passengers of India, the AkshayaPatra caters to the school children from poor family backgrounds. Both these systems play a major role of socio-ethical responsibility which makes both of them comparable in terms of the higher goals it aims to achieve.

In addition, the AkshayaPatra base kitchen was also situated close to the IIT Guwahati campus and its operations were easy to access and examine for the purpose of this research. Close proximity also provide easy access to the different stakeholders for interview and data collection.

However we need to know the background details of the Mid-day meal scheme of the government of India to understand the contributions of the AkshayaPatra Foundation and its role and contribution to the Mid-day meal program intended to government schools across India before studying this system in detail.

3.3.1 About the Mid-day meal Program of Government of India

Health and Education are important domains in which the Government of India intervenes through various social schemes.

The Government Mid-day meal program in India is the world's largest school feeding program reaching out to about 0.12 billion children in over 1.265 million schools across the country. It has a long history. The scheme promises lunch free of cost to the children on all the working days.

Studies show that the primary school enrolment rate in India has increased over the years. However, school dropout rates continue to be high and even though there has been a slight decrease here, it is one of the most important factors for poor literacy. The Indian social mind-set is such that children are treated as bread winners in most low income homes. At a comparative level, more girls (61.5%) drop out of high school than boys (58.6%). At middle school more boys drop out than girls and at primary levels the dropout rates are marginally higher for girls (Alim, Khalil, Mirz, & Khan, 2012).

In India poverty is the main reason why students drop-out of government schools. Inability to pay the school fee, the cost of uniform, shoes, transport, stationary, adding to the agony, many of them who go to schools, go with an empty stomach. These impoverished children perform poorly in schools due to short attention spans associated with hunger. Many students, who enrol, discontinue schooling at a very early age and seek work to earn money to feed themselves and their families. The biggest problem facing the schooling system is that over 50% of children who join up in Class I drop out by Class VIII. A large percentage of children are unable to benefit from the free educational facilities provided by government because they are needed at home to participate in the basic tasks of the household economy (Laxmaiah et al., 1999).

The Supreme Court of India passed an order on November 28, 2001 which stated that, "Cooked Mid-Day meal is to be provided in all the government-aided primary schools in all the states." The main goals of implementing the programme were to provide protection to the children from classroom hunger, decrease the dropout rate, increase admission and attendance in the schools, and improve socialization among the children who belong to different castes. Studies have shown that school meal programmes exert a positive influence on enrolment and attendance in schools. A hungry child is less likely to attend school regularly. Hunger drains them

of their will and ability to learn. Chronic hunger can lead to malnutrition. It also delays or stops the physical and mental growth of children. There is also evidence to suggest that apart from enhancing school attendance and child nutrition, mid-day meals have an important social role to foster equality. As children learn to sit together and share a common meal, one can expect some erosion of caste prejudices and class inequality.

3.3.2 The AkshayaPatra Foundation (TAPF) and Mid-day Meal program

AkshayaPatra Foundation is an NGO that has been making one of the most significant contributions in the successful implementation of the Mid-day meal program in India.

The AkshayaPatra Foundation (TAPF) joined hands with the Government of India and offered to run centralised base kitchens in both urban and rural areas, to meet the challenge of preparing food for school children as part of the Mid-day meal program. As very few mid-day meal programs operated in rural districts AkshayaPatra began its rural services in August 2005 in the region of *Baran*, located in east Rajasthan. By the year 2007, TAPF (The AkshayaPatra Foundation) had expanded to feed 567,622 children daily in 2,000 schools in ten locations in India. At present TAPF caters to 1.3 million children across 9 states and 18 locations. The AkshayaPatra Foundation is regarded as an excellent demonstration of a public-private partnership, as it is run partly with the subsidies from the Government, besides financial support from corporates, individuals and philanthropists. AC Nielsen, an independent research firm, performed an impact assessment in 2010, measuring key indicators such as enrolment, attendance and health of school children. The study demonstrated an increase in enrolment, especially among the female students, and better health and improved performance among all students who received school lunches.

It was in the year 2009, that the state government of Assam invited the AkshayaPatra Foundation to start functioning in the state. The foundation set up their unit in Amingaon, North Guwahati and began to cater to 385 schools with 5000 students. Now it is currently serving about 50,000 children in the rural areas of

Guwahati, Assam. With more than a hundred employees running the base kitchen, the aim of the organization is to extend their facilities to 0.2 million students in the coming years in Assam alone.

3.3.3 Design Assessment Workshop of AkshayaPatra Base Kitchen, Amingaon

Field visits were undertaken to make a detailed study of the AkshayaPatra Foundation base kitchen as the referral system for study, The complete system was studied by visiting the base kitchen and accompanying vehicles to the schools in order to understand the operations of the whole system The focus of the study was to examine its operations on aspects of sustainability and to identify design interventions that may help further optimize operations of its Mid-day meal program. The following themes formed the focus of enquiry:

1. Study of operations of the central kitchen from a sustainable perspective – economic, socio-ethical and environmental.
2. Sustainability and scalability
3. Design and Social responsibility.

3.3.4 System study of AkshayaPatra Base Kitchen

A tour of the central kitchen was undertaken and study was done on its various operations including technical aspects at each stage in detail. A video presentation of the step by step process was shown along with a power point presentation, followed by a question answer session and a brainstorming session. The detailed study included aspects of the following stages of running the kitchen: Planning of the schedule, Procurement of food grains from FCI, Procurement of vegetables from the local farmers, Cleaning of food grains, Cooking of rice, lentil (dal) and vegetables (*sabji*), Packaging of ready food in stainless steel vessels, transportation of food in insulated vehicles to the schools, other related issues like material handling, housekeeping, administrative jobs and maintaining accounts, returning vessels from the schools to the central kitchen, washing of vessels, preparation of schedule for the next day's requirement.

Beyond the main consideration of rendering social service, AkshayaPatra has been successful in creating a culture of sustainable practices throughout the organization.

From their centralized kitchen model it is very clear that the management is aware of the environmental and social issues and also their effect to the organization's financial performance. For example the use of thick gauged (1.6mm) stainless steel material for the vessels give it a long life and also reuse of the same vessels many times which eliminates the wasteful use of any plastic containers and packaging that generates wastes. The washing of these utensils are also done in a very systematic and efficient manner. This can be a useful method of adoption for organizations like Indian Railways where a good dish washing system if developed can help reduce the use of plastic packaging that can eliminate large volumes of waste generated and its management. The quality checks at each step and the surveillance of the wastes at all stages not only make the process more effective but also give leverage to the environmental factor (refer **Figure 39** below).

The centralized kitchen uses automation and mechanization wherever possible. Cutting the vegetables after it is cleaned, for Sāmbhar and *sabji*, are carried out in an automatic cutting machine that could vary in both shape and size depending on requirement. The right level of automation has the advantage of both improving efficiency through mechanization as well as utilizing the local manual labour, thereby fulfilling the social responsibility of supporting the local population through employment.

AkshayaPatra Foundation is a good example of a product service system as they are not just preparing food but the whole process is defined from raw material procurement, cooking, packaging, transportation, return of vessels and waste disposal making it a closed loop. This closed loop makes waste minimization possible and waste disposal minimal. It is a good example of a product service system where a service of providing meals to the school children are rendered thereby making the future generations healthy and more productive. However there exists scope for design intervention that can enhance the optimization of the existing PSS model through efficient transportation, distribution and customization of the menu preferences and the use of local labour.

Shown below is the schematic diagram of the various stages of catering system followed at the AkshayaPatra base kitchen with details of the:

1. Pre-preparation stage with quantities of food grains stored as inventory including Cereals and pulses, vegetables, Spices and its Quality checks
2. Food preparation stage outlining the daily consumption of Food grains, Fresh produce like vegetables, consumption of water, fuel and electricity
3. Distribution stage outlining modes of transport and delivery of food
4. Disposal stage outlining the generation of waste.

A schematic diagram also highlights the quality checks during the different stages.

(Refer **Figure 39**)



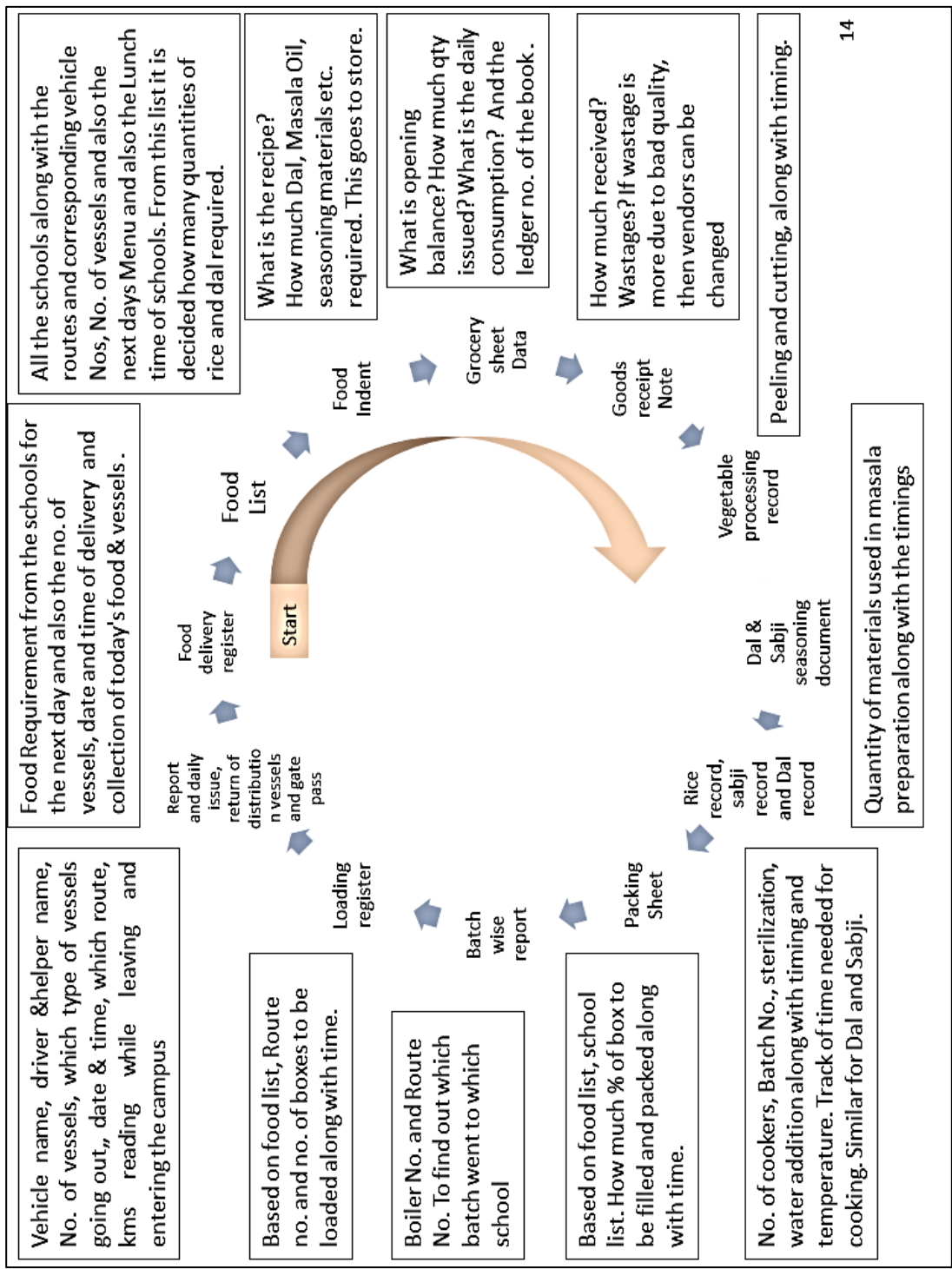


Figure 39: Quality checks at each stage

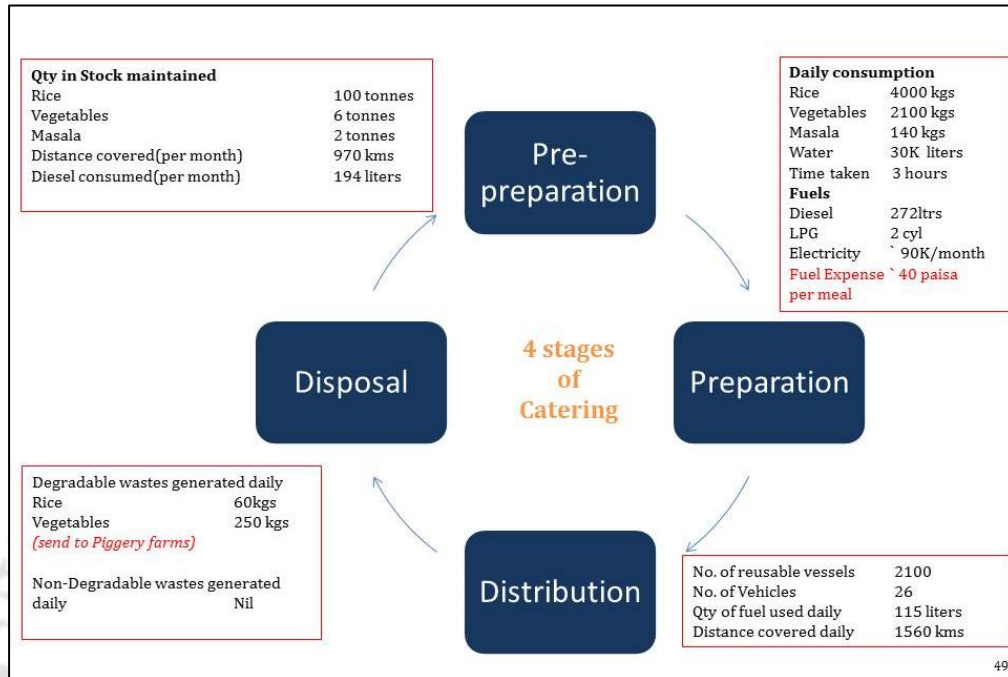


Figure 40: Data in the four stages of catering in AkshayaPatra

3.3.5 System Map of AkshayaPatra Base Kitchen

The System Map supports the (co)-designing and visualisation of the system structure, indicating the actors involved and their interactions. It is basically a graphic representation showing the socio-economic actors involved in the system and the different interactions between the various actors: material and/or product flows and those of information, money and work. The system map of AkshayaPatra Base kitchen is given in **Figure 41** below:

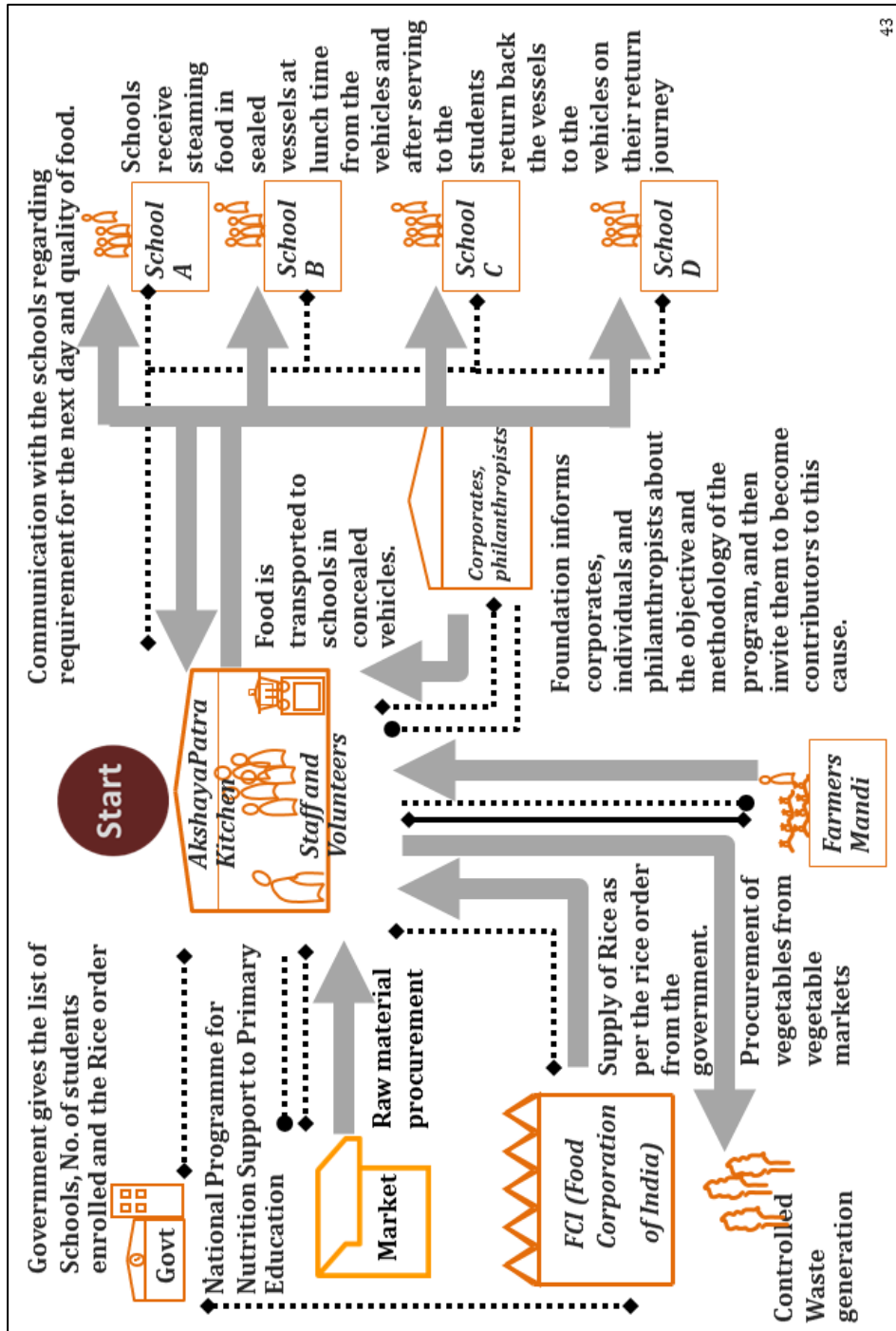


Figure 41: System Map of the AkshayaPatra Base Kitchen Guwahati

The AkshayaPatra Foundation, the subject case example for this research is an NGO organization that effectively operates and contributes invaluable to the society in the context of social needs that meet priority requirements of a developing country like India. The visit to the base kitchen gave an exposure to understand 'good design' practices that need large-scale handling and delivery but at the same time are sustainable, less wasteful and maintain high quality and hygienic standards in operations. It brought about an enriching understanding of the socio-ethical dimension of design intervention that focuses on social responsibility, ethical values that go beyond considerations of profit making and situations that the designer will be confronted in professional practice in the near future. A pertinent aspect to consider is one of sustainability and scalability. How sustainability criteria can be met when food is to be served to larger number of schools. Logistics of operations will have to be reassessed and a simple scaling up of the central kitchen may not be a sustainable solution.

3.4 Analysis and Insights of the reference system - AkshayaPatra

Following the same procedure as applied to the assessment of the IRCS, the operations of the AkshayaPatra base kitchen too as the referral system is analysed applying the SDO toolkit. Here the reference system is analysed based on all the three dimensions of sustainability namely; Environmental, socio-ethical and economic. This is done to know which criteria can be considered as the best practice which could be potentially a solution to be adopted in IRCS systems as well. For each dimension of sustainability the system is assessed by answering a series of checklists grouped under six different criteria. For each criterion there is provision to write replies and comments in the field provided. After making a modified checklist (Response sheet) as the question bank with a Likert scale answering mode, it is discussed with the various stakeholders depending upon their role in the system; design priority for each criterion is assigned. (0 - 0.49 - "-", 0.5 - 1.49 - "=", 1.5 - 2.49 - "+", 2.5 - 3.0 - "++"). In the response sheet there are 25 questions for the Environmental Dimension, 19 Questions for the Socio-ethical Dimension and 23 Questions for the Economic Dimension which are colour coded depending upon the sustainable dimensions. The stakeholders and experts from whom the responses

were discussed and gathered are: a) M3 –Manager (Operations) at AkshayaPatra Base Kitchen Guwahati b) R1 – Research Scholar in the field of Sustainability f) R2 - Industrial Designer. The response sheets for each respondent are slightly modified for him/her to elaborate the response required from them. A person to person interview using the question bankcard by the researcher was carried out and the responses were marked after detailed discussions. Many good practices were identified in the AkshayaPatra system which gives it a good score on most of the criteria in each dimensions of sustainability.

3.4.1 Environmental Dimension for AkshayaPatra Base Kitchen

From **Figure 42** it can be inferred that three parameters out of the six in the environmental dimension are scoring high in the reference system. They are the system life optimization, waste minimization and toxicity reduction. A thorough scrutiny reveals that the practices adopted in AkshayaPatra as a very responsive system in the maintenance and other related activities seems to be the reason for this. They have quality checks at each stage which are completely documented. They have clearly demarcated responsibilities for their staffs. This makes the system a well maintained one with the timely maintenance and upkeep. From this point it can be inferred that a clearly demarcated schedule of maintenance and upkeep along with a demarcated duty responsibility could be identified as one good practice which is helping AkshayaPatra system scores high on the criterion of system life optimisation. For waste minimization their strategy of reducing the usage of materials which becomes wastes after their use is the successful formula to reduce waste generation. They use only reusable packaging and utensils and hence are able to achieve the stage of zero wastage thrown to the environment. Another important aspect is the use of a good communication system for giving the information about the requirement of the next day which makes the planning for the next day more accurate thereby reducing large quantities of food waste. Other practices which the AkshayaPatra base kitchen has adopted are the maximum possible use of natural light and ventilation in their kitchen which helps them in reducing the electricity consumption which leads to resource reduction. The kitchen has a good water

filtration plant in place which enables the reuse of water for purposes like vehicle cleaning, gardening etc.

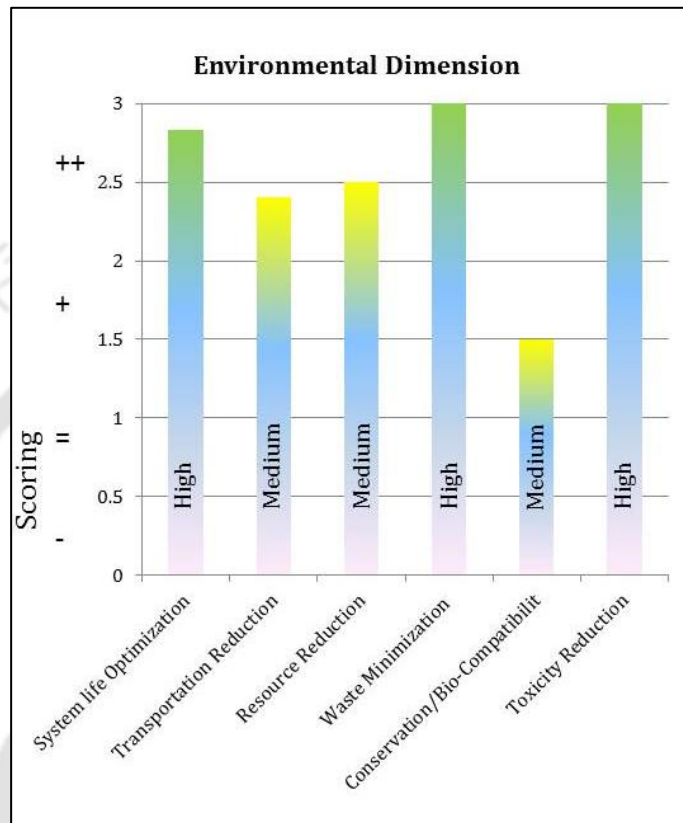


Figure 42: Scoring of AkshayaPatra for Environmental Dimension

3.4.2 Socio-ethical Dimension for AkshayaPatra Base Kitchen

For the socio-ethical dimension it can be inferred from **Figure 43** that AkshayaPatra base kitchen is scoring high on 5 out of six parameters. One of the reasons for this is that it is contributing much to the local environment. The first parameter; improve employment and working conditions for the staff is scoring high due to many reason as discussed with stakeholders. One of them is that the workers in the base kitchen are encouraged to adopt all the safety protections and hygiene measures thereby making the work place a safe working environment. This factor could be carried forward as a good practice which could be implemented in the IRCS where the

scenario is not conducive for the workers. The factors which help in improving the equity among the stakeholders of the system are the whole system is designed in such a way that how it works is clearly documented and is made aware to all the stakeholders along with a clear demarcation of the duties and responsibilities of each stakeholder.

The system upholds an ethical aspect of absence of discrimination towards female staffs which is characterised by about 27% women staffs employed in the kitchen. This system helps in empowerment of the local population as all the workers except the top level administration are recruited from the same locality and also the raw material procurement from the local market which in turn makes them empower and valorise the local resources. The system also promotes social cohesion among the communities in the neighbourhood. There is more value addition to the product as there are special menus being included on special occasions like festivals which help in promoting local cuisines. The system also sees to it that the menu is decided along with the raw material procurement so that it gives maximum nutrition to the students with the existing available resources.

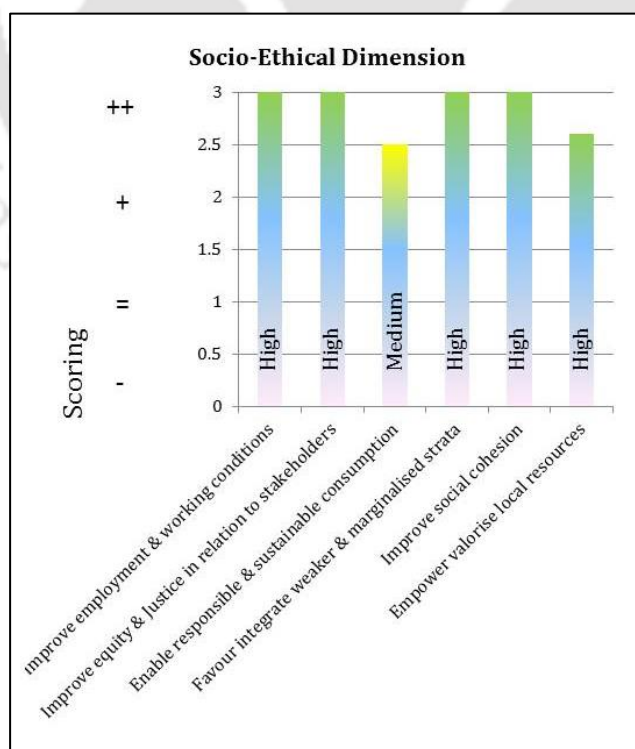


Figure 43: Scoring of AkshayaPatra Socio-ethical dimension

3.4.3 Economical Dimension for AkshayaPatra Base Kitchen

From **Figure 44** it can be observed that since this system depends wholly on the contributions from the philanthropists and corporates, to sustain in the long run they need to make the system more efficient. It can be seen that the system though does not exist to make profits is as efficient as any profit making companies due to its efficient and effective management, cost cutting measures, optimised expansion projects and so on. Having said about the good side of this system, there are certain areas which needs improvement. The maximum utilization of non-conventional energy sources for cooking as well as for transportation and reduction of dependency on fossil fuels are the areas which this system needs to further improve in the long run. AkshayaPatra system scores less in terms of resource reduction, conservation and bio compatibility.

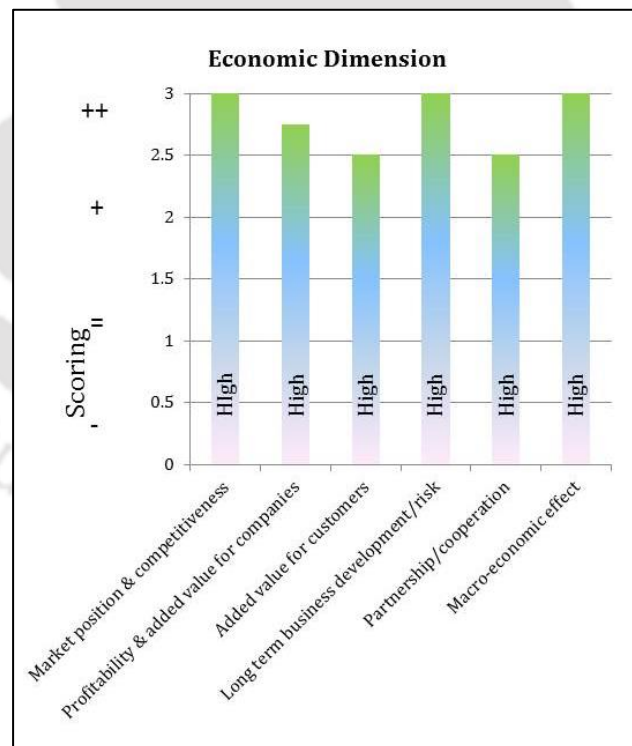


Figure 44: Scoring of AkshayaPatra Economic dimension

After interaction with various stakeholders of the system, and analysing the response sheets, many good practices from the sustainability point of view were

identified with the reference system. Under the environmental tab the best practices identified can be listed down as:

- No Use & Throw materials used in the system
- System technologically updated and timely maintenance carried out
- Natural lighting, Ventilation used
- Zero wastes thrown to environment
- Re-use of water
- Re-usable containers used

These could be potential points to be kept in mind while outlining the improved system. Similarly for socio-ethical dimension the best practices identified are:

- Workers adopt all the safety protections and hygiene measures
- How the system works is clearly documented and is made aware to all the stakeholders.
- System is accessible to people with low income.
- 27% women staffs are employed
- Regional cuisines are promoted.
- Local population is benefitted. All the workers are from the same locality.

For the economic dimension the best practices identified are:

- Though not functioning for profit the efficiency with which it is functioning makes it more competitive and sustainable.
- Low fuel cost per meal
- With the same expenses, the menu is decided in such a manner that the children get nutritious food.
- A beautiful example of partnership and cooperation among various stakeholders. The strong bond among the stakeholders is due to their transparent interactions.

3.5 Comparative Analysis of Both Systems

After the main problems were identified for the existing catering system and the key improvement points which were identified for the reference system AkshayaPatra Base kitchen, a comparative analysis of both the systems were carried out. There is a considerable difference in the expenses for fuel in both the systems. The existing Indian Railway catering system is very much dependent on the LPG fuel while the AkshayaPatra Base kitchen even though running on fossil fuel, have used diesel boilers to steam cook the rice and lentils which retain nutritious value in the food and which has reduced the fuel consumption significantly. The fuel cost per meal at the Indian Railway Catering system is 120 paisa while at AkshayaPatra base kitchen Guwahati its only 40 paisa. In the base kitchens of AkshayaPatra at other locations they have used bio mass briquettes as fuel which has brought down the fuel further to 9 paisa per meal.

The quantity of wastes generated is another point to be considered. In AkshayaPatra base kitchen there are no Non-degradable wastes generated and the leftover organic food wastes generated are sent as feed to piggery farms in the nearby vicinity. The main reason which can be attributed to the waste reduction is the use of reusable food grade stainless steel containers. The system is designed in such a manner as to facilitate this. For example the utensils cleaning area is designed with shower wash with three stages of cleaning which facilitates easy and fast cleaning of the returned vessels. Similar interventions if done at the design stage can bring significant improvement in the sustainability score of the system in the three dimensions of sustainability (Balakrishnan KK & Punekar Ravi Mokashi, 2014). The comparative study of both the systems are summarised in **Table 10** below.

IRCS			AkshayaPatra Base kitchen Guwahati		
Items	Qty	Remarks	Items	Qty	Remarks
No. of meals served per day	10,000 Nos		No. of meals served per day	10,000 Nos	
Quantity of rice per meal	150 gms		Quantity of rice for each meal	150 gms	
Time taken to cook the food	5 hours	LPG burners for cooking	Time taken to cook the food	3 hours	Steam boilers for cooking
Quantity of fuel used for cooking	300 LPG Cyl	Preparations using LPG only	Quantity of fuel used for cooking	13 LPG cyl/ 1236 L D	LPG preparing seasoning only
Monthly expenses for fuel (Cooking)	Rs.3,60,000	Because only LPG	Monthly expenses for fuel (Cooking)	Rs. 88,992	Also only 6 days per week
Monthly expenses for Electricity	Rs. 5000	Very small campus	Monthly expenses for Electricity	Rs. 18000	Big campus
Monthly rent for the space	Nil	Contractor owned space	Monthly expenses for the space	Rs. 200000	Space taken on lease
Total fuel cost per meal	120 Paisa	Dependent only on LPG	Total fuel cost per meal	40 Paisa	Both diesel and LPG
Quantity of waste thrown to the environment	150 kg (O) 190 kg (P)	Not reused or recycled	Quantity of waste thrown to the environment	Nil	Only food wastes
No. of disposable containers used	6 X 10,000 = 60,000	A meal has 6 packets	No. of disposable containers used	Nil	Only reusable containers
No. of reusable containers for distribution	15 crates	Only from kitchen to platform	No. of reusable containers for distribution	432 Nos Utensils	Students bring their own plates
No. of cycles the containers (Crates) are reused	More than 1000 times	Not very intense use	No. of cycles the containers are reused	More than 1000 times	Very intense use
No. of Staffs	22		No. of Staffs	32 Nos	
No. of lady Staffs	0	Laborious work	No. of lady Staffs	7 Nos	Cleaning/cutting/chopping work
Total distances covered per month for food distribution	2400kms		Total distances covered per month for food distribution	7069 kilometres	
Monthly consumption of Diesel for distribution of food	90 litres	Base kitchen closer to station	Monthly consumption of Diesel for distribution of food	707 litres	Location of schools faraway
Monthly expenses for fuel (Distribution)	Rs.5400		Monthly expenses for fuel (Distribution)	Rs.42,450	Centralized distribution

Table 10: Comparative analysis of IRCS and AkshayaPatra Base kitchen

From the Table 10 above, it can be seen that there is a significant difference between monthly cooking expenses of both IRCS and the AP Base kitchen when compared by equating for the same number of meals per day. This could be attributed to the use of only one fuel for cooking in IRCS i.e. LPG. The total fuel cost per meal is three times in IRCS than in AP base kitchen. This could be one area which if intervened can bring down the costs and increase the profit margin.

The waste generation for AP base kitchen is almost negligible as they are not using any disposable packaging and also the food wastes and other organic wastes are sent to the piggeries nearby. There is a fixed channel through which these wastes are all collected and brought back to the kitchen. The IRCS on the other hand has large quantities of waste being thrown to the environment. This lack of a proper waste disposal system adds to the ever increasing threats to the environment in terms of waste generation and handling. The AP base kitchen has a very efficient communication system which in turn has much good impact on the overall efficiency of the system. For example the requirement for the next day is very accurately and timely intimated to the base kitchen so that they prepare the appropriate quantity of food for the next day and hence minimizing wastage. Measures like the use of reusable vessels for the distribution of food are also a step which the AP base kitchen has adopted, helping it reduce the Non-degradable waste generation. These could be areas for design intervention for the IRCS which if improved can certainly reduce the food waste as well as non-degradable wastes. So an efficient waste management system, communication network embedded in the production cycle and reusable vessel distribution system could be considered as areas for a conscious intervention in the proposed system for IRCS.

On the contrary, the consumption of diesel for distribution of food is very high for the AP base kitchen. This has two inferences; firstly, the AP base kitchen should adopt methods and system by which they could reduce the dependency on fossil fuels and secondly, the IRCS has an opportunity of reducing this dependency on fossil fuels as it is a system already on the move which could integrate many operations like procurement and transportation with the system itself.

From the socio ethical point of view, the ratio of female to male staff in the system is very low in the IRCS when compared to the AP base kitchen. A Reason for this is that the system in use in the IRCS involves more laborious work. So a system with a mix of appropriate automation and man power could also be a direction of ideation for the proposed system for IRCS.

During the study of both these systems it was found that both these systems have their strengths and weaknesses which can be attributed to the differences in the context in which both are operating. Though Indian Railways are considered as the lifeline of the nation which has integrated both people and markets across the length and breadth of the country (Prasad, 2007), it also have a bad reputation due to large quantities of waste being thrown to the environment, it has both the strength and opportunity of reducing the transportation in the whole system by utilising the train travel through different regions, making it more greener with initiatives from the ministry of renewable energy and reducing the energy expenses for the raw material procurement. It is observed that even though AkshayaPatra base kitchen uses the most modern technology for its operations, it lacks the edge by not utilising the non-conventional energy sources to the maximum and depending heavily on the fossil fuels for its distribution network, trade off in balancing the mechanization with the available manual labour and most importantly on the economic front being dependent on the philanthropists and donations from the industry. The SWOT analysis of the existing IRCS and the AkshayaPatra Base kitchen on all the three dimensions of sustainability are shown in **Figure 45** & **Figure 46**.

SWOT	Strength	Weakness	Opportunity	Threat
Environmental Dimension	Green Initiatives by Indian Railways. 40 % subsidy from Ministry of renewable energy	Large quantity of wastes thrown to environment.	Could be the greener & preferred mode of transportation. More Initiatives from Government side	Inertia to change by officials & staff. Needs large scale awareness campaign
Socio-ethical Dimension	Reachability in the Rural Areas. Can empower the rural population	Monopoly of a few Contractors and vendors with support of officials. Gender biased.	It can sow seeds of development throughout its tracks all over India	Lack of coordination and communication among various zones, states etc.
Economic Dimension	Used by billions of people. Initial Investments available	Rates have to be checked as this is the common man's transport	100 % FDI is to be invited in this sector	Passenger earnings only 26 % of the total earnings. It needs improvement

Figure 45: SWOT Analysis of existing IRCS

SWOT	Strength	Weakness	Opportunity	Threat
Environmental Dimension	Zero emission to environment. Social commitment, Govt. support	High Dependency on Fossil fuels.	Use of more Non-conventional energy sources	Dependency on Philanthropists may not be same forever. Needs to sustain on its own.
Socio-ethical Dimension	Developing the local environment, nurturing local population	Balancing of automation of kitchens with manual labor	Rural development possibility to be explored	Balancing the intervention of local population.
Economic Dimension	Efficiency at each step enhances the economic stability	Dependent on the philanthropists and volunteers	Scope of adopting self sustaining measures	Change of policies of the government in future

Figure 46: SWOT Analysis of AkshayaPatra Base Kitchen

Keeping in mind the entire plus and minuses of both the systems and tracing down the good practices by the reference system the next step in the process is to explore the opportunities. This step supports the building of a sustainability design-orienting scenario, in other words the set of possible configurations that the new product-service system could take. This process is carried out in detail in the next chapter.





CHAPTER 4: DESIGN AND ANALYSIS OF THE PROPOSED SYSTEM



Proposal for Revised Sustainable IRCS - Approach, Synthesis and Assessment

In the previous chapter, the IRCS was analysed to identify the various stakeholders and the PSS elements involved in the catering system. Following this a system map for the existing system was compared with a reference system of the AkshayaPatra Foundation base kitchen. The systems maps enumerate the socio-economic actors that form a part of the system and their interactions in terms of material, money, information and workflows in the two systems. A SWOT analysis was carried out on both, the existing IRCS as well as the reference AkshayaPatra base kitchen system. This helped to identify the domains of PSS intervention. The analysis helped identify the possible configuration which could yield positive results in the direction of sustainability.

In this section, which forms Phase-III of the research study, we attempt to apply the SDO toolkit to further analyse and synthesise the insights gained from the previous section to help conceptualize a revised proposal for the IRCS based on the improvements on the three parameters of Sustainability. Here the SDO section: 'Orientate Concept' of the tool kit will be used. Brainstorming and idea generation techniques involving the inputs from actors will help in generating sustainability-oriented ideas at the product and service level with sustainability as the yard stick.

After identifying the key elements of the system we will define the characteristics of the services and products that are part of the system. The service level idea tables from the SDO toolkit are used for this purpose. The SDO toolkit is used as a support tool to build sustainability design-oriented scenarios; in other words the set of possible configurations that the new product-service system could take.

A second assessment is done to examine any potential improvements, or any worsening, associated with the three dimensions of sustainability compared to the existing system. This is done by maintaining checklists to compare the proposed solution and the existing system. Radar diagrams are generated to visualize the results of the analysis (SDO section: 'Check Concept' and 'Radar')

4.1 Brainstorming - Steps followed

Five design research scholars (including the author) participated in the brainstorming sessions that were carried out mainly through the SDO toolkit. First, the MSDS methodology was elaborated to the participants along with the stakeholder's needs, the context, the studied system, the reference system and the various tools like the SDO toolkit used in this process. Then the findings from the comparative study of both the systems (refer Table 10) were discussed with the participants. The main points which have to be considered for the proposed system were also discussed:

- A proper waste management system for minimising food waste and reducing non-degradable wastes
- Embedding of a communication system in the production and distribution cycle
- Efficient Information transfer methods and system
- Reducing the work load to the staffs and improving work environment
- Including the local population in raw material procurement system so that they are benefitted
- Including organic food in the system and their procurement
- Reducing the dependency on fossil fuels
- Tackling the issue of recycling/reduction of large quantities of plastic wastes thrown to the tracks in the form of packaged drinking water
- Bringing down the fuel cost per meal etc.

These points could be achieved by designing a system/sub-system, a product, or a new service component or together. The following steps were carried out for the brainstorming session and ideation.

Step I

Once the analysis of the data collected for both the systems, identification of the environmental, socio-ethical and economic priorities of the IRCS and also the good practices followed in AkshayaPatra base kitchen, the identification of all the stakeholders involved in both the systems were carried out. Next is to visualise and list the potential actors (Stakeholders) who could be involved in the satisfaction of a given demand in the proposed system and to arrive at the satisfaction map (**Figure**

47). This brings in new possibilities of collaboration and contributions from new actors in to the system.

Step II

Sustainable PSS idea generation (brainstorming session) using the orientate concept of the SDO toolkit. The ideas and possible directions were entered on the tool interface. Each design guideline were discussed thoroughly, depending upon the priorities and the set of design guidelines (hints from both system and service perspective) many ideas were thoroughly discussed and the most promising ideas were selected depending upon its benefits. Refer Appendix 5. These ideas are clustered to form the polarity diagram (**Figure 51**).

Step III

First version of the PSS concept was formed based on the ideas emerged from the discussions. Different layers and sub systems of the proposed system were developed to form the system map (**Figure 52 & Figure 53**).

Step IV

The PSS concept was elaborately designed using the offering diagram (**Figure 59**) and system map. At each step what is the desired satisfaction which has to be offered is kept in mind while designing the whole system.

Step V

Tools like Interaction storyboard (**Figure 58**) which is used to design and visualise the various phases of the proposed system as well as the potential interaction the various actors might have with the offered solution and the products which has to be designed for each stage were developed. Actors participate in activities and they have an aim and a perception of the delivered values (Tomohiko Sakao, 2009). These things are taken into consideration while designing the systems and sub-systems. These steps are discussed in detail in the following sections.

4.2 Generation of Satisfaction Map

The first step towards this is to form the Satisfaction map (refer **Figure 47**). The Satisfaction system map is a support tool for the generation of system ideas. The purpose of this tool is to identify and visualise the potential socio-economic actors who could be involved in the satisfaction of a given demand for well-being. This

visualisation is used during the ideation process as a stimulus to understand which actors could potentially take part in the satisfaction system. The Satisfaction system map can be drawn on paper without the use of any software. However, here power point software is used to facilitate management and modifications. The whole system was roughly divided into four roles: Raw material supply, food preparation, administration and maintenance. As it can be observed new stakeholders were identified like the farmers who could also be stakeholder in the system as this systems aim in meeting the demand of providing good and healthy food to the passengers. Another possibility which arose as a part of the discussion was the Appliance provider who would be installing the appliances in the site and maintaining it enabling the company to earn based on the pay per use as per the system requirements. Another stakeholder who was suggested was the call centre executive for the information hub who would be controlling and coordinating the activities of various centres and nodal points in the system. These roles were envisaged to be very important as this will help in the smooth flow of the system with very little bottlenecks and mis-communication.

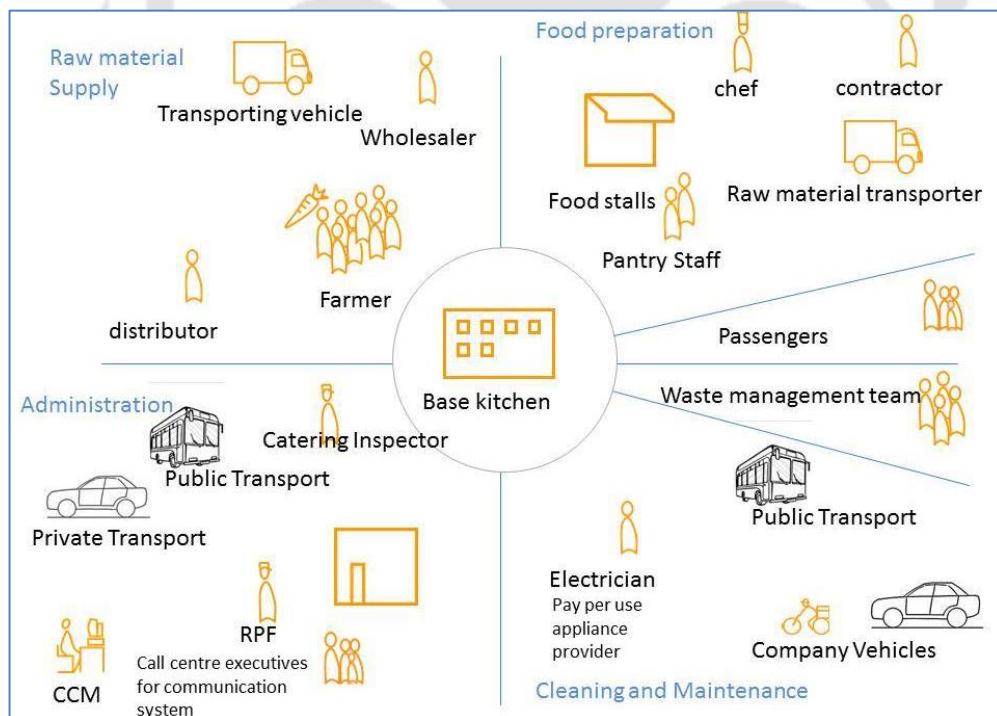


Figure 47: Satisfaction Map

Once the satisfaction map is ready the next step, which is brainstorming, follows.

4.3 Orientate Concept _ SDO Toolkit

Both the empirical data and the literature study formed the inputs for the brainstorming sessions and idea generation. This has led to the formation of different configurations and inclusion of various new stakeholders in the system to make it more efficient and sustainable. For a sustainable PSS to be put into practice, it requires a change in the mind-set of the customer, changes in company organizational structures, changes in regulations, and changes in culture which are very slow and gradual. It requires both macro level and micro level changes at both the technical and socio-cultural level, which makes it complex and therefore difficult to be predicted, planned and managed. The goal of sustainable development in system is to be reached by interventions at different levels. For this to happen, one clearly needs to be aware of whether the system is still unsustainable or the goal of sustainability has been reached. A feedback has to be obtained to get an assessment of one's achievement status. A major deciding factor for this is one's particular vision of sustainability and the answers one finds for questions regarding relevant spatial and time scales.

The Bellagio Principles came up as a result of the meeting that was held in November 1996 at Bellagio, Italy which was funded by the Rockefeller Foundation. The aim was to set some principles for monitoring the progress towards sustainable development (Hodge & Hardi, 1997; Simon Bell, 2008). It advocates certain key principles; one of them would be that the meaning of sustainable development should be clearly defined beforehand and should be viewed in a holistic sense considering the economic, social and ecological components as well as Effective communication of the progress to all stakeholders etc.

The Customer satisfaction yardsticks for the Indian railways to be met are: Production and/or service of food products to all segments of the passengers of the Indian Railways both at Railway stations and during journeys and their business metabolism- a mix of Business to Business (B2B), Business to Government (B2G) and Business to Customer (B2C). Keeping these in mind an effective brainstorming was undertaken to generate promising ideas and new stakeholder configurations.

4.3.1 Generating sustainability-oriented system ideas

Using the idea tables in the SDO toolkit, a series of sustainability –orientated system ideas were generated. This was done starting with the highest criteria and using the guidelines as a stimulus. The ideas generated are noted down in the digital post-it boxes at the tool page. The same procedure is followed for the economic and socio-ethical dimensions. For example, one of the points which the tool suggests under the system life optimisation tab of the environmental sustainability parameter is to complement product or infrastructure with services for their maintenance, reparability, substitution. Refer **Figure 48**.

The screenshot shows the SDO Toolkit interface. At the top, there are tabs for 'Environmental Sustainability - Orientate Concept', 'System', and 'Service'. Below these, there are sub-tabs for 'System life optimisation', 'Transportation/distribution reduction', 'Resource reduction', 'Waste minimisation/valorisation', and 'Conserv'. The 'System life optimisation' sub-tab is active, displaying a list of ideas on the left and a detailed view of the selected idea on the right.

System life optimisation
priority: H

Complement product or infrastructure with services for their maintenance, reparability, substitution

Complement product or infrastructure with services for their technological up-gradeability

Complement existing product or infrastructure with services that increase/enable their aesthetical or cultural up-gradeability

Complement product or infrastructure with services that increase their re-configurability (adaptation in new location)

Offer shared use services for products or

The ideas listed on the left are:

- The solar panels at the base kitchen will be under maintenance contract by the manufacturer.
- Free maintenance service and a long term relationship between the actors is established.
- The re-usable lunch boxes could be shared. It goes from one base kitchen to the other each time it is
- One single base kitchen for all the stalls in a railway station and trains passing through that route.Base
- Water sold in high grade plastic bottles will be taken back by pay back policy and will be re-used.

Figure 48: Orientating Concept-System life Optimization (SDO Toolkit)

Few suggestions which came up in the sessions were to provide solar panels for the base kitchen which will be under a maintenance contract with the service provider which can be used for preheating water for cooking and also as back-up power source, use of reusable lunch boxes which has to be standardized so that it can be shared by the base kitchens, a network of base kitchens with a single base kitchen which caters to all the requirements of the stalls (both medium and large) in one railway station and trains passing through that route. Also possibility of base kitchens distributed on areas where raw material supply is possible from rural areas, through the railway tracks and stations where it could be easily loaded and unloaded on time were also raised. These points were further elaborated after discussions with sketches. Refer Appendix 5.

The Points which were raised and discussed in the session for the transportation reduction criterion was entirely different. For example ideas like farmers doing track farming making use of the trains for transporting farm produces and reducing the need for separate transportation modes, a good system where the base kitchen always updates the farmers' cooperative about the stock position and requirements which is easily communicated to the farmers and produces supplies on time, base kitchens in the railway station premises which eliminates use of transportation using motorized vehicle, setting up of the waste compost unit near the base kitchen so that transportation of wastes are minimized etc. were discussed in detail to explore the concept further. Refer **Figure 49**. This process was carried out for all the criteria in the SDO toolkit for all the three dimensions of sustainability. All the ideas were formed into a mind map which will visualise all the ideas under each dimensions of sustainability. Refer **Figure 50** and Appendix 5. Sessions carried out along with the orientate concept phase of the SDO toolkit, which coupled with the identified best practices of the reference system for benchmarking gave enough directions to create scenarios and clusters.

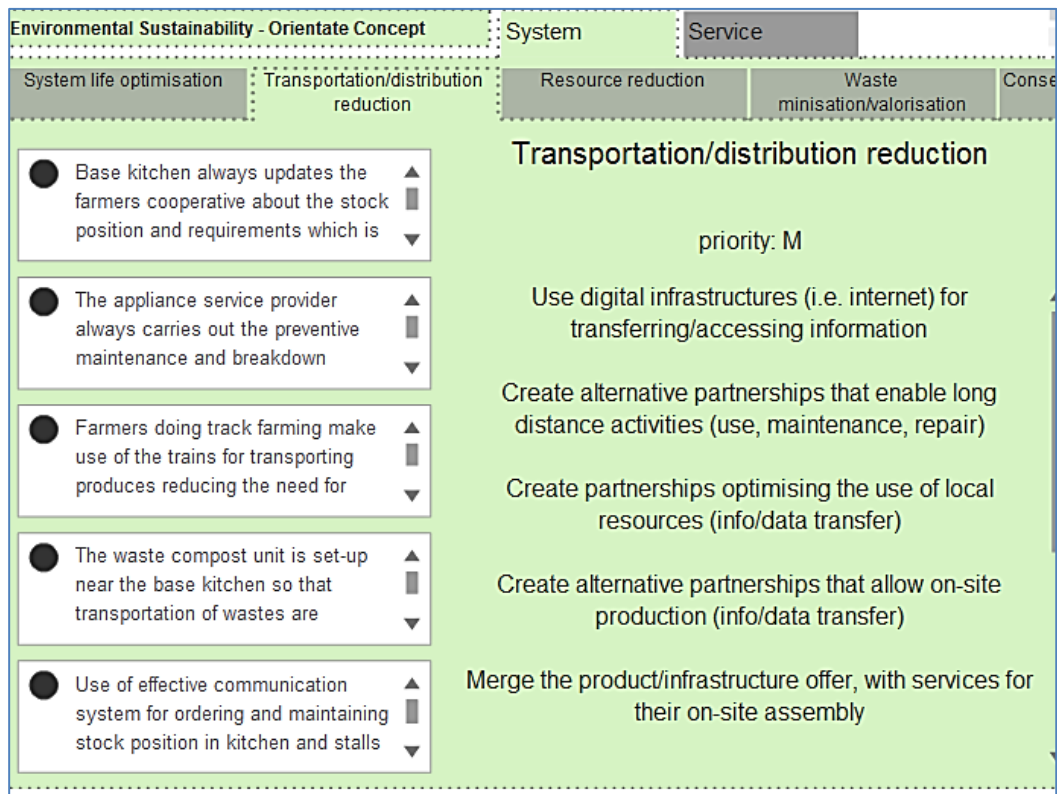


Figure 49: Orientating Concept-Transportation reduction (SDO Toolkit)

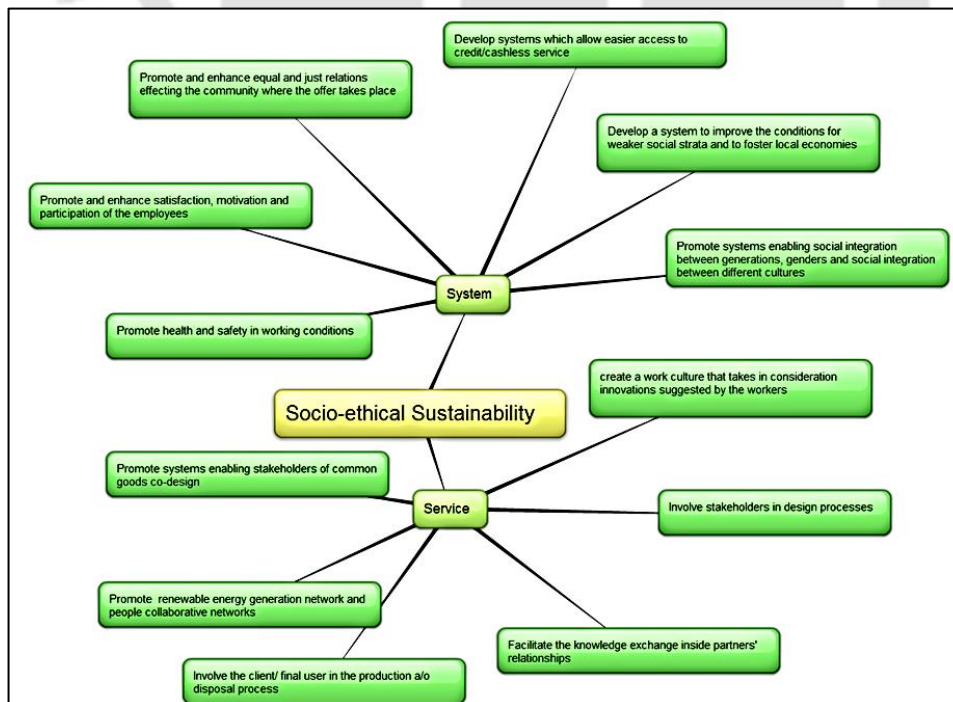


Figure 50: Brainstorming

4.3.2 Defining scenarios, visions and idea clusters

The most promising ideas that had emerged from the previous activities were selected and arranged for visualizing what is called the sustainability design orienting scenario, i.e. the set of possible configurations that the new product-service system could take. This operation is useful for organizing ideas, generating new ones and defining visions.

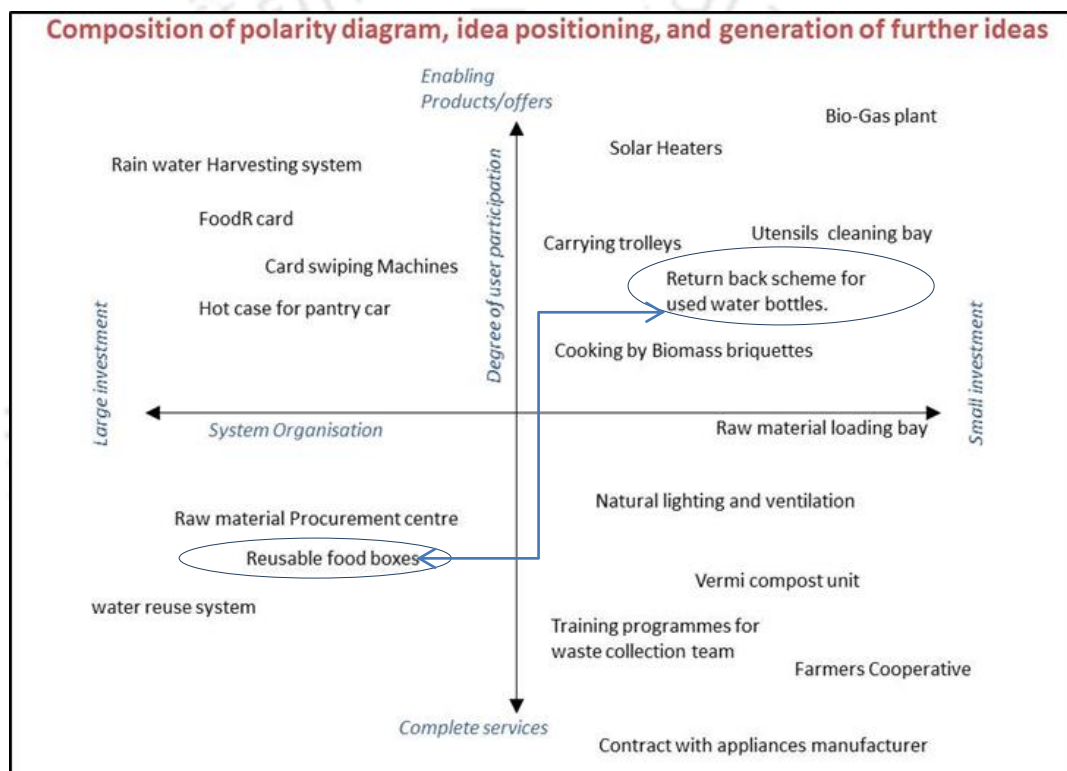


Figure 51: Polarity Diagram

The Polarity diagram is drawn up in such a way that the emerging ideas can be spread over all the quadrants. Here, the ideas have been positioned on the diagram. The aim of this step is to organise, present and stimulate the generation of further ideas. At this stage it is possible to shift ideas from one quadrant to another to potentially bring out new ones. As shown in the **Figure 51** above, all the ideas have been positioned to define visions, which represent the schematic descriptions of

how the context could evolve if certain design options were adopted. Each vision will represent a potential, promising orientation on which the system could evolve. Here a farmers' cooperative could be a potential vision in which the system could evolve. For this the supporting sub-systems should also be considered for the brainstorming sessions. The next step is to cluster the emerging ideas, i.e. to create groups of ideas with shared characteristics. This helps to improve the management and presentation of these ideas. The amalgamation of several clusters of ideas (also from different quadrants) constitutes the starting point for the generation of one or more system concepts. For example, here the design of reusable food boxes which require a large initial investment and more manual intervention and the return back scheme for used water bottles could be clubbed as this has certain common infrastructures required like the loading bay, packaging etc. The previously processed ideas are selected and combined to form the system concept. Users, stakeholders, enterprises and enterprise units or divisions as well as even agents are classified as actors.

4.4 The Proposed System - FoodR

After combining the visions to form the clusters, four layers were formed for the proposed system as sub systems. They are the Waste management system, the Raw material Procurement system, the Information Transfer system and the Food order communication system. (Refer **Figure 52** below)

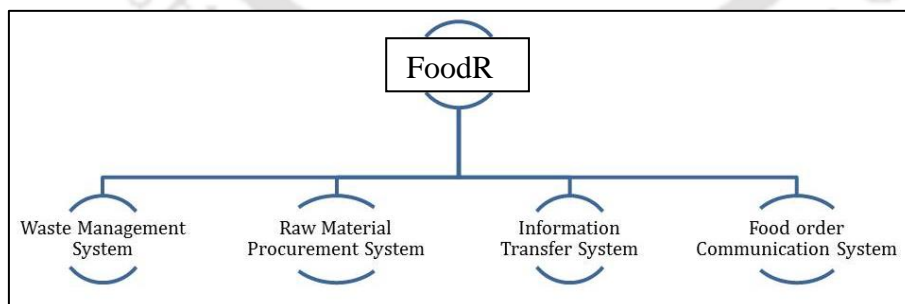


Figure 52: Different layers of the proposed system

The proposed system for the Indian Railways Catering service is named FoodR (Food Railway).

The proposed system aims to give a complete image makeover to the Indian Railways Catering system and change the bad perception people have about the food in trains. The philosophy of FoodR is to provide the train passengers dishes made from the freshest, cleanest, organic and healthy ingredients on time by using the produces grown and harvested in respective localities forming a co-operative society which will uplift the local farmers and also forming a thorough waste management system in place with a dedicated team trained for the waste handling along with use of latest ICT technologies, a waste recycling plant which will help value addition to the wastes being collected. This reduces the waste generated considerably, making FoodR sustainable in the long run. In the proximity of the base kitchen is the farmers' cooperative which keeps a track of the raw material demand from the nearby base kitchen and coordinates with the local farmers and procure it in the procurement centre from where it is taken to the base kitchen in the train en-route that locality with the help of the raw material loading centre where the train halts for a short period of time. During this time the segregated wastes are also unloaded from the trains which come from the base kitchen to be used in the compost and bio-gas plant. The local industries are encouraged to participate in maintaining the whole network of bio-gas plant, compost unit and the dairy farm under the CSR policy. The information transfer about the requirements at the kitchen to the farmers' cooperative, the coordination of the procurement centre and the loading of these in the trains and return of the used vessels back to the base kitchen for cleaning and to be kept ready for the next use and segregation of the wastes and sending the degradable wastes to the farm are all monitored and controlled by the IRCS information hub. The participation of the stakeholders, the material exchanges happening, the money and information flows are all represented in the system map shown in **Figure 53**.

After analysing the various stakeholders and their aspirations, it was necessary to come up with an idea deriving from the reference system selected for benchmarking. One main reason identified for large amounts of waste generation is the use of disposable packaging for the distribution of food in trains and in railway platforms. One good practice earmarked in the reference system is the use of reusable containers to distribute food. This system is specially designed to handle the associated activities related to the use of reusable containers like the washing bay, transportation facilities, trolleys to carry those utensils etc. A notable point which came out of the brainstorming session is the use of reusable containers instead of the disposable ones for the supply of food in trains. As per the new catering policy 2010 (Indian Railways, 2011) Railways will be phasing out on-board pantry and will facilitate only base kitchen catering from railway stations. The proposed system suggests base kitchens of varying capacity in selected stations depending on the rail traffic and strategic location. Prepared food packed in specially designed reusable food boxes stacked in trolleys will be loaded on the trains from stipulated stations. This will be controlled by the IRCS Information Hub (IRCSIH) which will track the train timings and give the food order to the concerned base kitchen well in advance. After distributing the food boxes and water bottles to the passengers, it will be collected back and unloaded in the next base kitchen station. All these activities are controlled by the IRCSIH.

This concept proposes the supply of vegetables, dairy products and other raw materials from a farmer's cooperative movement which is formed in the rural areas not far from the locations through which the train passes. The requirement and seasonal availability of the produces will be discussed and finalised among the catering officials and the cooperative team leaders and will be communicated to the concerned farmer's cooperative which will be then passed on to the small scale farmers. The produces from the small scale farmers collected in the Raw material Procurement centre are then sorted and kept ready for loading in the train from the loading bay. The height of the loading bay is kept same as the train floor which will enable easy loading and unloading. An associated sub system connected with this is the closed loop waste management system where waste segregation and sorting is done to separate recyclable wastes and degradable wastes. The degradable wastes

are then transported by trains to the Vermi-compost unit of the farmers. This is unloaded when the raw materials are loaded in to the train. One of the striking features proposed here is the new stakeholder relationship with the appliance manufacturers. They will be installing the appliances in the base kitchen and will be maintained onsite. Their responsibility will be to provide the appliance in working condition onsite. For this the adequate manpower and technical support will have to be provided by the manufacturer. The base kitchen uses all the latest energy saving appliances like solar heaters, solar cookers etc. There are considerable savings in terms of the energy consumption when these appliances which depend on the non-conventional sources of energy are used (Vguard Industries, n.d.). Environmental friendly appliances like the solar cookers and solar heaters are to be installed depending upon the climatic conditions in that region (Banerjee, 2011). The recovery period for these solar cookers if installed is 5 years. This will help save large quantity of fossil fuels and curb environmental effects (Muthu Sathyavathi, n.d.). The system configuration is iterated many times during the brainstorming stages according to the design inputs both from the toolkit as well as the discussions.

System Maps of various Sub-Systems

4.4.1.1 Waste management system

Waste generation and improper waste management were the most important points which came up during the brainstorming sessions. Managing waste and using resources wisely are the two main global issues in the field of sustainability. Using the latest technologies to recover resources and energy from waste and to create awareness among the authorities on practices that make landfills less damaging to people's health and the environment were the points which were dwelled upon. This was a point of concurrence that the waste reduction goals should be defined by the Indian Railways in the planning phase of a project, taking into account the regulatory and green certification waste management requirements which will give a complete image makeover and a long lasting goodwill for the Indian railways . A closed-loop approach to sustainable waste management can provide value at every phase of the proposed system. The system map of the waste management system is

shown in **Figure 54**. It is proposed that waste segregation is the first and foremost thing to be done to minimise the environmental effects caused by wastes. Lack of an amiable relationship among the stakeholders of the waste management system in the urban areas is a reason for ineffective waste management system (Joseph, 2006). Including various stakeholders and clearly identifying their roles and creating a bonding among these stakeholders will make the waste management system more effective. Various stakeholders like the passengers, local authorities, planning agencies, pollution control board, politicians, public sector industries, NGOs, media, research institutions and financial institutions should also be given clear roles for participation in the system. In the proposed system, the waste management system has a very important role being defined with an active participation from the health department and the pollution control board in providing training for the team members. Also a food bank concept is formulised where in the leftover consumable food are collected and shared with the needy and destitute in the nearby areas of the base kitchen. Only the remaining food wastes are sent to the compost units in the farmers cluster from where the raw materials are loaded into the trains. This gives a value addition to the wastes generated from the base kitchen and trains. No extra mode of transportation is required as the train network is utilised to the maximum.

of this system which will make their rehabilitation possible and enable them towards a better standard of life and dignity. This team would swing into action when a train reaches the station and collects the already segregated wastes for recycling as well as sending to the composting of the bio-degradable wastes. The bio-degradable wastes are then packed and sent to the nearest farmers' cooperatives through trains. The raw materials are loaded and the wastes are unloaded from the loading bays at stipulated places throughout the track through which the train passes.

4.4.1.2 Raw Material Procurement System

A successful system would secure both the demand and supply side for their produces. For e.g. the AMUL cooperative has developed an organization representing not only the farmers but also their customers thus securing both the demand and supply side of the milk industry. Agriculture is a source of income for millions of rural agricultural producers, and it contributes towards strengthening the livelihoods of small scale farmers who form the majority of India's rural population. After going through various literatures it was inferred that producer-centric institutional structures that strictly conform to cooperative principles provide rural farmers a greater access to the organized market there by fetching more prices and demand to their produces. The proposed cooperative society (Village coordination society VCS) aims to provide the unorganised rural farmers greater selling opportunities of their surplus to the organized sector by expanding village based agriculture procurement systems that facilitate fair and transparent transactions. The VCS will strengthen the agriculture produce procurement system in the already existing cooperatives by promoting the formation of clusters in areas where cooperatives are not present or have less popularity. By implementing this a sustainable Agriculture Produces Procurement System will be established, which will ensure that quality produces are collected by bringing in maximum farmers under a single roof thereby safeguarding the interests of small scale farmers by providing rural agricultural producers greater access to the railway catering raw material procurement sector. This would include vegetables, grains, milk and dairy products. A uniform demand rate for a raw material is difficult to be achieved in this

case as the food preparation may vary depending upon the order request. However, over a period of time depending on the rate of production of various products requiring the raw material, an optimal procurement policy for raw materials could be attained depending on the production batch size for the particular train on a particular day. In this system also the IRCSIH controls the loading of raw materials and the procurement status and communicates the requirement to the raw material procurement centre the requirement for a specific base kitchen for that particular day. The Software will optimize the whole network and will instruct the in-charge at the raw material procurement centre to load the required quantity of raw materials on the concerned train passing through that place at that time. The Stakeholder system map is shown in **Figure 55**.

The benefits envisaged by this system are the optimum use of the procurement centre in collecting and dispatching raw materials to various base kitchens by the maximum utilisation of the train network minimizing congestion and pollution. Detrimental environmental impacts of conventional agriculture-businesses can be avoided through the promotion of small-scale local production that underpins the notion of healthy and communal living of that locality. The consumption of fresh and seasonable food reduces the need for energy for cooling and freezing as the transportation distances are considerably reduced. It has to be noted that for enhancing the sustainability and implementing a PSS innovation the main focus should be on the efficiency. For example, fuel efficiency is the main focus for a PSS whose main concern is about the transportation where there is the maximum expenditure of energy (Bocken, Short, Rana, & Evans, 2014). The solution supports the local food producers by distributing their goods and promotes economic and environmental community life and the health benefits of locally grown fresh produces. It is envisaged that this would to a certain extent curb the uncontrollable migration of people to the urban cities. This system of raw material procurement when extended to other zones of railways can bring in more impact to the life of the people living in the rural areas. The IR also could be seen as an “Enterprise on Wheels” where the farmers could be given dedicated space/compartments to load their produce which are to be sent to base kitchens across the network and even could sell it in the trains and stations thereby opening a new corridor for trade. This

will provide a new frontier for farmers to sell their produces and also people to buy fresh organic vegetables and other produces directly from the producers through a cooperative initiative.

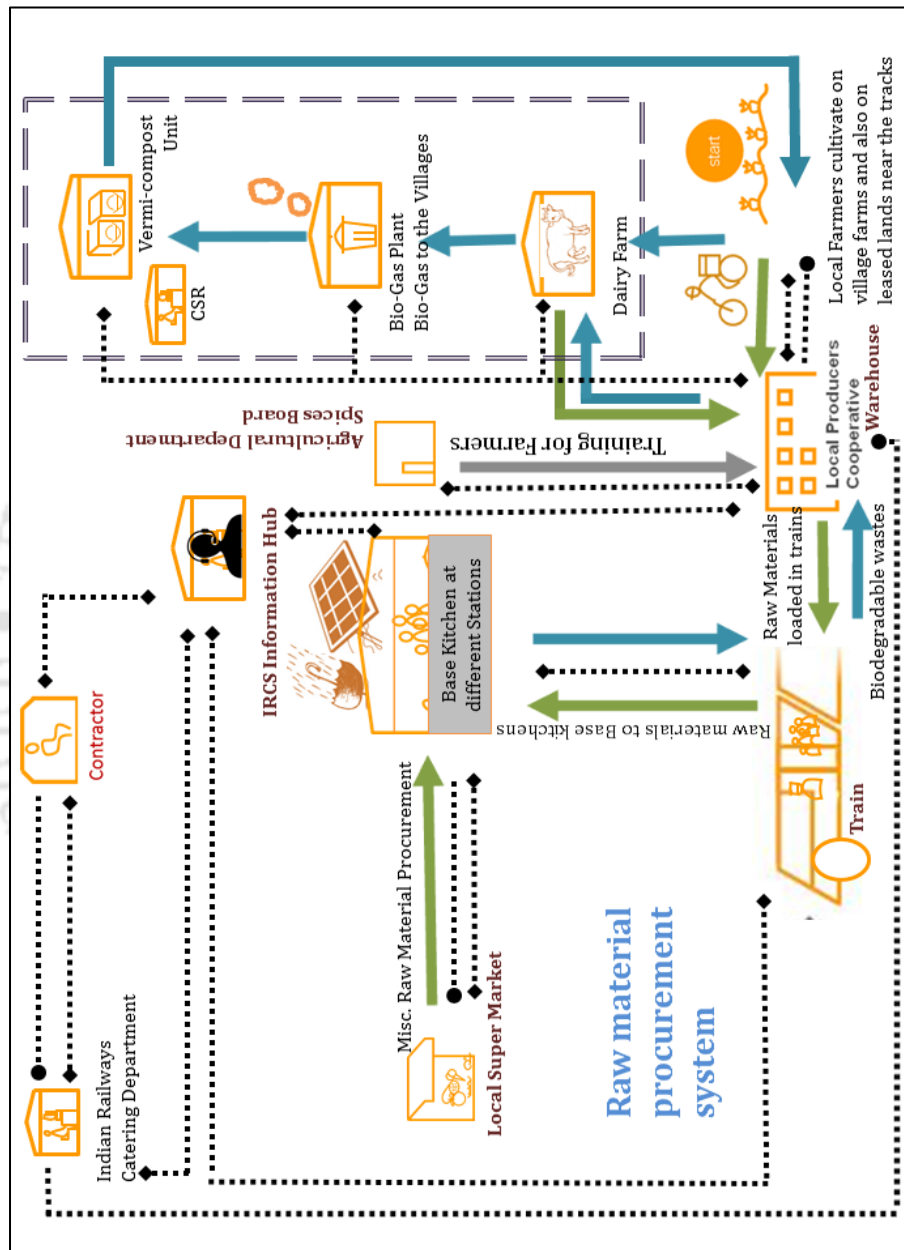


Figure 55: Stakeholder System Map of the Raw Material Procurement system of FoodR

4.4.1.3 Information Transfer System

The system mentioned here suggests loading of prepared food from the base kitchens located at various railway stations en-route the train destination. In Indian conditions there could be situations where the train runs late. So these kinds of unforeseen conditions should be anticipated in the system. The need arises for a 24 hour up to date data management information system tailored to the specific requirements of the Indian Railways. A live train tracking system connected to the Information transfer system monitors the current running status and provides information to the base kitchens after calculating the approximate time required to reach that particular station. The information is passed well in advance as the prepared food can be packed and kept ready so that it is loaded quickly without wasting any time. This system monitors the tracking status and gives orders to the base kitchen accordingly. The Stakeholder system map is shown in figure 43 below.

Any system to be effective and efficient needs good coordination supported by adequate, sufficient, appropriate, accurate, consistent and 'on time' exchange of information. Communication is always the key factor leading to the success or failure of a construction project. The use of the Internet as the communication platform can help information transfer more effectively during the functioning of a system. In the proposed system (Tam, 1999), the Information transfer system controls all the sub systems which require correct information at the right time. All the sub systems here require 'on time' information regarding the running status of the train. This is being handled by the ITS. This collects, manages and transfers the information to the base kitchen, raw material procurement system, trains, cooperative clusters, agricultural departments, PCB, Health departments, Appliance Manufacturer and coordinate all of it in the effective running of the system.

4.4.1.4 Food Order Communication System

There were increasing numbers of complaints from passengers about the pantry staffs charging high prices for the food on trains, since the passengers are left with limited choice but to buy food from the pantry. Also, the pantry staffs are always struggling to return the exact change amount after the deduction of the food rates. Introduction of the FoodR card gives much flexibility to the passengers as they need not carry any currency with them and the pantry staffs as they are relieved from the task of tendering exact change of the balance amount. The passenger can book his meals while booking his ticket. Even if the ticket is booked, the passenger can call the call centre of the food order communication centre if he or she has a FoodR card and book meals and the money will be automatically deducted using an interactive voice response system. The central server accepts orders and calculates the expected arrival at the nearest base kitchen depending upon the rail traffic for that day and gives food orders to the concerned base kitchen keeping in mind the preparation time in advance. The advantages of introducing the Food order system for FoodR is swift service to the passengers as there are no currency transactions, cash balancing and tendering change hassle. This enables the hassle free distribution of food. Easy to use Touch Screen Tills (Card swiping Machine) should be introduced. The information on the number of orders is obtained well in advance which gives the possibility of a more efficient and hygienic routine. The FoodR card is a debit card and with pre-loading of credit onto the cards there is a positive cash flow situation. Passengers can top-up the card in advance. Since there is no currency exchange while the system logs every transaction event with the card, audit reports are made fast and complete. Refer **Figure 57** for System map of Food Order Communication system.

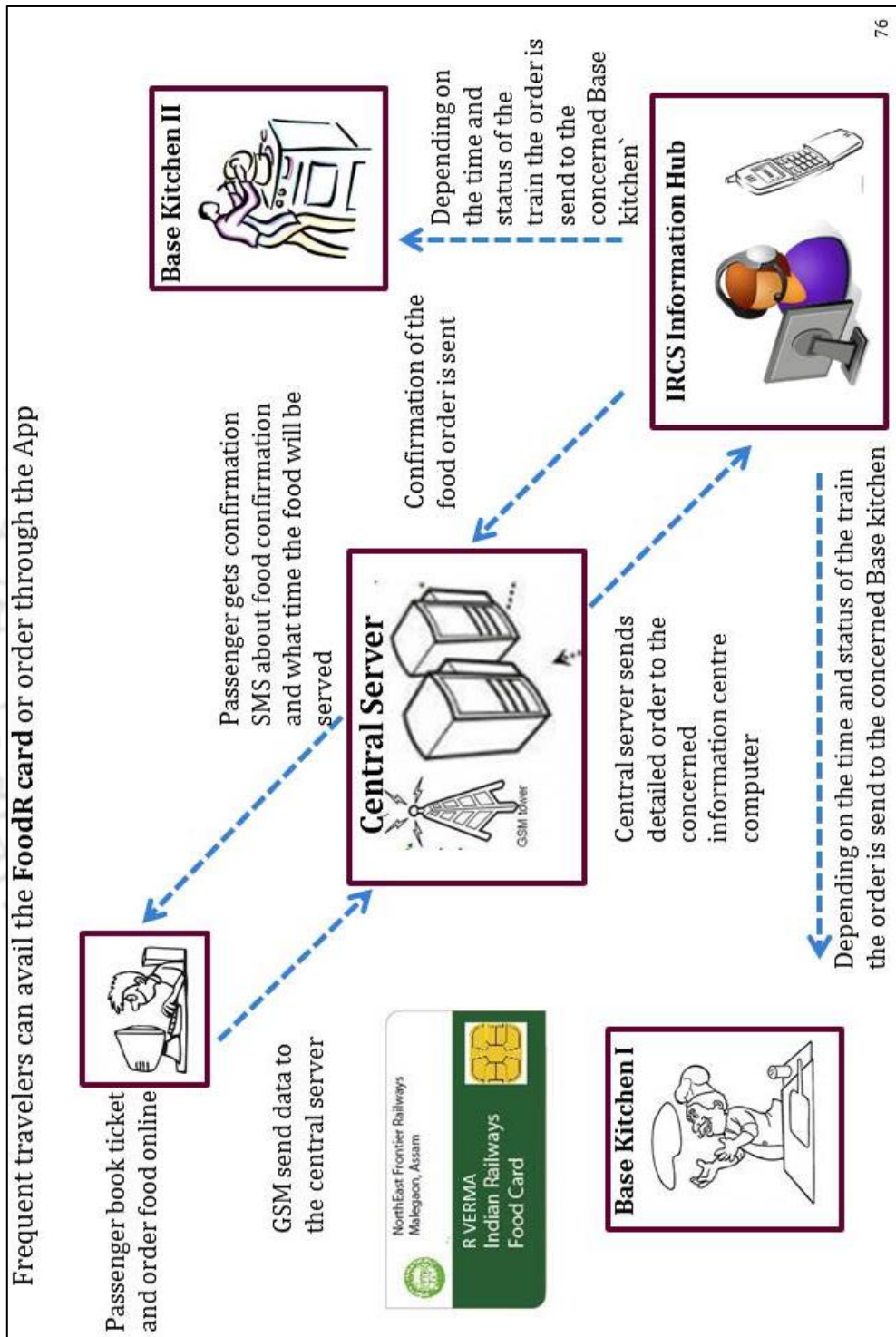


Figure 57: Stakeholder System Map of the Food Order Communication system of FoodR

4.5 Phase – IV: Communication

In this step the developed design concepts are visualised to communicate and disseminate results. It involves the combination of different mental images that have evolved in the construction of a shared concept. This could be done in many ways depending upon the skill set of the design team. The main challenge here is to organise the key functions (strengths and weaknesses) into narrative and aesthetic clusters, define the storyline and the storyboard and the production of audio-visual presentation if any. This step can provide an epistemological and aesthetic contribution towards envisioning a possible future. In addition to these, a question bank was furnished for the three dimensions of sustainability with colour coding and the questions were categorized according to the stakeholder. A systematic assessment of the outcome was carried out through the stakeholders' feedback and the result was analysed accordingly with valuable inferences drawn.

4.5.1 Interaction Story Board

Once these basic elements have been established we try to understand what potential interaction the stakeholders might have with the offered solution. This is done using a story board where a description of the user's interaction with the actors involved in the production and the delivery of the offered solution is given. Here every interaction step is itemised separately, specifying all the components required to complete it: tools (support products, signs, etc.), interaction rules (rules that guide how the interaction should take place), expertise (which the user and actors should have in order to be able to interact), and information (required during the interaction both by the user and by the other actors). The various Products, services and the system suggested in the proposed system FoodR (PSS innovation) are: **Products:** Layout of base kitchen, Solar Heaters, Vessel cleaning bay, Raw material loading Bay, solar cookers, reusable food boxes and trolleys, raw material loading crates, sacks for carrying degradable wastes, hot cases for pantry cars, FoodR card, Application for farmers and passengers, interface for the farmer Application etc. **Systems:** Farmers' cooperative and procurement centre, water reuse system, system for natural lighting and ventilation utilization, Raw material procurement system, cooking using biomass briquettes, Information hub, FoodR

card swiping machines, waste collection system, recycling plant, return back scheme for used bottles, biogas and compost plant etc. **Services:** Collaboration with appliances manufacturer, ICT services, food bank service for the needy, Option of organic food, reward schemes for the staffs etc. All this summarised together is shown in **Figure 58** and Appendix 5.

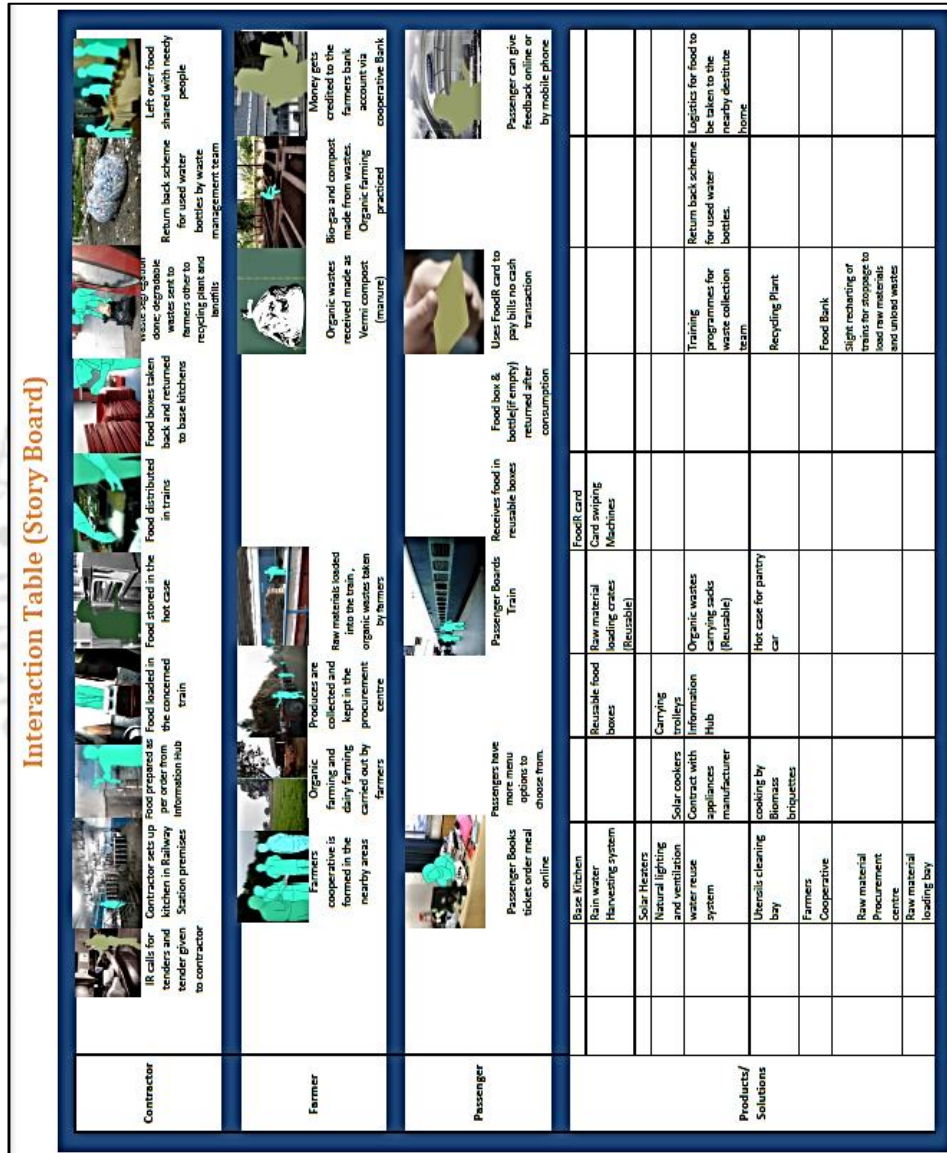


Figure 58: Interaction Story spot of proposed FoodR system

4.5.2 Offering Diagram

The functions delivered by the set of products and service that make up the offer is shown in the offering diagram. For example, the passengers are offered good, healthy and organic food in the trains and are relieved off the burden of disposing the packaging in which it is served there by improving the overall experience. Refer **Figure 59**.



Figure 59: Offering Diagram of proposed FoodR system

4.6 Scenario Building for explaining the system

To understand how the system works the scenario building process is carried out with reference to a case example. Consider a case where Train No. 12505 North-East Express is travelling from Guwahati to Delhi. It starts at 9.45 AM from Guwahati railway station and reaches Delhi AnandVihar Terminal after 33.35 hours of running time. This train runs daily from Guwahati to Delhi. This long distance train stops at 14 stations in between the destination. The route map is shown in **Figure 60** below. The charting is done as per the time of halt at each station for the loading and unloading of lunch boxes from each station.

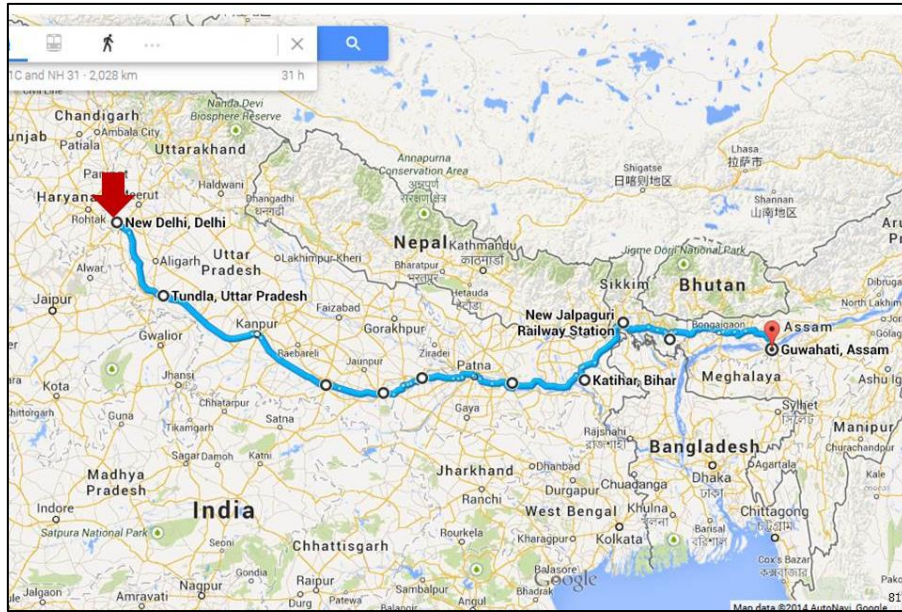


Figure 60: Route Map of Train No. 12505



Figure 61: Stations where loading unloading of food boxes done (Train No. 12505)

The detailed chart showing the loading and unloading of food boxes in the main stations of the train route for train No. 12505 is given in **Figure 61**. The arrow direction indicates the loading or unloading of food boxes. The time of halt at each station is given in the bracket. As shown in figure 58 for train No.12505, the lunches

for day 1 are loaded from Guwahati railway station at 9.30 AM and are kept on the hot cases. After the distribution of lunches, the empty food boxes are unloaded at the New cooch behar station where it is taken to the base kitchen for cleaning and next used in some other train. The dinner food boxes are loaded from New Jalpaiguri at 17.00 hrs and again stored in the hot cases. After the dinner the empty boxes are unloaded at the Barauni Station at 00.25 hrs. The breakfast is loaded from Buxar Junction station at 5.00 AM. After the distribution the return boxes are unloaded at the Allahabad Junction Station from where the lunch boxes are loaded simultaneously. These empty lunch boxes go to Tundla Junction base kitchen at around 15.50 hrs.' and the train reaches its destination at around 19.15 hrs. This is a tentative schedule and can be changed depending upon the time of arrival and delay at various stations. All these activities are controlled by the Information Transfer System. The empty vessels are received in the base kitchen and the left-over food if any are collected, segregated and are then sent to the piggery farms and other organic farms who are also the stakeholders of this system.

4.7 Products and Support Products

While the system and service design is carried out as discussed in the previous section through the SDO toolkit, it also requires few customised products also to be designed for it to function as a proper PSS as envisaged. Factors to be considered for the development of the products from a sustainability point of view are:

- Non-toxic for the passengers
- Safe & easy handling for pantry staff
- Environmentally sound
- Economically viable

For this proposed system the various products and support products to be designed are:

a) Trolleys for distribution of the Food boxes.

Trolleys are meant to be used as a carrier for the food boxes from the base kitchen, to the platforms with fully loaded food boxes stacked, loaded in the train compartments, pushed through the aisles, food distributed and then returned food boxes stacked and safely taken to the next base kitchen. The specifications required for the trolleys are that they should be:

- Easy to handle for the women staff
- Easy to be loaded into the trains
- The width should be less than 500mm so that it can be moved easily through the aisles inside the compartment.
- It should stack food for at least two compartments
- Food boxes should be safely stacked.
- Easy to stack and take-out food boxes
- Stable even when fully loaded
- Fit in the vestibule areas of the compartment without any hindrances.
- Rugged and long lasting as it should be re-used for a maximum number of times.
- Have a standard design throughout as it is to be shared between different base kitchens.
- Should have thermal insulation

b) Reusable Food Boxes

The food boxes are to be used to safely and securely contain the food contents, which could be easily stacked into the trolleys, moved around, taken out at the time of distribution to the passengers, taken back and sent to the base kitchen, cleaned at the cleaning bay and kept ready for the next use.

The specifications required for the design of food boxes are:

- Non-toxic and healthy to the user
- Easy to clean
- Light weight

This thesis focuses mainly on the improvements in the whole system at a holistic level. However, some initial doodles of the concept generation and the design ideation were carried out. (Refer Appendix 5)

4.8 Advantages of the proposed system

A Railway catering system has a huge potential in terms of environmental sustainability and the social commitment it has to the nation. But the deployments of these potentials are highly dependent on the implementation strategy and the business model. Since the proposed system excludes any 'use and throw' materials, the system is technologically updated with timely maintenance carried out by the appliance provider. A contract with the appliance provider is made not only to sell the appliances but to maintain the appliance in the specified location. Other interventions made are natural lighting, ventilation used to maximum possible extent, zero wastes thrown to the environment and the re-use of water which will be very light on the environment. The main advantage on the environmental dimension is the use of reusable containers for food distribution. This will have a very positive impact on waste reduction in the long run by reducing large volumes of wastes being accumulated on the tracks.

On the socio-ethical dimension, the workers of the base kitchen are made to adopt all the safety protections and hygiene measures. This is ensured as the preparation of food is only by the base kitchen which could be easily monitored unlike the pantry kitchen in a running train. The system functions are clearly documented and demarcated and are made aware to all the stakeholders. This is facilitated by the IRCSIH which in fact transfers the necessary information to the stakeholders in time making the system transparent. The efficiency of the whole system is increased by reducing the cost incurrence for the preparation of the food in the base kitchen. This is done by using more non-conventional sources of energy and by reducing the losses at each stage. As a result the offering by the system could be made accessible

to the people (passengers) at a lower rate thereby meeting the social commitment of the Indian Railways towards the nation. Employing more women workers is also made mandatory in the base kitchens which will balance the social commitment towards gender equality by the Indian Railways. One of the important advantages of this proposed system is the adoption of more regional cuisines and the usage of seasonal produces on the menu. This will not only give more menu options to the passengers but also support the healthy food combinations followed in the traditional system available to the passengers. The evaluation of the change in lifestyles due to the system cannot be done instantly in rural areas and villages, as it needs to be observed over a longer period. The social dimension that can be taken into consideration in the described product service system is the opportunity for the prosperous development of the people in rural areas who form the major chunk of the migrating population to urban areas.

On the economic dimension, as derived from the reference system taken for benchmarking the AkshayaPatra, making the system more efficient by timely maintenance gives it more economic advantage (Scheer & Sterling, 2002). In the long run, saving fossil fuels and using non-conventional sources of energy will be beneficial to the society. Alternate fuel options are also sought which will make the fuel cost per meal lower. With the same expenses, the menu is decided in such a manner that the passengers get full nutritious and healthy food. This system is envisaged as an example of the partnership and cooperation among various stakeholders including farmers. The strong bond among the stakeholders is due to the transparent interactions. With the development of the infrastructure, expanding the facilities to rural areas and training and employment for the rural population and providing urban facilities in rural areas will be sustainable on the long run.

4.8.1 Sustainability assessment of the proposed system

Following the same procedure as applied to the assessment of the IRCS, the proposed system is also analysed applying the SDO toolkit. The proposed system is also analysed based on all the three dimensions of sustainability namely; Environmental, socio-ethical and economic. This is done to know which criteria are scoring more thereby to trace back to the choice of the practice that had made it so

and also the overall improvement in all the three dimensions of sustainability. For each dimension of sustainability the system is assessed by answering a series of checklists grouped under six different criteria. For each criterion there is provision to write replies and comments in the field provided. After making a modified checklist (Response sheet) as the question bank with a Likert scale answering mode, it is discussed with the various stakeholders depending upon their role in the system; design priority for each criterion assigned. (0 - 0.49 - “-“, 0.5 - 1.49 - “=”, 1.5 - 2.49 - “+”, 2.5 - 3.0 - “++”). In the response sheet there are 25 questions for the Environmental Dimension, 19 Questions for the Socio-ethical Dimension and 23 Questions for the Economic Dimension which are colour coded depending upon the sustainable dimensions (Refer APPENDIX 2: Response Sheets). The stakeholders and experts from whom the responses were discussed and gathered are: a) M3 – Catering Manager IR Base Kitchen Guwahati b) R1 – Research Scholar in the field of Sustainability c) R2 - Industrial Designer and d) Passenger in train no. 12501. First, the proposed system is first briefly described to the respondent. The response sheets for each respondent were slightly modified for him/her to elaborate the response required from them. A person to person interview using the question bankcard by the researcher was carried out and the responses were marked after detailed discussions. There was encouraging feedback from a few respondents and at the same time those respondents who were closely involved with the system like M1 were concerned about the degree of openness the authorities might have to this idea.

On the basis of the results emerging from the environment and socio-ethical assessment, some parts of the system concept were redefined and as a whole it is developed in greater detail. The anticipated improvements of the proposed system are dealt in detail in the following section. This is summarised after discussion and getting feedback from the respondents.

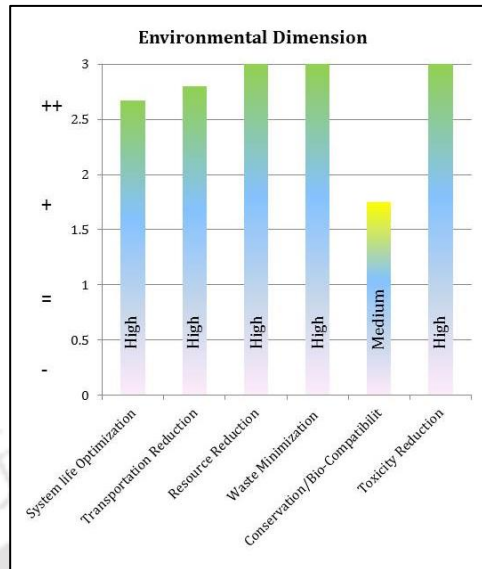


Figure 62: Anticipated advantages of the FoodR- Environmental Dimension

As shown in the **Figure 62** above, on the environmental dimension, it is observed that a High improvement in almost all the parameters is anticipated. The base kitchen mode of preparation of food and the new alliance with the appliance manufacturer will enhance the system life. However, during the evaluation feedback a concern was raised by the respondents regarding the use of equipment with longer life span from the inception as this requires much buffer time for the design and manufacturing. Utilization of the railway network in transporting the raw materials is considered a major step towards reduction of transportation. By the use of non-conventional sources of energy, the system absorbs low quantities of energy and by using the reusable containers; the packaging is made less material intensive. This improves the system score for the resource reduction. By avoiding the use of plastic materials in the system, the toxicity will also be reduced considerably. It can be seen that the conservation and bio-compatibility criteria is scoring low. This is attributed to the concern that whether the consumption of the resources will be at par with renewability rate of the resources.

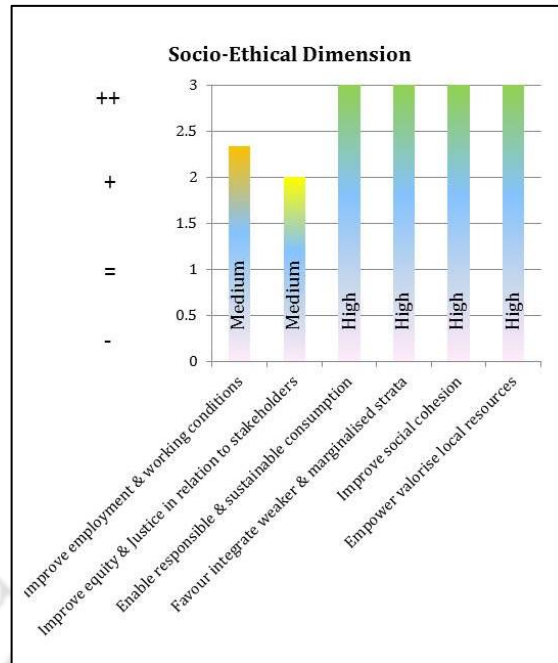


Figure 63: Anticipated advantages of the FoodR- Socio-ethical Dimension

As shown in the **Figure 63** above, on the socio-ethical dimension it is observed that improvements in two parameters are said to be moderate while on the other four high improvements are anticipated. The employment conditions are considerably improved by suitable design interventions at the base kitchen and the way of distribution with trolleys for stacking food boxes. The proposed system put forth the cooperative system which can improve social cohesion among the farmers. It also valorises the local resources and produces. Moreover it also brings in the unorganised sectors of rag pickers in the loop of the waste management system and provides the leftover food to the needy people around the base kitchen reducing the food waste and also supporting the weaker section of the society. The System is made more efficient hence the cost of offering is reduced which makes it accessible to people with low income. Employment for women staff made possible with resetting of the workload so that the ratio of the male female workers are somewhat balanced. The low scoring tendency for the “improve equality and justice in relation to stakeholders” criteria was again due to the concern about the execution of the

documentation and awareness drive to all the stakeholders for making the system transparent.

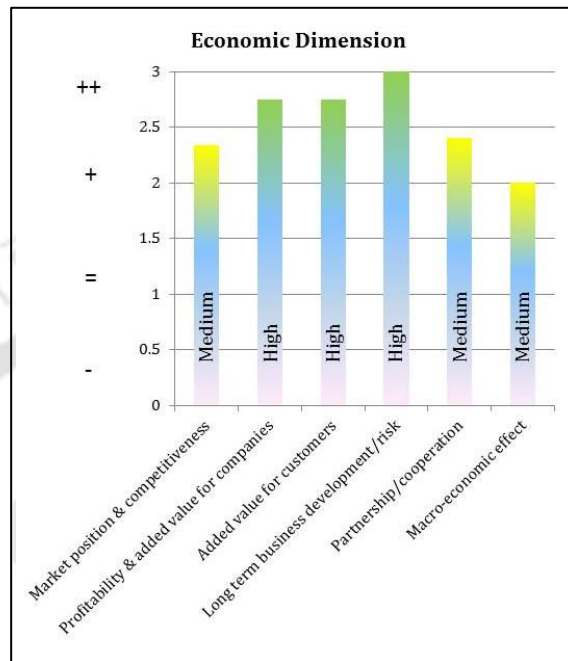


Figure 64: Anticipated advantages of the FoodR- Economic Dimension

The proposed system can provide profitability and added value for companies by increasing the efficiency of its operations. Making the system more efficient by timely maintenance gives it more economic advantage. Uses of alternative fuels are sought which lowers the fuel cost per meal. The new system of providing organic, healthy and value for money food along with more nutritious offer can bring about new possibilities of demand for the meals offered. It also offers added value for the customers as the rail passengers are getting more food options, clean and healthy food and also are freed of the responsibility of disposing the food packaging. However, the rebound effect could not be dismissed. There may be possibilities that the system, if not made proactive and flexible could bear possibilities of falling back to the worse state with 'red-tapism' and other hindrances.

4.8.2 Visualisation on impact of Sustainability Parameters - Radar Diagrams

After defining the basic elements of the product-service system, the potential improvements that the solution will be able to bring at environmental, economic and socio-ethical levels are assessed. Using the response sheet, a series of checklists are answered for each criterion. This enables to understand the potential level of improvement (radical, incremental or zero) or worsening compared to the existing system. The result is visualised on a radar diagram, on which it is also possible to note the main advantages for each criterion. The tool is also useful to understand whether it is necessary to modify any of the concept characteristics in relation to any of the ideas. The radar diagram on the three dimensions of sustainability shows the visualisation of these improvements. It compares the priority assigned to a particular parameter, the performance of the reference system and the performance of the proposed system. **Figure 65** below shows the radar diagrams for the proposed system.

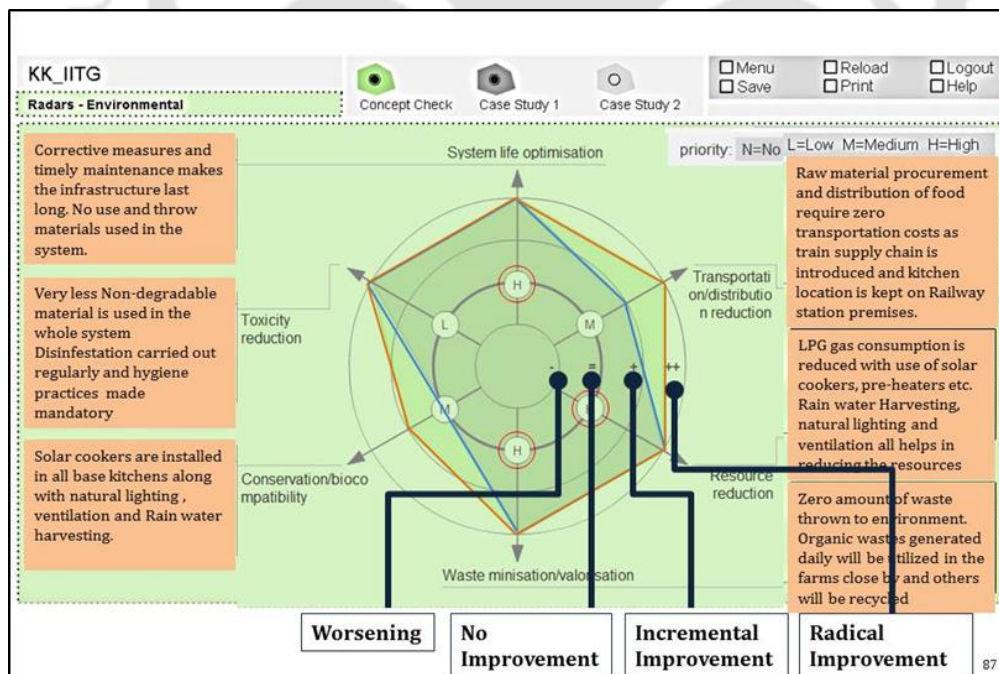


Figure 65: Radar Diagram of the FoodR- Environmental Dimension

It can be seen that the parameters which required the maximum attention during the design process were the system life optimization, resource reduction and waste minimization. From the radar diagram for environmental dimension, it can be seen that all the three parameters had a radical improvement in the proposed system due to the MSDS methodology which used the SDO toolkit for orienting the system towards sustainability. In figure 62 above, it is observed that there is a significant improvement in the transportation reduction parameter which can be mainly attributed to the maximum utilization of the Indian Railways network for transporting raw materials, prepared food and the wastes generated without depending on the conventional ways of fossil fuel dependent on transportation methods. The improvement of the system life optimization parameter can be attributed to the new way of partnership designed for the maintenance of the appliances in the base kitchen and also to the complete elimination of the on-board catering where the food is prepared in the pantry cars of the running trains. This will help maintain uniform quality control procedures possible throughout the preparation process. The closed loop waste management system shows an anticipated radical improvement in the waste minimisation and valorisation parameter by generating zero amounts of wastes thrown to the environment and minimizing non degradable wastes being generated. Similarly for other parameters, like resource reduction and conservation bio-compatibility, various measures were proposed like maximising the use of non-conventional energy sources, maximum utilization of natural lighting and ventilation in the base kitchen premises, rain water harvesting, solar cookers, pre heaters etc.

Similarly for the socio-ethical dimension, the parameters which were of the highest priority were to enable responsible and sustainable consumption and to improve the employment and working conditions. By designing a very clear and transparent way of documentation and a well set awareness campaign, anticipation in the radical improvement to enable responsible and sustainable consumption is possible in the future. For the other parameter of improving the employment and working conditions, there is an increment being anticipated. This could be attributed to the infrastructure constraints that exist in the train bogies and compartments which make it less pragmatic. As shown in the **Figure 65** above, it is clear that for the

factor improving the working conditions, the equity and justice seemed to be a bit less compared to the reference system because of the difference in the motive behind each system; the reference system being a non-profit organisation.

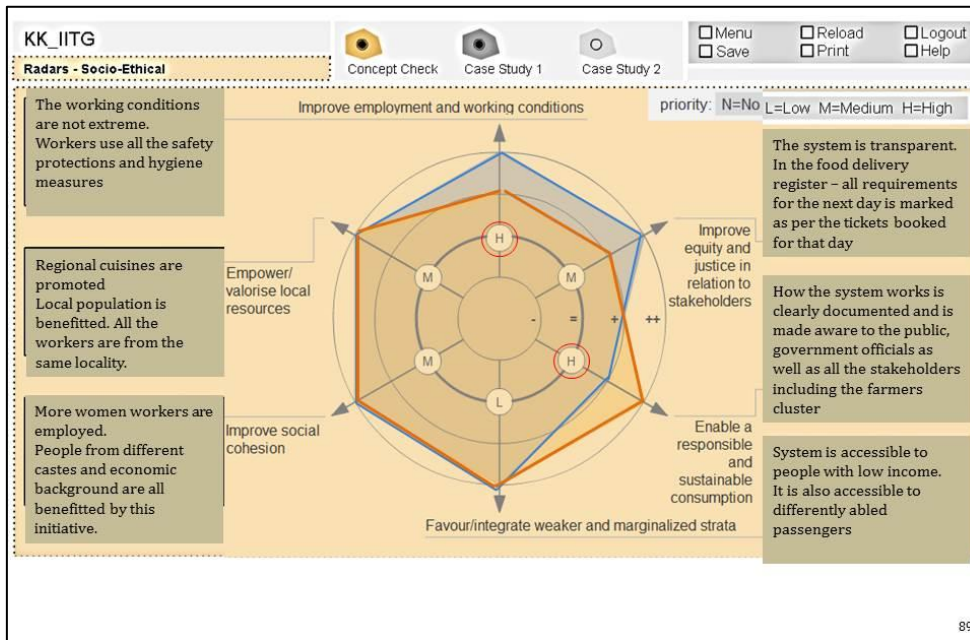


Figure 66: Radar Diagram of the FoodR- Socio-ethical Dimension

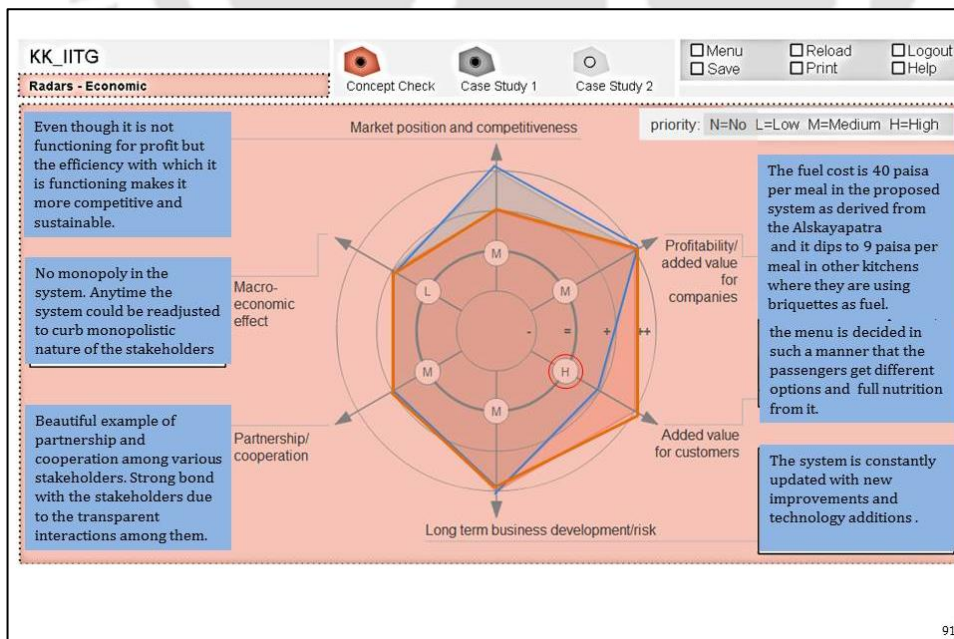


Figure 67: Radar Diagram of the FoodR - Economic Dimension

These radar diagrams (**Figure 66** and **Figure 67**) show the anticipated improvements of the proposed system after incorporating the best practices identified from the reference system and also passing through the sustainability design steering tools and the brainstorming included in this process. Analysing this method of PSS approach and MSDS has given the opportunity for design intervention in the existing system after identification of the problems associated with it and comparison with the reference system has given the insights to the best practices which could be embedded in the proposed concept. This has given opportunity to identify the design intervention points which could help position the conceptual model more towards sustainability. After forming the conceptual model it was again taken through the SDO toolkit where the improvement of the conceptual model in those parameters which had scored less in the existing system was again checked. The radar diagrams above shows the improvement in each parameter for all the three dimensions of sustainability. Analysing the system through a PSS approach has enabled us to identify the point of design interventions possible in the existing system which can orient the system into a sustainable model. After forming the radar diagrams it is evident that the conceptual model leans more towards sustainability and scores more than the existing system in terms of the three parameters of sustainability. This elucidates the hypotheses No. 2 (H2).

4.8.3 Recommendations, Scope and Strategy for Implementation

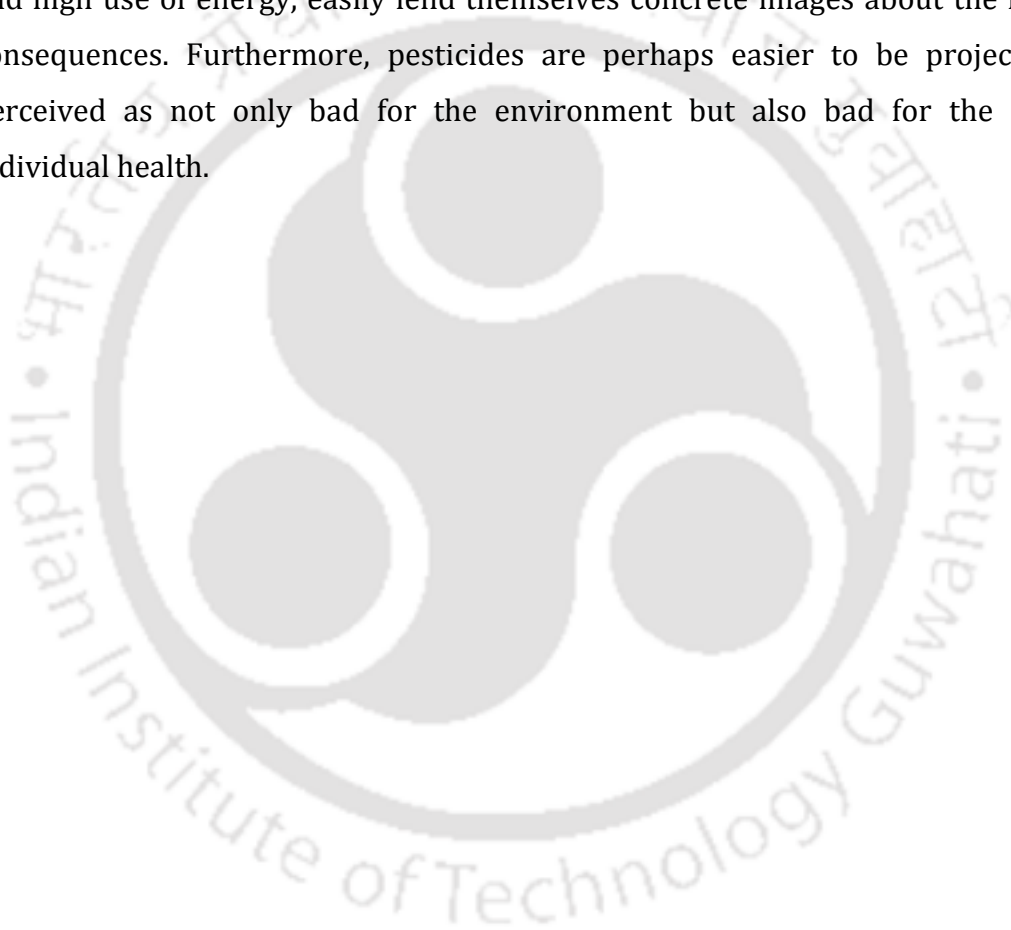
For any system with environmental considerations related to food, the most important factor is the corporate policy when it comes to the purchasing behaviour of the customers (Bergström, Solér, & Shanahan, 2005). Purchasers are mainly guided by business parameters with respect to price, quality and service. These factors are given priority over co-operation along the food supply chain. In fact co-operation among the various stakeholders have been shown to have the potential to encourage environment friendly purchasing decisions among the buyers. The proposal made here fall under radical innovations which has factors like cooperation among the stakeholders as an important business parameter. There will be many limitations for the implementation of such a project mainly due to reasons like the time period available, immediate funding availability, unforeseen impacts

etc. To overcome this the process to be adopted here is to first introduce this project as a socio-technical experiment and then scaling up to its full implementation (Ceschin, 2013). Literatures show that there are many successful cases which show that the adoption of an experimental, learning, and network-based management approach, can increase the chances of a successful implementation. In the case of the Indian Railways, the proposal could be first experimented at a selected small region which will give scope for learning and exploring how the PSS innovation can be improved and the contribution to the societal acceptance and embedding. This proposal is more towards a Sufficiency Economy Movement which aims to promote sustainable development in this globalized world. It helps in building and developing the strong foundations of a society, through enhancing the ability to adapt and adjust for any changes occurred (Piboolsravut, 2004). This stage is more important as many of the consequences could arguably have had a short-term impact. Unlike other cases as the proposed system has recognition from the government and the officials it is easy to start off with but timely interventions should be made to make it non-structured, non-bureaucratic and flexible.

After the socio technical experiment phase, it can be taken forward to the next phase of scaling up where the momentum of implementation is increased and slowly becomes part of the common way in which the need is fulfilled.

For any environmentally beneficial system, to overcome the inertia and gain momentum in the market, the two major things to be done are to influence the consumer's behaviour to use this system and to increase the acceptance level of the environmental friendly system among the masses. There could be many ways of doing this; either by giving customers less choices to choose from other than these products or to promote eco-friendly products by using eco-labels. Many novel ideas have to be thought out for influencing the user/consumer. In this context one has to think about the way in which awareness campaigns are devised to reduce the smoking and tobacco consumption tendencies in people. In advertisements the side effects of smoking and use tobacco are highlighted, like cancer and other deadly diseases. Even though there are many advertisements being aired in the media, there are myriad varieties of cigarettes and tobacco available abundantly in the

market. This makes the effective implementation of these campaigns difficult. Similarly, for a new thought on sustainability to be promoted, effort has to be made from both the service provider end and the customer end. In the case of IRCS, it is ideal to make available only the healthy and organic food made in the FoodR system in trains and platforms. Another way out is to have an intense advertisement campaign highlighting the positive effects of using FoodR. As mentioned in (Grankvist & Biel, 2007) the explanation on the risks associated with the use of chemical pesticides, in comparison with risks of the emission of greenhouse gases and high use of energy, easily lend themselves concrete images about the negative consequences. Furthermore, pesticides are perhaps easier to be projected and perceived as not only bad for the environment but also bad for the farmers' individual health.







CHAPTER 5: PROSPECTS AND CONCLUSION



5.1 Hypotheses Explored

As mentioned earlier we began exploring sustainability and design from the perspective of a PSS in the Indian context. The possibility of finding out the performance of the Indian Railway catering system from a sustainability point of view was examined and the directions in which design interventions could be made were also explored though the use of appropriate methods and tools.

The two main hypotheses put forth by this thesis were:

H1. The Catering system, presently in vogue in the Indian Railways scores low on sustainability parameters viz. economic, environmental and socio-ethical.

H2. Assessment of the Indian Railway Catering Service (IRCS) following a Product Service System (PSS) approach will help identify the scope of design intervention in the improvement of the catering system of the Indian Railways for the different stakeholders in the system.

In order to confirm our hypotheses, at first the existing Indian Railway Catering Service was studied from a PSS perspective and analysed with MSDS tool to assess its performance in terms of the three parameters of sustainability namely environmental, socio-ethical and economic. (H1). As explained in chapter 3 section 3.2, Figures 34, 35, 36 which proves the point that the existing catering system at present in the Indian Railways scores low on the three parameters of sustainability namely environmental, socio-ethical and economic. Hence Hypotheses 1 is accepted.

Then it was subsequently compared with the reference system- AkshayaPatra- to identify the best practices followed in the reference system and to find out the scope of improvement and design intervention at a system level. Then an outline for an improved system for the IRCS was proposed by imbibing the best practices adopted by the reference system and it was oriented towards sustainability using the established Method of System Design for Sustainability (H2). Thereafter this proposal was discussed with the various stakeholders to get the feedback on perceptual improvements and possibilities of implementation which has given rise

to the radar diagrams shown in Chapter 4, section 4.6.2, Figures 62, 63, 64. Hence Hypotheses 2 is accepted.

5.2 Research Questions Answered

In the first and second phase, we had one research question (RQ1) that we were able to answer

1. The performance of the Indian Railway catering system on the three dimensions of sustainability namely; Environmental, socio-ethical and economic were assessed. For this we also examined a reference system from which we could get the comparative performances and the insights of both the systems. It was evident from the questionnaire responses as well as the application of the IRCS on the method of MSDS that the present system followed in IRCS lacks in many criteria of sustainability when compared with the AkshayaPatra base kitchen which is far more advanced and better scoring in terms of the three dimensions of sustainability.

In the third phase we had three main research questions (RQ1, RQ2, and RQ3) that we were able to respond to:

1. The MSDS method gives an understanding of the potential design intervention points at the product, service and system level for the Indian Railways. In the case of the IRCS, the responses obtained from the various stakeholders give a fair idea about the problems faced and the possible interventions identified by them. Classifying these problems identified as the intervention points at the product level, service level or system level through the polarity diagram give a fair idea about the design entry points.
2. Visual representation using the radar diagram on the IRCS, AkshayaPatra and the proposed system FoodR gave indications on the improvements achieved by the design intervention. We found that there are considerable improvements in the various criteria in all the three dimensions of sustainability.

3. Taking back the proposed system to the stakeholders and getting the feedback gave us a fair amount of idea about the perception of the stakeholders about the proposed system. The proposed idea even though is more towards a radical innovation than an incremental solution which was unfamiliar to the existing stakeholders were perceived as promising and were supported by them.

5.3 Specific Contributions

The research studies and assesses the IRCS from a PSS perspective and identifies the scope of design intervention in the improvement of the overall system, its various sub-systems and suggests a context specific solution with four layers of clusters - the waste management system, raw material procurement system, information transfer system and the food order communication system giving more importance to dematerialised designs.

With reference to the domain of sustainability and a PSS, the process adopted in this research help analyse and compare an existing catering system with any benchmark system in different areas and locations.

This thesis clarifies the concept of result oriented PSS for complex systems like the Indian Railway catering system and comes up with a concept of PSS innovation which includes agricultural sector in the rural areas by forming the cooperatives, which seems to be more appropriate in the context of a developing country. This is an effort to address the Indian Railway catering system from all the three dimensions of sustainability and to understand the various challenges.

The detailed study carried out in this thesis of the two practical examples of complex systems has given an insight and better understanding about the complexity in operations of the systems and the design attitude and strategy required by designers to intervene at a holistic level keeping in mind the three dimensions of sustainability.

This research proposed a new improved system for the IRCS which couples the benefits from the concept of sustainable PSS with the principle of design for sustainability in the context of a developing country like India keeping in mind the environmental, socio-ethical and economic concerns which are of utmost importance. The comparison with the reference system helped identify many good practices followed in the context of a developing country and added insights as to how that can be translated into adoptable practices for other systems. Visual representations of the three systems in the form of radar diagrams show the anticipated improvements obtained by means of the design intervention at product, service and system level.

The research work developed a practical understanding of the Indian Railway Catering system from a sustainability perspective, especially with respect to the Product service system model. The concept proposed here may help researchers who are doing PSS study of any system see a method of approaching the system from a sustainability point of view at the systems level. The proposed system also gives the researchers a direction to come up with novel innovative concepts at a holistic level. As the concept of sustainability has to be seen as a broad area, the ideas also need to be first attempted at the systems level before taking it forward to the product level. At a macro level, the inclusion of new stakeholders into the system too, gives rise to new realm of proposing a system model.

5.4 Limitations and Future Prospects

Since PSS systems require time for introduction and diffusion which needs to be done in stages, in view of the limited time constraint it was not possible to test it after actual implementation. To overcome this, from the beginning a sustainable system design steering tool was selected, which will help to actually orientate the system towards sustainability by including the various stakeholders at the different stages of system design. Moreover, researchers, designers and academic experts were also involved to assess the design approach and the concept outline in terms of their potential practicality, preferences and effectiveness. Many questions still need to be addressed; whether the passengers would accept this new system and whether there would be any unforeseen behaviour with the various stakeholders

which may surface only when it is implemented and studied further. These concerns require further study, many tests and analysis after the pilot implementation phase. Another limitation that could be argued is that the reference system selected does not cater to providing food to a dynamic customer base, as their business deals with providing food adheres to a fixed number of customers and the same customers again and again. But as the reference system selected has the many laurels of an efficient system and also since this thesis is an exploratory one, the slight difference in terms of the business sector could be neglected as the value addition is found to be more on undergoing a PSS study of the reference system. The factors identified which affect the proper implementation of any sustainable system is the dominance of short-term economic issues in decision-making and the lack of co-operation among the stakeholders to achieve environmental aims (Säynäjoki, Heinonen, & Junnila, 2014). These are the factors to be kept in mind when taking this research further in the future.

The direct mingling and interaction of the researcher with persons involved in this case for data collection and system study could be seen as a limitation as it could influence the research objectivity. To minimise this as much as possible, other design research scholars from the department of design IITG, a Designer (from outside the department of design IITG) and a train passenger were also involved to carry out an independent evaluation for assessing the improvements in the proposed system. However, it also needs to be stressed that the close involvement and interaction with the various actors of the system during data collection stage has in fact been advantageous in closely understanding the system, the practices followed and to obtain many system design insights.

Another limitation is the fewer number of stakeholders involved in this project. Firstly, this was due to the fact that permission from railway authorities was limited to only few officials and the availability of these people and the time spared was less for the interview. The sense of suspicion of the catering manager and the pantry staff on documenting this study and the survey as to how it will be used can also be seen as a limitation. Effort was made to overcome this by closely interacting and mingling with the staff but the possibility of their responses being guarded cannot

be written off. Another point is the challenge of conducting the passenger survey on the crowded trains during journeys also might have affected the completeness of the responses from the respondents.

Lastly, the research was done only on certain types of trains. There are many other types of trains which were not considered due to logistical reasons. Limited numbers of stakeholders were chosen for getting inputs for the response sheet due to time and distance constraints. The case considered is Northeast Frontier Railway Zone and there could be slight variations in the parameters and challenges faced by other railway Zones. These factors need to be taken into consideration when extending this study to other railway zones. As this research was carried out at an individual level, it has its own limitations as the system is complex. This type of complex projects requires it to be done at the departmental level with more team members and involvement from the Railways so that the component of policy level matters could also be incorporated. This thesis concentrates less on the policy level matters of the IRCS and focuses mainly on the process related to the design of the system. This could also be seen as a limitation. The model proposed here may be on a conceptual level but it is built on actual facts.

The future scope would be the formation of a group so that this concept could be taken forward as a socio -technical experiment along with laying down the roadmap for the subsequent scaling up. This kind of continuous implementation of systems are required so that the involved actors can reflect upon the activities undertaken and improve upon the PSS innovation and enable gradual societal embedding. It can only be introduced as a Socio-technical experiment (Carlo Vezzoli, Ceschin, Diehl, & Kohtala, 2015) by actually employing the proposed model for Indian Railways catering system in a real life situation and then slowly be scaled up.

Furthermore, at the moment there is no scope for practical implementation and testing of this system as it involves the socio-ethical dimension which is very varied and is difficult to be assessed and the economic aspect needs a strong will to raise the initial capital. In future it can also be explored as to how this system could be utilized for other catering kitchens that exist in the nearby areas. For example, the inclusion of canteens, Hospital canteens, restaurants etc. in the vicinity of railway

stations in the supply chain where organic produces from the rural areas are transported through the trains to reach its destination. These are some directions which could be explored in future.

5.5 Conclusion

This thesis attempts to study IRCS from a PSS perspective and to analyse it using the MSDS tool to find its performance in terms of the three dimensions of the sustainability and compared it with a reference system for benchmarking where the best practices present in the reference system were identified and the scope of improvement and design intervention for IRCS at the system level were explored and an improved system (FoodR) for the IRCS was proposed by imbibing the best practices adopted by the reference system and oriented it towards sustainability using the MSDS methodology. The FoodR promises to deliver the passengers good, clean, healthy and organic food at the correct time relieving them from the onus of disposing the plates and packaging. The service provider will take care of the disposal of the plates, transportation etc. without dumping that on the shoulders of the passengers. Indian Railways though considered being the life-line of India, holds the black trail of environmental pollution due to the use of large quantities of disposable packaging. After a thorough study and a comparison with the reference system, a proposed model was outlined. In this concept, many environmental factors like the use of reusable containers for the reduction of waste being generated, promoting organic food and raw materials in the system there by avoiding the ill effects of using chemical fertilizers, reducing dependency on fossil fuels by utilizing the existing train network for transportation of raw materials etc. are some of the major steps taken in the direction of environmental sustainability. For socio-ethical sustainability, formation of cooperative societies in rural villages for producing raw materials required for the IRCS, promoting more employment opportunities, encouraging the inclusion of regional cuisines etc. are some of the steps taken. Similarly, for economic sustainability, guidelines to make the system more efficient are being advocated. A point which caught our attention was the challenge to make non-conflicting communication between the authorities and the stakeholders. In the actual scenario the communication between the farmers and the catering staff could

be confusing. Understanding this has helped in the design of an Information system, IRCSIH which would control all the communications and the necessary transfer of information.

Systems thinking of the Indian Railways catering system enabled the identification of the concept of sustainable development in the context of a developing country. It also enabled the perspectives of the different stakeholders more transparent and clearly demarcated, which helped in outlining the new concept in the direction of sustainability by including new stakeholders. In these kinds of social innovations the end users and local communities play a major role in the implementation and self-sufficiency of these solutions. It is stressed that for the implementation of this solution the support of designers must be included as well. Another crucial point inferred as a part of this study was that designing any setting which involves different stakeholders and the transactions between them requires a systems perspective and Product Service Systems perspective gives a broader and, at the same time, a close focussed frame for scrutiny.

The concept model of the proposed system had many anticipated advantages in terms of sustainability in the long run. As an outcome of the brainstorming sessions, the ideas that emerged were not only on the environmental front but also on the socio ethical side which emphasises on the uplift of the local society as well. The idea envisioned here vouches support to the agricultural sector in the rural areas by forming the cooperatives that will directly help the farmers and be more beneficial to them in the long run. The Agriculture sector can sustain only if the profit generated is distributed among the farmers and not with middlemen. Only this will encourage more people to resort to farming. The cooperatives are a solution which will provide more employment opportunities to the villagers and promote sustainable growth in rural India. The proposed system will enhance the rural prosperity and will reduce the gap between the rural and the urban amenities by throwing seeds of development through the places where the Indian Railways is marching forward. It was found in the study that empowerment is the only solution for societies to sustain in the long run. This is reflected in the concept solution which will empower the rural population, the different stakeholders and the whole system.





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LIST OF FREQUENTLY USED ABBREVIATIONS

BSR	Business for Social Responsibility
CNB	Kanpur
FoodR	Food Railways
GHY	Guwahati
GMC	Guwahati Municipal Corporation
IR	Indian Railways
IRCS	Indian Railway Catering Service
IRCSIH	Indian Railway Catering Service Information Hub
IRCTC	Indian Railways Catering and Tourism Corporation
JBP	Jabalpur
MDMS	Mid-Day Meal Scheme
MSDS	Method for System Design for Sustainability
NCAER	National Council of Applied Economic research
NDLS	New Delhi
NFR	Northeast Frontier Railways
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PSS	Product Service System
PURA	Providing Urban amenities in Rural Areas
PWMC	Plastic Waste Management centre
SDO	Sustainability Design Orienting toolkit
VCS	Village Coordination Society
WCED	World Commission for Environment and Development

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APPENDICES

APPENDIX 1: Questionnaires

Passenger Questionnaire

I introduce myself as a Research Scholar of the Department of Design, Indian Institute of Technology, Guwahati. I am conducting a research on the “The Catering service system (Pantry) of Indian Railways”. The valuable information provided by you will help me in the completion of my research project. I sincerely hope you can spare a few minutes to answer the following questions. I assure you that information provided by you shall be used only for academic purpose and will be kept confidential.

Age: _____ Gender: _____

1. How often do you travel by train?

More than twice a month Once every month Once every 3 months
Once every 6 months Once every year

2. In which Class do you usually travel?

First AC Second AC Third AC Sleeper Class General

3. From where do you have your food during train journeys?

Pantry Platform Carry food along

4. How frequently do you opt for Pantry food from trains?

Frequently Sometimes Rarely Never Not sure

5. If you don't take Pantry food from trains, please check for your reasons below and tick accordingly for other reasons, go to question (i) below. (You can tick more than one box)

- a. Lack of cleanliness in the pantry car
- b. Not sure about the quality of raw materials used for preparing the food
- c. Not satisfied with the service and promptness of the pantry facility
- d. The quantity is too less for my requirement
- e. Cost is too high; will get cheap food from other sources.
- f. Some personal beliefs associated with taking food from outside.
- g. Not satisfied with the personal hygiene practices of the pantry staff.
- h. The overall quality of the food served is below acceptable limit.
- i. Any other reason which you may like to specify :

.....

- j. According to you what is the best thing about the food you get in trains?

.....

- k. Is the food served in train hot and fresh? Yes No

Please rate the following below in a 5- pointer scale (1 – lowest and 5 – highest)

6. Variety of the dishes in the menu : 1 2 3 4 5
7. Overall quality of food served : 1 2 3 4 5
8. Value for money of the food served : 1 2 3 4 5
9. Behaviour of the pantry staff : 1 2 3 4 5
10. Safety of the food served in trains : 1 2 3 4 5
11. Overall cleanliness of the pantry car : 1 2 3 4 5
12. Overall cleanliness of the pantry staff : 1 2 3 4 5
13. The present waste management system by railways : 1 2 3
4 5
14. The quantity of food served is sufficient : 1 2 3 4 5
15. The system of food distribution at present in trains : 1 2 3
4 5
16. On-time serving of food in trains : 1 2 3 4 5
17. Rate the ideas below:
- a. Food being served in specially designed air tight stainless steel containers and then taken back by staff for cleaning and reuse.: 1 2 3 4 5
- b. An extra 10% charged for good food served as mentioned in question no. 17a? : 1 2 3 4 5

18. Do you prefer food served in Disposable packaging Clean Re-usable Lunch boxes?

19. Do you prefer water served in Disposable plastic bottles Re-usable bottles?

20. Any suggestion for improving the Pantry services in Indian Railways?

Thank You

Pantry Staff Questionnaire

प्रश्नावली - पैंट्री स्टाफ

मैं भारतीय प्रौद्योगिकी संस्थान गुवाहाटी में एक शोधकर्ता हूँ. मैं "भारतीय रेलवे की खानपान सेवा प्रणाली (पैंट्री)" पर एक शोध कर रहा हूँ. मुझे उम्मीद है कि आप निम्न सवालों के जवाब देने के लिए कुछ समय निकालेंगे. आपके द्वारा उपलब्ध कराई गई जानकारी शैक्षिक उद्देश्य के लिए ही इस्तेमाल की जाएगी और गोपनीय रखी जाएगी.

नाम (स्वैच्छिक) : _____ उम्र: _____

लिंग : पुरुष महिला

1. आप किस राज्य से हैं? : _____

2. क्या आप भारतीय रेल की एक स्थायी कर्मचारी हैं? हां नहीं

3. आप केटरिंग क्षेत्र में कितने साल से काम कर रहे हैं? : _____

4. आप इस ठेकेदार के साथ कितने साल से काम कर रहे हैं?: _____

5. आपके काम की काये अवधी क्या है : _____

6. कितनी बार आपके पर्यवेक्षक आपके काम के बारे में सुझाव या प्रतिक्रिया देता है?

हर समय कई बार अक्सर

कभी कभी कभी नहीं

7. आपका वेतन पैकेज अन्य केटरिंग संस्थाओं की तुलना में अच्छा है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

8. आप अपने संगठन द्वारा दिए गए लाभ से संतुष्ट हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

9. ठेकेदार को परेशानि बताने पर उचित प्रतिक्रिया या कारवाई होती है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

10. आप अपने कायेस्थल के वातावरन् से सन्तुष्ट हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

11. आप आपको काम करने के लिए प्रदान की गई उपकरणों और सामग्रियों से संतुष्ट हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

12. आप अपने काम के माहौल में सुरक्षित और आरामदायक महसूस करते हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

13. आप संगठन की कायेशैलि से संतुष्ट हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

14. आपका संगठन् आपके स्वास्थ्य और कल्याण के लिये प्रतिबद्ध है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

15. आप अपने काये प्रणालि से जुड़े जोखिम और खतरों के बारे में जागरुक है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

16. आप अपने व्यवसायिक और निजी जीवन को संतुलित कर पा रहा है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

17. आप अपने काम के माहौल में तनाव महसूस करता है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

18. आपके संगठन के भीतर कैरियर के विकास के लिए अवसर है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

19. आपका संगठन आपके काम से संबंधित प्रशिक्षण और विकास में सहयोग देते हैं .

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

20. आप अपने कार्यस्थल पर किसी प्रकार के उत्पीड़न का शिकार नहीं हुए हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

21. आप पर लंबे समय तक काम करने के लिए दबाव डाला जाता है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

22. आप काम के बीच में अंतराल लेते हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

23. आपका कार्य समय लचीला है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

24. एक साथ काम करना इस संगठन में प्रोत्साहित किया जाता है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

25. आपका प्रबंधन आपकी हर बात सुनता है

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

26. आपके संगठन में अलग और नए विचारों का सम्मान करते हैं

पूरी तरह से सहमत हैं थोड़े से सहमत हैं न सहमत न असहमत

थोड़े असहमत हैं पूरी तरह से असहमत हैं पता नहीं

Caterer Questionnaire

प्रश्नावली (रसोईया)

मैं भारतीय प्रौद्योगिकी संस्थान गुवाहाटी में एक शोधकर्ता हूँ। मैं "भारतीय रेलवे की खानपान सेवा प्रणाली (पैन्ट्री)" पर एक शोध कर रहा हूँ। मुझे उम्मीद है कि आप निम्न सवालों के जवाब देने के लिए कुछ समय निकालेंगे। आपके द्वारा उपलब्ध कराई गई जानकारी शैक्षिक उद्देश्य के लिए ही इस्तेमाल की जाएगी और गोपनीय रखी जाएगी।

नाम : _____ उम्र : _____

1. आधार रसोईघर का पता :

2. रेलवे स्टेशन से कितनी दूर :

3. ठेकेदार का नाम :

4. क्या आप ट्रेनों में पैन्ट्री रसोई का प्रबंधन करते हैं? हां नहीं

5. आपके खाद्य कितने ट्रेनों में वितरित किये जाते हैं? :

6. कितने स्टालों रेलवे प्लेटफार्मों में आप भोजन की आपूर्ति करते हैं? :

7. आधार रसोई की अधिकतम क्षमता क्या है: _____ भोजन

8. प्रतिदिन तैयार की जाने वाली भोजन की मात्रा (जैसे पाकट, संख्या, इत्यादि)

नाश्ता : स्नैक्स :

लंच : डिनर :

9. कितने कर्मचारियों अपने रसोई घर में काम कर रहे हैं? :

10. वहाँ कितने प्रबंधक हैं? :

11. आप रसोई घर के लिए कचचे माल की खरीद कहाँ से करते हैं? :

12. यह रसोई से कितनी दूर है? :

13. आप कहाँ से सब्जियों खरीदते हैं? :

14. दैनिक कार्य समय क्या है? :

15. एक कर्मचारी का वेतन कितना है? :

16. आपके भोजन मेनू सूची क्या है? :

17. कचचे माल की दैनिक खपत कितनी है? (लगभग)

चावल _____ किलोग्राम

दाल _____ किलोग्राम

मसाला _____ किलोग्राम

सब्जियों _____ किलोग्राम

18. आप बोटलबंद पानी बेचते हैं? हां नहीं

19. आप इसे कहाँ से प्राप्त करते हैं? :

20. आप रोजाना कितने बोतलें बेचते हैं? :

21. रसोई गैस सिलेंडरों की मासिक खपत क्या है? :

22. पानी का स्रोत क्या है? :

23. आपको रसोई घर चलाने में किसी भी प्रकार की समस्याओं का सामना करना

पड़ता था?

24. आपको भारतीय रेल से अधिक क्या समर्थन की जरूरत है?

25. आप रसोई घर में कचरा प्रबंधन कैसे करते हैं?

1. आप अपने रसोई घर में सौर कुकर का प्रयोग करते हैं? हां नहीं

2. आप अपने रसोई घर में सौर हीटर का उपयोग करते हैं? हां नहीं

3. आप अपने रसोई घर में वर्षा जल संचयन का उपयोग करते हैं? हां नहीं

4. आप अपने रसोई घर में जल उपचार संयंत्र का उपयोग करते हैं? हां नहीं

5. आप अपने रसोई घर के कचरे को खाद संयंत्र में उपयोग करते हैं? हां नहीं
6. आप अपने रसोई घर में सौर बिजली का उपयोग करते हैं? हां नहीं
7. आपने भारतीय रेल से कोई प्रशिक्षण प्राप्त किया था? हां नहीं
8. आप अपनी रसोई में पर्यावरण संबंधित नीतियों को किस तरह लागू करते हैं? हां नहीं

खानपान सेवा में सुधार के लिए कोई सुझाव:

APPENDIX 2: Response Sheets

AkshayaPatra Base Kitchen Guwahati

Name : _____

Date : _____

Environmental sustainability Dimension

System Life Optimization

1. Rate the infrastructure provided by the AkshayaPatra Base Kitchen
Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3
2. Rate the usage of disposable product packaging or support products used in the system?

Rate it on a scale of 0 to 3 ((0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

(How much quantity of disposable product packaging is used per day? – 190 kg from one Base kitchen)

3. Do parts of the catering system tend to be technologically, culturally or aesthetically updated? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

Does the kitchen need upgrade?

0 1 2 3

4. Is the system used and shared optimally as a whole and also as parts? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Rate the ruggedness/durability of the system (product, infrastructure and support product) Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

Rate the maintenance and upkeep of the AkshayaPatra Base Kitchen?

Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

Transport Reduction

Rate the system used for transportation of goods in AkshayaPatra? Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

5. Excessive transportation of semi-finished products or bi-products are absent in AkshayaPatra base kitchen Guwahati? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Completely)

0 1 2 3

6. Excessive transportation of people are absent in AkshayaPatra base kitchen Guwahati? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = completely)

0 1 2 3

7. Are the transportation means in service fully used? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

8. Excessive use of packaging is absent in AkshayaPatra? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Completely)

0 1 2 3

Resource reduction

9. Is the system consuming less quantities of energy (Electricity, Fuel, etc)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

10. Do you think the system is consuming low quantities of natural resources or consumables? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Waste minimization & Valorisation

11. Do you think that all the wastes generated by the AkshayaPatra system are HANDLED RESPONSIBLY? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

12. AkshayaPatra eliminates generation of high quantities of landfill waste at the end of the service life? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Conservation /bio-compatibility

13. Is the energy used in AkshayaPatra Base kitchen Guwahati from fuels other than fossil fuels? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

14. Do you think that the AkshayaPatra Base kitchen minimizes exhausting resources for energy production and usage? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

15. Do you think that the AkshayaPatra Base kitchen Guwahati makes use of sources other than depleting and/or non-renewable materials for their production process? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

16. Do you think that the use of depleting and/or non-renewable materials for the products, support products, packaging and infrastructure is avoided in AkshayaPatra Base kitchen? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Toxicity Reduction

17. Do you think that the processed resources at AkshayaPatra Base kitchen Guwahati are not toxic and potentially non-toxic for the workers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

18. Do you think that the processed resources used during distribution of food at AkshayaPatra base kitchen Guwahati are Non-Toxic? Rate it on a

scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

19. Do you think that the processed resources at AkshayaPatra are not at all toxic for the user? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

20. Do you think that during the after service-life treatment, the products, support products, packaging and infrastructure are not toxic or potentially harmful? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Socio-ethical sustainability dimension

Improve employment and working conditions

21. Rate the health and safety standards maintained for the staffs? Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

22. There is no discrimination in workplace at AkshayaPatra Base kitchen Guwahati? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

23. Problems like Work overload and inadequate wages are absent in AkshayaPatra Base kitchen Guwahati? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Improve equity and justice in relation to stakeholders

24. There is only appreciation about the system from all the stakeholders.
Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

25. There is only full appreciation from the client/end-user side (school authorities, students) about the supply system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

26. There aren't any unjust relationships between the partnerships? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

27. AkshayaPatra doesn't maintain any unjust relationships with suppliers, contractors and sub-suppliers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Enable a responsible and sustainable consumption

28. Are the client/final user able to acknowledge clearly and easily the social unsustainability along the whole value production chain? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

29. Are the school authorities and the students able to understand the responsible sustainable behavior by the supply system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Favor/integrate weaker and marginalized strata

30. The supply system followed at AkshayaPatra doesn't create obstacles or limit access to people with weak social status (e.g. Kids, women,

differently abled)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

31. Are the offerings by AkshayaPatra Base kitchen system accessible to people with lower income? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

32. The system at AkshayaPatra Base kitchen Guwahati in any way doesn't favor people marginalization? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Improve social cohesion

33. The AkshayaPatra system is NOT creating or favoring any form of intra-gender, intra-cultural or intra-generational emargination? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

34. Do you think the AkshayaPatra system doesn't create any forms of discrimination (religious, sexual, cultural, gender etc. Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Empower valorize local resources

35. Do you think the system followed at AkshayaPatra enriches local cultural values and identities? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

36. Do you think that the AkshayaPatra system offers many solutions, /many variations for all religions and cultures? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
37. Do you think AkshayaPatra Base kitchen currently have a positive impact on the social well-being of the local community? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
38. Do you think AkshayaPatra Base kitchen is enriching the local economies? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
39. The AkshayaPatra base kitchen DOESN'T absorb any local non-renewable resources? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3

Economic sustainability dimension

Market position and competitiveness

40. Do you think AkshayaPatra Base kitchen has a strong market position in the current system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
41. Is it possible to further improve your market position that you do not use at the moment? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
42. Do you think there are no threats to the market position of AkshayaPatra Base Kitchen? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3

Profitability and added value for companies

43. Do you think the profitability (Efficiency) is high for AkshayaPatra and other external partners? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

44. Do you see anybody producing better offers than AkshayaPatra in a cheaper way? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

45. Do you think AkshayaPatra Base kitchen Guwahati has used all the possible opportunities to create more value in the whole value chain/system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

46. Is the System in place and nobody is using this opportunity except you (e.g. selling your products second hand)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Added value for customers

47. Do you think the value offered is the best for customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

48. Are you successful in offering concrete tangible savings in time material use etc. for the customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

49. Are you successful in offering priceless intangible added value like esteem experiences etc. which the customer is willing to pay? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

50. Do you think that no competitors of AkshayaPatra Base kitchen are creating more value for money offerings for the customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Long term business development/risk

51. Do you think that there are no threats in the current system for the business of AkshayaPatra in long-run? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

52. Do you foresee that there will be never ending demand for your offer in future? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

53. Do you believe that there are no identifiable risks from external sources to AkshayaPatra (clients, government, legislation, NGOs etc.) for its offer? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

54. Are you offering a long term solution which will not disappear soon? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Do you think that your offer is not threatened by technological and fashion changes? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

55. Is your financial background Sound? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Partnership/cooperation

56. Is your market position out of danger? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

57. Is your market position strong? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

58. Is it possible to use strategic partnership and cooperation? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

59. Are your competitors co-operating and have a better market position? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

60. Do you have competencies internally that you need today and in future? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Completely)

0 1 2 3

Macro-economic effect

61. Are there problems on a macroeconomic level, e.g. disclosure of participants in economy, monopolistic structures, and rebound effects? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Existing Indian Railway Catering Service at NFR Guwahati

(Both Base kitchen & On-board Catering)

Name : _____

Date : _____

Environmental sustainability Dimension

System Life Optimization

1. Is the infrastructure provided by the Indian Railways not sufficient?

Contentment scale?

Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

2. How much disposable product packaging or support products are used in the system?

Rate it on a scale of 0 to 3 (0 = very less, 1=less, 2= high & 3 = Too High)

0 1 2 3

(How much quantity of disposable product packaging is used per day? – 190 kg from one Base kitchen)

3. Do parts of the catering system tend to be technologically, culturally or aesthetically obsolete? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

Does the kitchen need upgrade?

0 1 2 3

4. Is the system individually used when it could be shared in some of its parts? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

5. Does some part of the system (product, infrastructure and support product) wear out more easily than others? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

6. Does the existing catering systems lack maintaining and upgrading services? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Transport Reduction

7. Is there excessive transportation of goods in the existing catering system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

8. Is there excessive transportation of semi-finished products or bi-products? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

9. Is there any excessive transportation of people? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

10. Are the transportation means in service not fully used? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

11. Is there any excessive use of packaging? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Resource reduction

12. Is the system consuming high quantities of energy (Electricity, Fuel, etc)?
Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 =
Extremely)

0 1 2 3

13. Is the system consuming high quantities of natural resources or
consumables? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2=
Very much & 3 = Extremely)

0 1 2 3

Waste minimization & Valorisation

14. All the wastes generated by the system don't end up in landfill? Rate it on
a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 =
Extremely)

0 1 2 3

15. Does the system produce high quantities of landfill waste at the end of the
service life? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2=
Very much & 3 = Extremely)

0 1 2 3

16. Do the production packaging and support products produce large
quantities of landfill wastes? Rate it on a scale of 0 to 3 (0 = not at all,
1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Conservation /bio-compatibility

17. Is all the energy used produced from fossil fuel? Rate it on a scale of 0 to 3
(0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

18. Is all the energy used produced from exhausting resources? Rate it on a
scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

19. Does the system use mainly depleting and/or non-renewable materials for the production process? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

20. Does the system use mainly depleting and/or non-renewable materials for the products, support products, packaging and infrastructure? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Toxicity Reduction

21. Are the processed resources toxic or potentially toxic for the workers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

22. Are the processed resources toxic or potentially toxic during distribution? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

23. Are the processed resources toxic or potentially toxic for the user? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

24. Are the products, support products, packaging or infrastructure toxic or potentially toxic during after service-life treatments? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Socio-ethical sustainability dimension

Improve employment and working conditions

25. Are there problems with health and safety of the staffs? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
26. Are there any problems of discrimination in the workplace? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
27. Are there any problems with work overload and inadequate wage? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3

Improve equity and justice in relation to stakeholders

28. Are the stakeholders criticizing the supply system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
29. Is the client/end-user criticizing the supply system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
30. Are there any unjust relationships between the partnerships? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
31. Are there any unjust relationship with suppliers, contractors and sub-suppliers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3

Enable a responsible and sustainable consumption

32. Are the client/final user not able to acknowledge clearly and easily the social unsustainability along the whole value production chain? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

33. Is the passenger not able to understand the responsible sustainable behavior by the supply system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Favor/integrate weaker and marginalized strata

34. Does the supply system creates obstacles or limit access to people with weak social status (e.g. Kids, women, people with differently able)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

35. Is the offering system inaccessible to people with lower income? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

36. Does the offering system in any way favor people marginalization? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Improve social cohesion

37. Is the offering system creating or favoring any form of intra-gender, intra-cultural or intra-generational emargination? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

38. Is the offering system creating any forms of discrimination (religious, sexual, cultural, gender etc. Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Empower valorize local resources

39. Does the current system impoverish local cultural values and identities?
Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
40. Does the current system offer only one solution, /few variations for all religions and cultures? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
41. Does the current system have a negative impact on the social well-being of the local community? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
42. Is the current system impoverishing local economies? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
43. Is the system absorbing local non-renewable resources? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3

Economic sustainability dimension

Market position and competitiveness

44. Do you have a weak market position in the current system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3
45. It is impossible to improve your market position that you do not use at the moment? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)
- 0 1 2 3

46. Do you see current and future threats to your market position? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Profitability and added value for companies

47. Is the profitability of the current system low for your company and other external partners? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

48. Is there anyone producing better offers than you in a cheaper way? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

49. Are there missed opportunities to create more value in the whole value chain/system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

50. Is somebody else using this opportunity (e.g. selling your products second hand)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Added value for customers

51. Is the profitability/value low for customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

52. Do you fail to offer concrete tangible savings in time material use etc. for the customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

53. Do you fail to offer priceless intangible added value like esteem experiences etc. for which the customer is willing to pay? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

54. Are competitors creating more value for money for the customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Long term business development/risk

55. Are there any threats in the current system for your business in long-term? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

56. Do you foresee the customers need for your offer will disappear in future? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

57. Are there any risks from external sources (clients, government, legislation, NGOs etc.) for your offer? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

58. Is your offer more a short term business, will it disappear soon? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

59. Is your offer threatened by technological and fashion changes? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

60. Is your financial background Weak? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Partnership/cooperation

61. Is your market position in danger? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

62. Do you have a weak market position you want to improve? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

63. It is not possible to use strategic partnership and cooperation? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

64. Are your competitors co-operating and have a better market position? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

65. Are you missing competencies internally that you need today and in future? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Macro-economic effect

66. Are there problems on a macroeconomic level, e.g. disclosure of participants in economy, monopolistic structures, and rebound effects? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Proposed Indian Railway Catering System "FoodR"

Name : _____

Date : _____

Environmental sustainability Dimension

System Life Optimization

1. Rate the infrastructure described in the FoodR system

Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

2. Rate the usage of disposable product packaging or support products used in the FoodR system?

Rate it on a scale of 0 to 3 ((0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

3. Do parts of the FoodR catering system tend to be technologically, culturally or aesthetically updated as of now compared to the existing IRCS? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

4. Do you think that the FoodR system is used and shared optimally as a whole and also as parts? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

What do you think about the ruggedness/durability of the system (product, infrastructure and support product) Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

Rate the maintenance and upkeep of the FoodR system as described to you? Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

Transport Reduction

Rate the methods adopted for transportation of goods in FoodR system? Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

5. Excessive transportation of semi-finished products or bi- products is not anticipated in FoodR system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Completely)

0 1 2 3

6. Do you think that there won't be any excessive transportation of people in the FoodR system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

7. Are the transportation means present in service fully used? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

8. Do you think that excessive use of packaging is absent in FoodR? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Completely)

0 1 2 3

Resource reduction

9. Do you think the proposed FoodR system is consuming less quantities of energy than the existing IRCS (Electricity, Fuel, etc)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

10. Do you think that the system is consuming only less quantity of natural resources or consumables than the existing IRCS? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Waste minimization & Valorisation

11. Do you think that all the wastes generated by the FoodR system are HANDLED RESPONSIBLY? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

12. DO you think that the proposed FoodR system doesn't generate high quantities of landfill waste at the end of the service life? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Conservation /bio-compatibility

13. Is the major portion of energy used in FoodR system is from fuels other than fossil fuels? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

14. The design of FoodR system is such that it minimizes exhausting of resources for energy production and usage? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

15. FoodR makes use of sources other than depleting and/or non-renewable materials for their production process? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

16. Do you think the system design is such that the use of depleting and/or non-renewable materials for the products, support products, packaging

and infrastructure is avoided in the FoodR concept? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Toxicity Reduction

17. Do you think that the processed resources as envisaged in the FoodR system are not toxic and potentially non-toxic for the workers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

18. Do you think that the processed resources used during distribution of food as envisaged in the FoodR system are Non-Toxic? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

19. Do you see that the processed resources as envisaged in the FoodR concept are not at all toxic for the user? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

20. Do you think that during the after service-life treatment, the products, support products, packaging and infrastructure are not toxic or potentially harmful? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Socio-ethical sustainability dimension

Improve employment and working conditions

21. Rate the health and safety standards maintained for the staffs in the proposed FoodR system? Rate it on a scale of 0 to 3 (0 = Very Poor, 1=Poor, 2= Satisfactory & 3 = Excellent)

0 1 2 3

22. Do you think that the proposed FoodR system doesn't have any scope of having discrimination in workplace? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

23. Do you think that the envisaged system won't have problems like Work overload and inadequate wages? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

Improve equity and justice in relation to stakeholders

24. Do you think that there will be only appreciation about the system from all the stakeholders? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

25. Do you think that there will be only appreciation about the system from the passengers about the supply system if the FoodR is implemented? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

26. There aren't any unjust relationships between the partnerships? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

27. The proposed FoodR concept doesn't have any unjust relationships with suppliers, contractors and sub-suppliers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Enable a responsible and sustainable consumption

28. Is the FoodR system designed in such a manner that the passengers are able to acknowledge clearly and easily the social unsustainability along

the whole value production chain? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

29. Are the passengers able to understand and acknowledge the responsible sustainable behavior by the supply system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Favor/integrate weaker and marginalized strata

30. The supply system designed for FoodR doesn't create obstacles or limit access to people with weak social status (e.g. Kids, women, differently abled)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

31. Are the offerings by FoodR system accessible to people with lower income? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

32. Do you think that the proposed FoodR system in any way won't favor people marginalization? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Improve social cohesion

33. Do you think that the proposed FoodR system will not create or favor any form of intra-gender, intra-cultural or intra-generational emargination? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

34. Do you think the FoodR will not create any form of discrimination (religious, sexual, cultural, gender etc. Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3

Empower valorize local resources

35. Do you think the system planned for FoodR will enrich the local cultural values and identities? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
36. Do you think that the proposed FoodR system offers many solutions, /many variations for all religions and cultures? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
37. Do you think that the proposed FoodR system will have a positive impact on the social well-being of the local community? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
38. Do you think that the FoodR system once implemented fully will enrich the local economies? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
39. Do you think that the FoodR system is planned in such a manner that it won't absorb any local non-renewable resources? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3

Economic sustainability dimension

Market position and competitiveness

40. Do you think that the proposed FoodR system will have a strong market position in the current scenario? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

41. Do you see that all possibilities to further improve the market position of FoodR are used at this moment? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

42. Do you think there will be no threats to the market position of FoodR Concept? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Profitability and added value for companies

43. Do you think the profitability (Efficiency) will be high for FoodR system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

44. Do you anticipate anybody else able to produce better offers than FoodR in a cheaper way? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

45. Do you think FoodR concept design has used all the possible opportunities to create more value in the whole value chain/system? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

46. Is the FoodR system foolproof and nobody can use this opportunity except FoodR? (e.g. selling your products second hand)? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Added value for customers

47. Do you think the value offered by the FoodR is the best for customers?
Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
48. Do you think the FoodR concept design is successful in offering concrete tangible savings in time material use etc. for the customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
49. Do you think the FoodR concept design is successful in offering priceless intangible added value like esteem experiences etc. which the customer is willing to pay? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
50. Do you think that no competitors FoodR system will be able to create more value for money offerings for the customers? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3

Long term business development/risk

51. Do you foresee that there will be no threats for the business of FoodR in long-run if it is implemented fully? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
52. Do you foresee that there will be never ending demand for organic, healthy &, tasty food in trains offered by FoodR? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)
- 0 1 2 3
53. Do you foresee that there will be no identifiable risks from external sources to FoodR (clients, government, legislation, NGOs etc.) for its

offer? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

54. Is FoodR concept offering a long term solution which will not disappear soon? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

55. Do you think that the offer by FoodR is not threatened by technological and fashion changes? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

56. Is the financial background of FoodR (IR) Sound? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

Partnership/cooperation

57. Do you think the market position for concept FoodR is out of danger?

Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

58. Do you think the market position for FoodR strong? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

59. Do you think that FoodR concept has fully used the possible strategic partnership and cooperation in their design? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Absolutely)

0 1 2 3

60. Are your competitors co-operating and have a better market position?

Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

61. Do you think IR and the FoodR concept have competencies internally that one system need today and in future? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Completely)

0 1 2 3

Macro-economic effect

62. Are there problems on a macroeconomic level, e.g. disclosure of participants in economy, monopolistic structures, and rebound effects? Rate it on a scale of 0 to 3 (0 = not at all, 1=somewhat, 2= Very much & 3 = Extremely)

0 1 2 3

APPENDIX 3: RTI

FORM "A"
Form of application for seeking information
(See Rule 3)

মহাপ্রকৃষ্ণন ক. কালক্রিয়ান
Chief of the
General Manager
Date
02 JUN 2014
Time
১২:৩০ বারো মিনিট, দুপুর - ১১
I.A. Railway,
Maligaon, Guwahati-781011

To,
The Public Information Officer
Office of the Chief Operations Manager
Northeast Frontier Railway Maligaon
Guwahati

1. Name of the Applicant : KK BALAKRISHNAN
2. Address : Research Scholar,
Department of Design
Indian Institute of Technology Guwahati
Assam - 781039
3. Telephone No. : 9678069465
4. E-mail Address : mechbalan@gmail.com
5. Particulars of Information :
(a) Concerned Department : Operations
(b) Particulars of information required :
i. Number of trains originating from Guwahati Railway Station per day:
ii. Number of trains terminating in Guwahati Railway Station per day:
iii. Number of trains passing through Guwahati Railway Station per day:
iv. Total Number of trains handled by Guwahati Railway Station per day:
v. Number of passengers handled by Guwahati Railway Station daily:
vi. Which 'Class' does Guwahati Railway station fall under?(Class A*/A/B/C.)
6. I, state that the information sought do not fall within the restrictions contained in section 4 of the Act and to the best of my knowledge it pertains to your office.
7. A fee of Rs.10.00 has been deposited by an Indian Postal Order No. 611114 dated 27-05-2014
The period to which the information relates: 2009-2013
Information Description (can include -record/document/email/press release/circular/order/logbook/report/papers electronic data etc.
8. Language of the said information should be in English
9. In case the subject matter /any of the information is held by / related to another public authority, you are requested to transfer the application or such part of it as may be appropriate to that other public authority with an intimation to the undersigned (Section 6(3) of RTI Act).

APPENDIX 4: Field visit reports

Field Visit – 1 Northeast Frontier Railways, Maligaon

Date of the Visit: 25th October, 2010

Suggested By: Prof - Ravi Mokashi Punekar

Goals of the visit:

1. To know about the possibility of getting permission and carrying out a research at the Railway station premises.
2. To learn about prospects of implementation of modifications in catering services in Indian Railways.
3. To know the overall hierarchy of administration at NFR Headquarters and railway catering services.
4. Interview the officers concerned with managing the catering services about the present scenario of facilities available to them and discuss how to improve them.
5. Get an overview of services offered the food plazas and other kiosks concerning catering with respect to the food quality and safety, cleanliness and cost.

Goals Met:

1. The information about the hierarchy of the organisation of NFR
2. Permission to carry out the research and data collection in the Guwahati Railway station
3. The interest from Railways to be more responsive in implementing improvements in the current system.

Persons Met:

1. Name: Mr. Harpal Singh

Designation: Divisional Railway Manager, Lumbding Division, NFR Guwhati

Duration and Timings of Discussion: 25th October 2010, 15:00 -19.00, 4 hours

2. Name: Shree, V. JHA

Designation: Additional General Manager and Director Public Grievance's (AGM)

Duration and Timings of Discussion: 25th October 2010, 15:00 -15.15, 15 minutes

Details of the Discussion:

We discussed about the problems in the fundamental issues concerning the NFR Railway station, platforms, catering services and the challenges faced. AGM also expressed his views of how NFR is visualising Guwahati railway station to be more open to changes and to be upgraded to a world class Railway station in the near future.

Details of the Discussion:

The details of the contractor who is running the pantry service in Guwahati railway station, the base kitchen location, the modus operandi etc. were discussed. Hierarchy of officials managing catering services in Railways and IRCTC were noted down.

Field Visit – 2 - J.K Ghosh Base Kitchen, Manipuri Basti Guwahati

Date of the Visit: 25th October, 2010

Goals of the visit:

1. To study the existing Indian Railway Catering system(both Base kitchen and on-board)
2. To identify the practices followed in the base kitchen in detail, discuss with the staffs and managers and to find out any issues and problems faced by them.
3. To find out the aspirations and

Goals Met:

1. Complete data about the base kitchen and the standards followed for preparation and distribution of the food in both railway station food stalls as well as in train.

Persons Met:

1. Name: Mr. Sankar Saha

Designation: Manager, J.K Ghosh Base Kitchen Guwhati

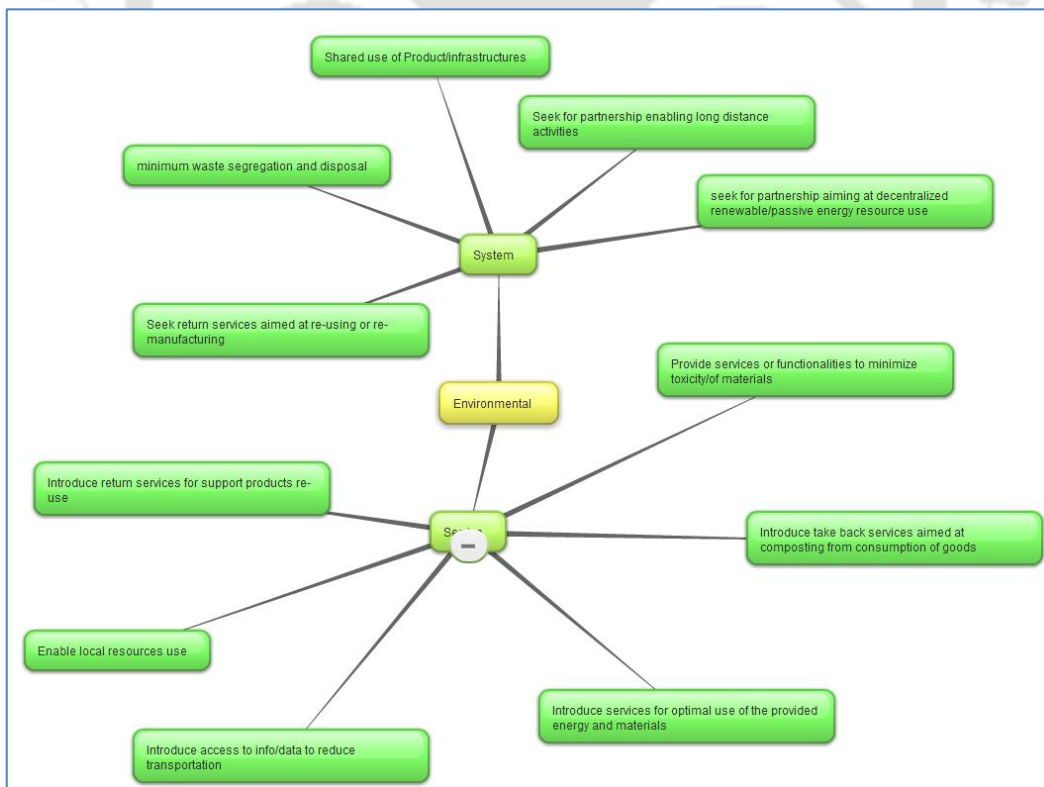
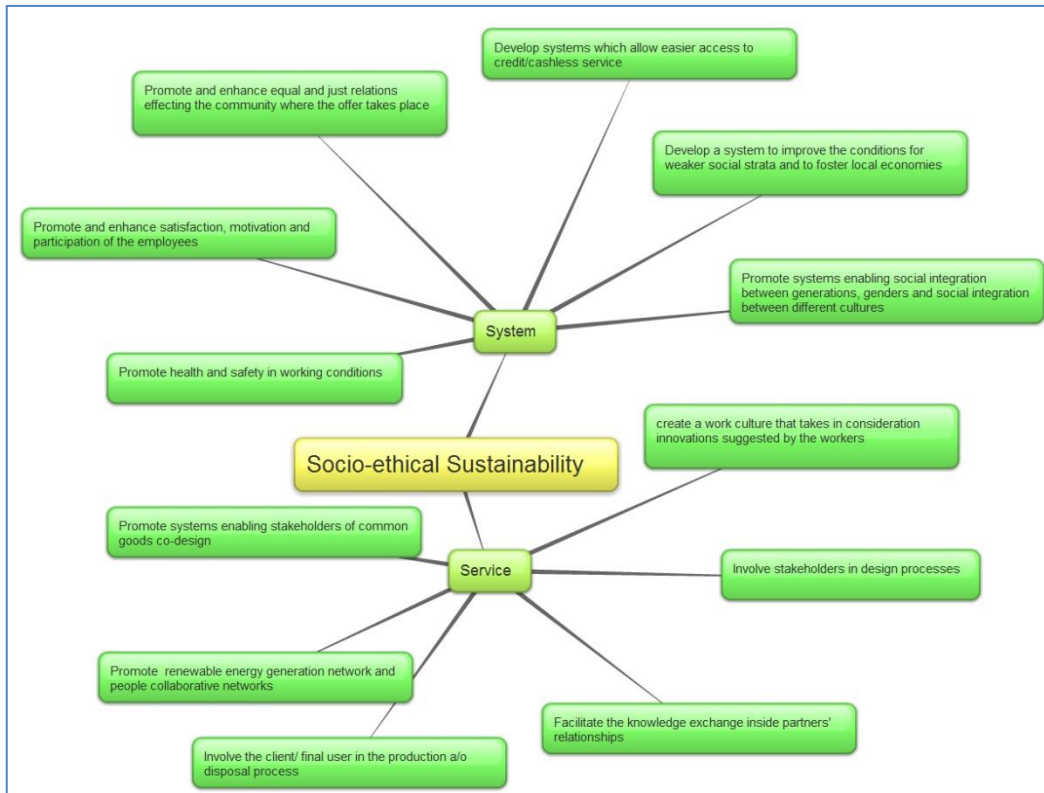
Duration and Timings of Discussion: 25th October 2010, 15:00 -19.00, 4 hours

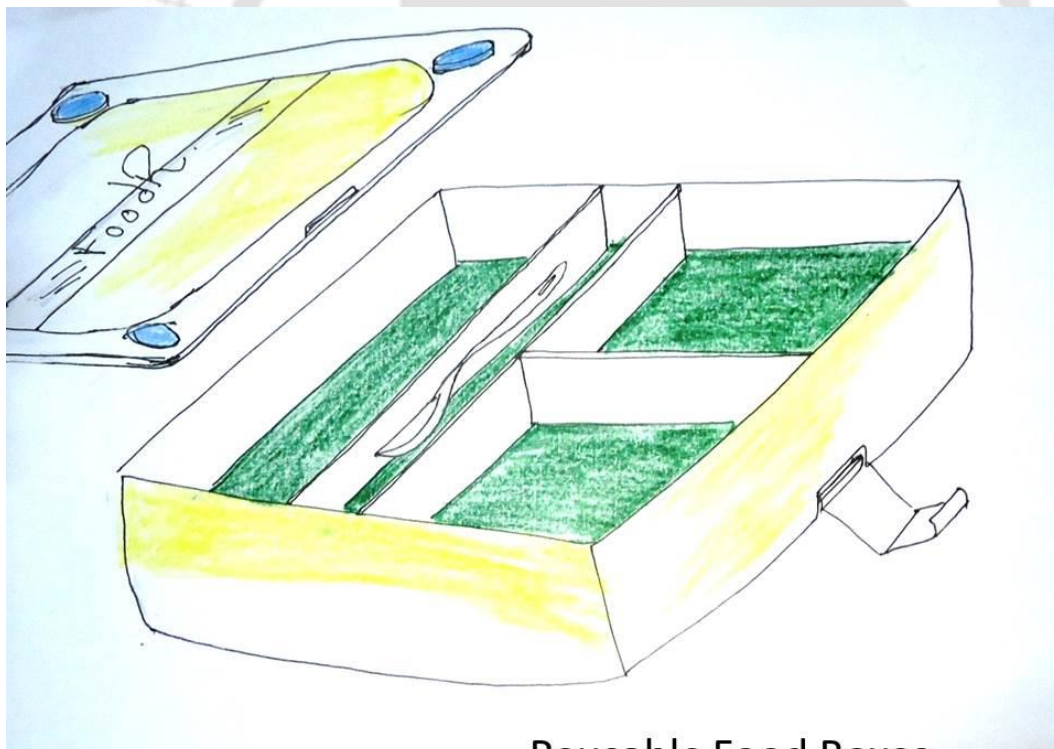
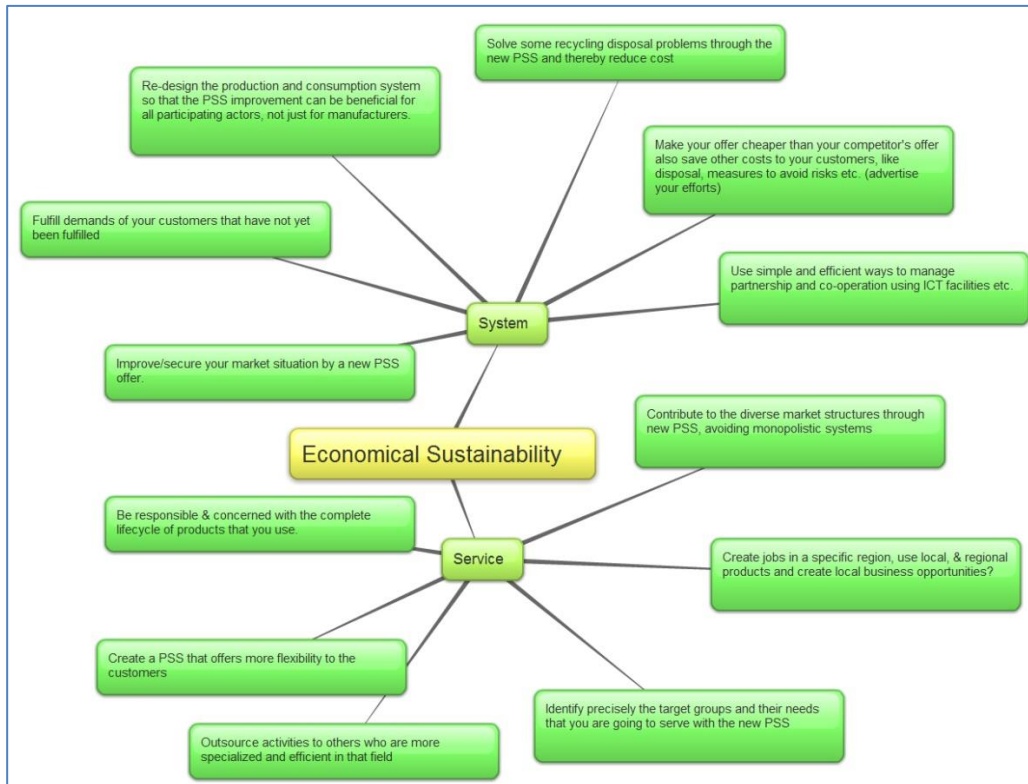


APPENDIX 5: Interaction story board, mind maps & Ideation sketches

Interaction Table (Story Board)

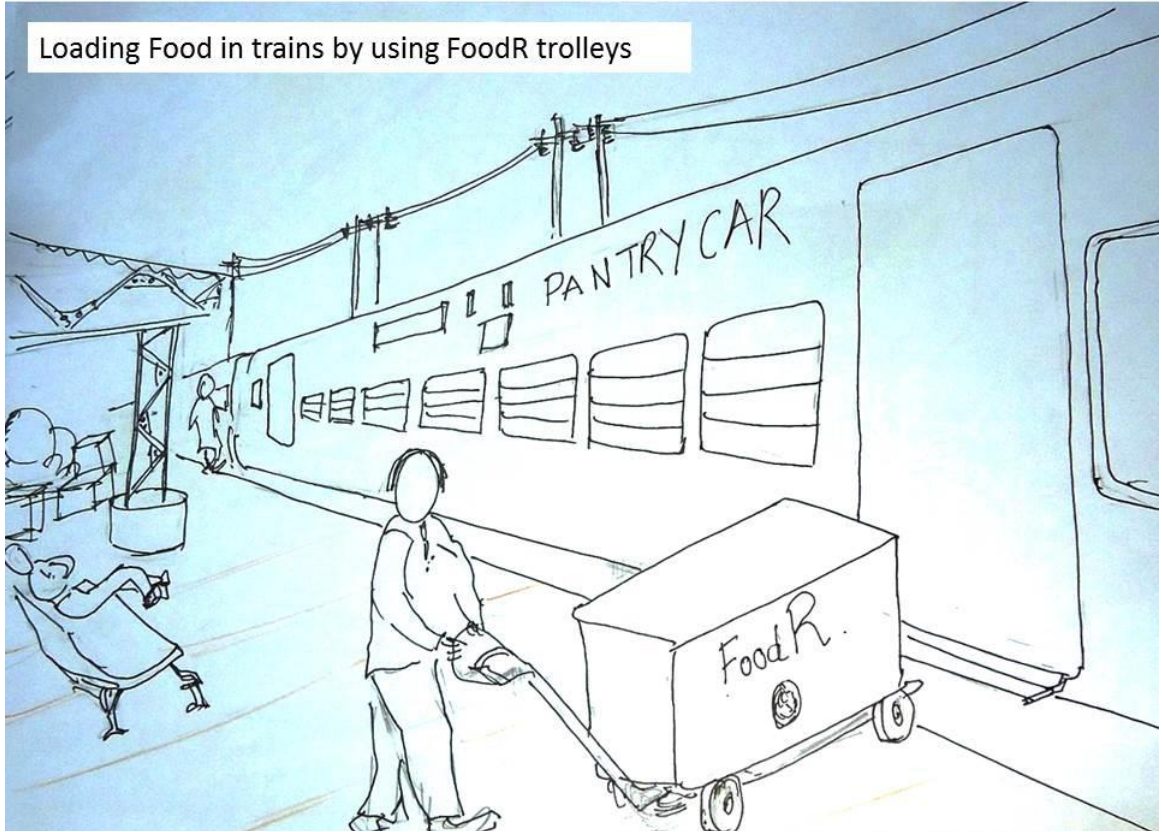
Contractor	 Contractor sets up kitchen in Railway Station premises  IR calls for tenders and tender given to contractor  Food prepared as per order from Information Hub  Food loaded in the concerned train  Food stored in the hot case  Food distributed in trains  Food boxes taken back and returned to base kitchens  Waste segregation done; degradable wastes sent to recycling plant and landfills  Return back scheme for used water bottles by waste management team  Left over food shared with needy people																																																
Farmer	 Farmers cooperative is formed in the nearby areas  Organic farming and dairy farming carried out by farmers  Produce are collected and kept in the procurement centre  Raw materials loaded into the train, organic wastes taken by farmers  Organic wastes received made as Vermi compost (manure)  Bio-gas and compost made from wastes. Organic farming practiced  Money gets credited to the farmers bank account via cooperative Bank																																																
Passenger	 Passenger Books ticket order meal online  Passengers have more menu options to choose from.  Passenger Boards Train  Receives food in reusable boxes  Food box & bottle (if empty) returned after consumption  Uses FoodR card to pay bills no cash transaction  Passenger can give feedback online or by mobile phone																																																
Products/ Solutions	<table border="1"> <tr> <td>Base Kitchen</td> <td>Reusable food boxes</td> <td>Raw material loading crates (Reusable)</td> <td>FoodR card</td> <td></td> <td></td> </tr> <tr> <td>Rain water Harvesting system</td> <td>Carrying trolleys</td> <td>Organic wastes carrying sacks (Reusable)</td> <td>Card swiping Machines</td> <td></td> <td></td> </tr> <tr> <td>Solar Heaters</td> <td>Solar cookers</td> <td>Hot case for pantry car</td> <td></td> <td></td> <td></td> </tr> <tr> <td>Natural lighting and ventilation</td> <td>Contract with appliances manufacturer</td> <td></td> <td>Training programmes for waste collection team</td> <td></td> <td>Logistics for food to be taken to the nearby destitute home</td> </tr> <tr> <td>Water reuse system</td> <td>Contract with Biomass briquettes</td> <td></td> <td>Recycling Plant</td> <td></td> <td></td> </tr> <tr> <td>Utensils cleaning bay</td> <td>Farmers Cooperative</td> <td></td> <td>Food Bank</td> <td></td> <td></td> </tr> <tr> <td></td> <td>Raw material Procurement centre</td> <td></td> <td>Slight recharging of trains for stoppage to load raw materials and unload wastes</td> <td></td> <td></td> </tr> <tr> <td></td> <td>Raw material loading bay</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	Base Kitchen	Reusable food boxes	Raw material loading crates (Reusable)	FoodR card			Rain water Harvesting system	Carrying trolleys	Organic wastes carrying sacks (Reusable)	Card swiping Machines			Solar Heaters	Solar cookers	Hot case for pantry car				Natural lighting and ventilation	Contract with appliances manufacturer		Training programmes for waste collection team		Logistics for food to be taken to the nearby destitute home	Water reuse system	Contract with Biomass briquettes		Recycling Plant			Utensils cleaning bay	Farmers Cooperative		Food Bank				Raw material Procurement centre		Slight recharging of trains for stoppage to load raw materials and unload wastes				Raw material loading bay				
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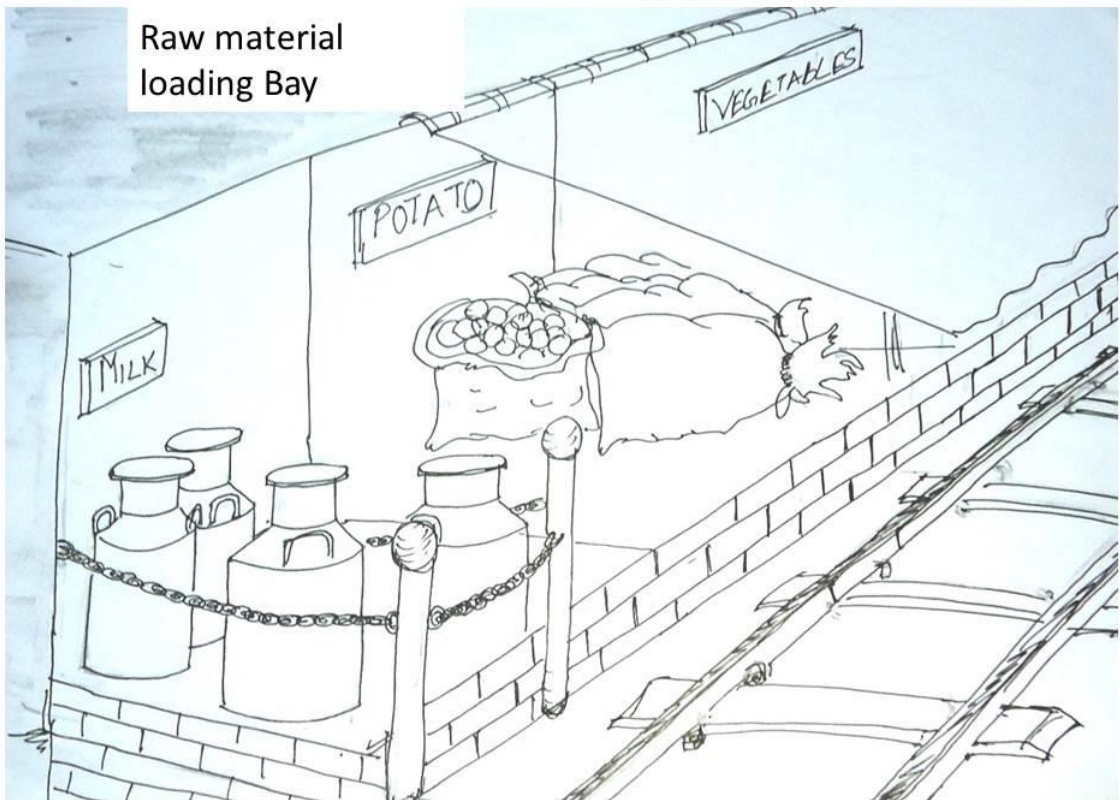


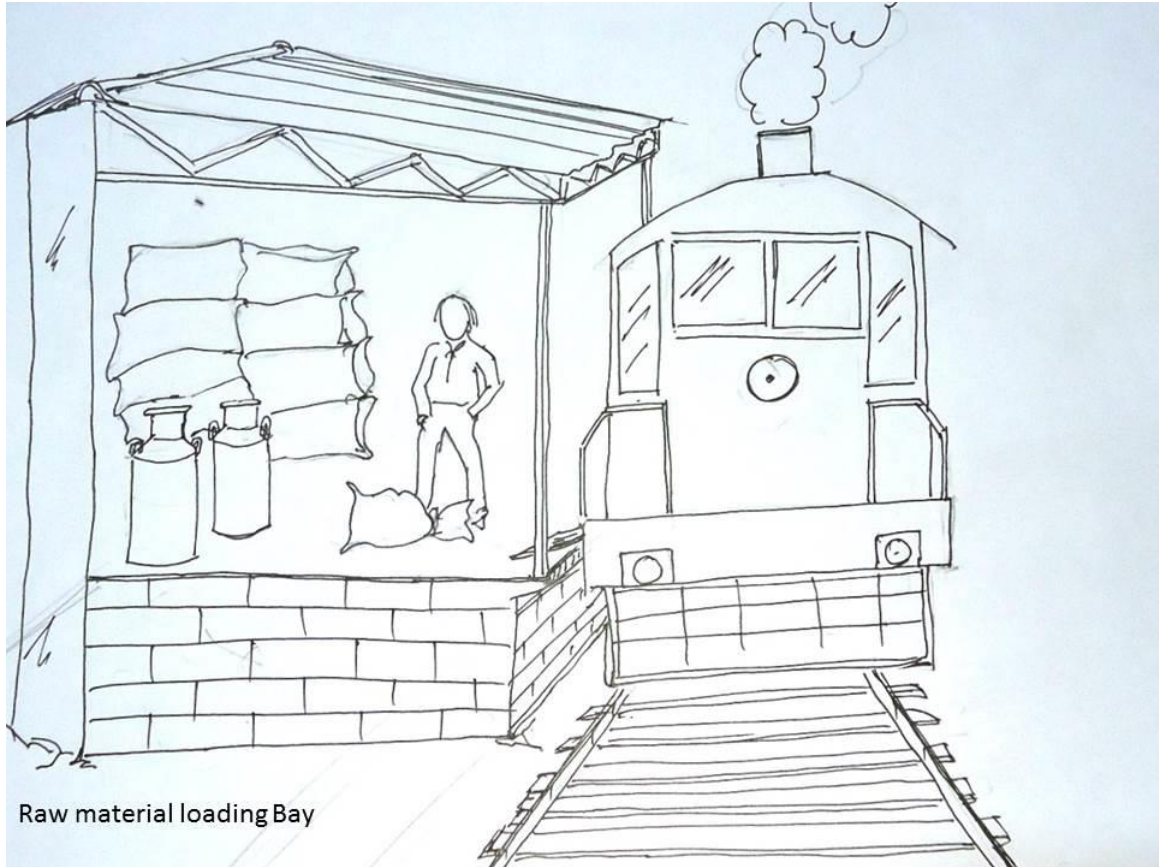
Reusable Food Boxes

Loading Food in trains by using FoodR trolleys



Raw material loading Bay





Raw material loading Bay

