A Pandemic-specific 'Emergency Essentials Kit' for Children in the Migrant BoP communities

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***Abstract*— COVID-19 has now been declared a 'Global Pandemic' by WHO. The pandemic has affected more than 200 countries since its first outbreak in December 2019. The spread of COVID-19 resulted in a state of lockdown globally. India too, closed its borders to contain the virus. Those worst affected by the pandemic are migrant workers at the 'Bottom of Pyramid' (BoP) due to unemployment and lack of monetary aid. Family sustenance has been difficult for them, with children impacted physically and psychologically. This paper proposes a Product-Service System (PSS) that provides essential emergency kits to infants (6-12 months), children (1-6 years), and their mothers during such emergencies. This PSS scheme strives to fulfil their basic hygiene, nutritional and psychological requirements. Three types of kits are distributed to the migrant families using an online service platform. The entire system operates on a sustainable, single-use plastic-free design. The case study of this humanitarian scheme is specific to India but is also valid for other developing nations. Reaching out to the communities is achieved through a smartphone app and website. The system uses ICT infrastructure to connect various stakeholders and can be admirably adapted to the framework of an inclusive smart city.**

Keywords*— *Pandemic, PSS, Migrant BOP Workers, Relief, Children, COVID-19, App development, donation system

I. INTRODUCTION

The novel coronavirus or the COVID-19 originated in Wuhan, China and within months has already made its mark across all the seven continents [1, 2]. In numerous countries, a lockdown was announced to ensure social distancing as the virus can spread from human to human via droplet transmission. India witnessed its first case on 14th January 2020 in Kerala [3]. Although the COVID-19 cases started to increase, the situation is rapidly evolving amidst strict controls [4]. On 17th March 2020, India witnessed its 125th case. At this point, the Government of India imposed a nationwide lockdown—with effect from 25th March 2020—to curb the further spread of the virus within the nation [5]. Migrant workers were affected the most by this drastic decision. The COVID-19 induced lockdown has pushed the migrant workers (including women and children) to travel to their hometowns in search of livelihood and safe accommodations. A 'migrant worker' is a person who either migrates away from his/her native place to pursue work within or outside their home country. Migrant workers generally have no intention of permanently staying in the country or region where they work [6]. In India, there are 139 million internal migrant workers, out of which approximately fifteen million are children [7]. Women make up an overwhelming 70.7 per cent majority of internal migrants [7]. In India, 30 per cent of domestic migrants belong to the 15-29 age group. Migrant workers are compelled to live in dismal conditions leading to poverty.

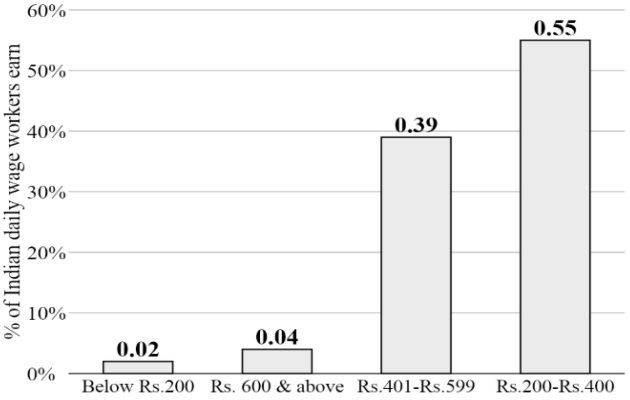

Fig. 1. Daily wages earned by the Indian workers.

The *Bottom of the Pyramid (BoP)* refers to a category of people who live in abject poverty and are placed at the bottom of the economic pyramid [8]. The world has around 2.7 billion people in the *BoP,* which is 37% of the global population [9]. Migrant workers who form a massive portion of the *BoP* society are usually involved in physically demanding jobs and earn a maximum daily wage of $3 per day (fig. 1). As they mostly work in unorganised sectors, they are vulnerable and not entitled to the benefits of various social security schemes provided by the government [8].

In India, the population living at the bottom of the pyramid has been affected the most. A lockdown scenario for these workers implies unemployment, inability to relocate to their hometown, lack of monetary resources and an additional burden of supporting their family [10, 11]. Most of them, who are daily wagers have lost their jobs. With no social security, they are adversely facing problems in meeting their basic daily needs and minimum requirements for their families. A stringent lockdown leading to the closure of inter-state borders have forced them to remain in their current location of residence away from their native place, which further puts pressure on their living conditions [12]. Families with infants and young children are at a highly compromised situation. Despite the efforts of the government to provide relief packages for migrant workers nationwide [13], recent findings

have shown that rations have failed to reach all sections of migrant workers [14].

Studies have shown that pandemics and disasters can have both immediate and long-term effects on children. Children face specific risks during the early phases of their childhood, since they are susceptible to environmental alterations owing to the rapid development of their brain architecture [15, 16]. Deteriorating economic conditions could further worsen the immediate threats to their overall health, safety, treatment, and education.

Food insecurity has a negative impact on health, and recent evidence suggests that it is strongly associated with poor diet quality [17]. Young children from low-income groups are subject to poor diets due to their inaccessibility to adequate resources [18]. Although many NGOs and non-profit organisations in different cities provide food to these children, these meals often fail to meet the nutritional requirements for a growing child [19]. Unhealthy meals can trigger mental health disorders and indirectly affect the family of a child. Children account for the future workforce of the country. They must be cared for in their growing years by ensuring food safety and availability, means of access, and affordability of nutritional resources. In India, 19.8 million children below the age of 6 years are malnourished, where one in every three children suffer from malnutrition [20]. A case study of Migrant workers' children in Ahmedabad, India revealed that out of 131 children, 52 children were stunted, 29 were wasted, and 66 were underweight due to malnutrition [21]. The prevalence of undernutrition leads to deterioration in physical and cognitive abilities. All these impediments have resulted in a situation where children, women and migrant communities are being exposed to the negative impacts of malnourishment, persistent hunger, lack of health-care, and unstable livelihoods [20].

Food distribution programs being conducted by many government organisations and NGOs may solve the problem of food insecurity, but only to a certain degree [22]. Hence, this paper aims to provide the children and mothers belonging to migrant workers family with healthy, nutritional food and other daily essentials as and when the need arises. *Shishu-Annapurna* is an online service platform which primarily provides essential emergency kits to infants (6-12 months), children (aged 1-6 years), and their mothers in the BoP. The kit will be provided during emergencies that aim to fulfil their basic hygiene, nutritional and psychological requirements. *Shishu-Annapurna* distributes three types of essential emergency kits: a complete essentials kit, a food-only kit for a mother, and a food-only kit for a child. The essential emergency kit contains hygiene products (two reusable masks, one bar soap), food products (one fruit, one tetra pack of milk, two nutritional meals) and a set of traditional toys. The entire system operates on a sustainable, plastic-free paradigm. The food items are wrapped in banana leaves which increases the nutritional value of the food. The toys are hand-made by local artisans, using chemical-free vegetable dyes. The soap bar is meant for daily hygiene and is biodegradable. The model operates on the involvement of local artisans, philanthropists, and existing food-service platforms. The *Shishu-Annapurna* scheme will be deployed through an online system that uses crowd-funding and community collaboration to source these kits to children and their mothers. Moreover, this PSS scheme seeks to reduce the burden on a mother to acquire food supplies and other essentials for her children in such adverse conditions.

II. METHODOLOGY

A. Design Thinking

Design thinking is a non-linear, iterative method of problem-solving that integrates the needs of the people and technological potentials along-with the stakeholder requirements. The critical elements of this process are questioning assumptions, redefining problems, constructing prototypes, and evaluating creative solutions. This approach consists of five phases — Empathising, Defining, Ideating, Prototyping, and Testing. The process is well suited for solving complex societal problems such as the one this work is trying to address (fig. 2).

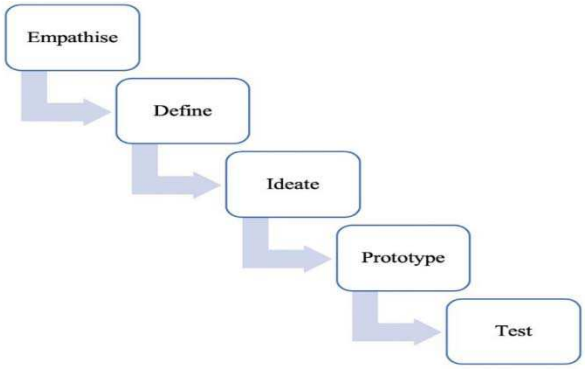

Fig. 2. Design–thinking process.

The problem of feeding the children of migrant workers was addressed using this approach in the following manner:

a) Empathise: After the nationwide lockdown was announced in India, migrant workers immediately lost their jobs. With no public transportation, the migrants were forced to walk back to their home states. These were few of the many problems faced by migrant workers.

b) Define: Defining the problem was a challenging task. The problem statement, established using the empathic design approach, is to ensure that migrant workers (especially mothers and children) have the resources required to survive the lockdown.

c) Ideate: Brainstorming—a technique of collective imagination—was used to generate ideas. Participants spontaneously contributed to a list of ideas in the brainstorming process, out of which four ideas were shortlisted. The design ideas were DIY Recipe Kits, Mobile Toy Library, 'Book and Board Game Exchange' Program, and Mobile Book Library. The concept of DIY Recipe Kits, Toy Library, and design for the migrant workers at the BoP, was finally chosen.

d) Prototype: A prototype is an early version model or the release of a product that is built to test a design or process. A working prototype for the smartphone application and the website has been developed. A supply chain [23] and business model is also proposed.

e) Test: Testing is a process of looking at how simple it is to use a product/service by involving active users to determine its functionality. In the future, a prototype of the smartphone application and the website would be tested on

real-time users. This would help in identifying flaws in the app and website and thereby formulating solutions to aid further development.

B. Morphological matrix based design synthesis

Morphological matrix provides a systematic approach to combine systems and solutions of various areas to form a complete systemic solution. Hence, to synthesise the designs for the distribution packages, alternatives of the target user base along with other vital parameters were used to create a morphological matrix (see table I). Three designs D1, D2 and D3, were filtered out after the initial screening from the set of alternatives. These design alternatives were obtained from the combinatorics of the alternatives from each category.

TABLE I. TRIZ MORPHOLOGICAL MATRIX

Alternatives →

Design Morphology ↓

User Base	Women	Children	Men	Senior Citizens	Teenager
Type of food	Cooked	Uncooked	Dehydrated		
Economic status	Below the pyramid	Lower middle class	Middle class	Upper class	
Cost	Rs. 500	Rs. 100	Rs.1000	Rs. 50	Rs. 10
Lifecycle	5 days	30 days	2 years	15 days	2 days
Production	Local production	Imported			
Design Alternatives	D1	D2	D3		

From the mentioned category of user groups, the initial designs focused on 'children and their mothers', 'a family of five members' from the BoP and family belonging to the lower middle class. For D1 and D2, the food was the pre-prepared type with preparation costs being Rs. 50 and 100 respectively. D3 consisted of dehydrated food packets with preparation cost being Rs 100.

C. Application Development (Smartphone and Web)

A smartphone application and a website were developed in order to facilitate the distribution of the proposed pandemic-specific emergency essential kits scheme (See Table II and Table III). Prior to the development of the system, the interfaces for the mobile and web platforms were created to access the interactions of the users from the perspective of usability and functionality.

TABLE II. SNIPPET OF CODE SCRIPTED FOR THE WEBPAGE

Landing Page	`<!-- Vector (Shape) -->`
	`<div id="u14" class="ax_default shape" data-label="Vector">`
	`<img id="u14_img" class="img " src="images/homepage/vector_u14.svg"/>`
	`<div id="u14_text" class="text " style="display:none; visibility: hidden"`

These interfaces were created using Figma and Axure RP (website only), which were then developed into an application. The smartphone app was developed on the Android studio with the front end being coded in XML and back-end using Java. Furthermore, the website development was completed on Sublime text using HTML, CSS and JavaScript.

TABLE III. A CODE SNIPPET FOR THE SMARTPHONE APP [24,25]

```
public class MainActivity extends AppCompatActivity {

    Button donate;

    @Override

protected void onCreate(Bundle savedInstanceState) {

super.onCreate(savedInstanceState);

setContentView(R.layout.activity_main);

donate =(Button)findViewById(R.id.button1);

try { donate.setOnClickListener(new
View.OnClickListener() {

@Override

public void onClick(View v) {

Intent i = new Intent(MainActivity.this,
Main2Activity.class);

startActivity(i);}

})catch(Exception e){
```

III. RESULTS AND DISCUSSION

The word *'Shishu-Annapurna' means "Food and overall well-being of children"* in Sanskrit. Shishu-Annapurna provides food to children at the bottom of the pyramid (BoP) and helps them combat physical, emotional and mental stress. This scheme nurtures them with healthy meals and provides a toy for them to play with, thereby reducing the daily burdens of a mother/guardian. During a global pandemic or natural disaster, this solution is useful as a relief-system for the migrant BoP families. This PSS scheme, which is built on an online-based platform (smartphone app [26] and website), could contribute to a 'smart city of today' which relies heavily on ICT (Information and communication technology) and inclusivity by providing essential services to all sections of society.

A. The Essentials Kit and the Food Kits

The essentials kit includes three main types of products: a) Food and beverage, b) Hygiene products, and c) a set of toys [27]. These are placed together and compartmentalised in a cardboard box which is sealed before delivery. The food items include a fruit, a tetra pack of milk, and three individual meals along with wooden cutlery. The quantities of food have been measured as per the needs of the children of different age-groups. The hygiene products include a set of reusable masks [28], mandatory for daily wear and commute in a viral pandemic scenario, and a dry soap-shampoo bar for cleansing purposes (fig. 4). These products have been added as a simple yet effective way to prevent the COVID-19 infection. Lastly, the box contains a set of wooden Channapatna dolls and toys, designed, and painted by local artisans, using vegetable dyes and thread. The food items would be wrapped in banana leaf

or any other locally-sourced natural packaging material available in the region. They are natural, sustainable and reduce the carbon footprint of the product-service system. The toys would be made by traditional local artisans who make Channapatna dolls, Kondapalli toys [27]. This also keeps the tradition of toy making alive. The secondary packaging, which is the box, would have a colourful and playful print on the exterior of the box. The colour of the paper sticker on the box provides information regarding the content of the box corresponding to the age-groups of children (fig. 5).

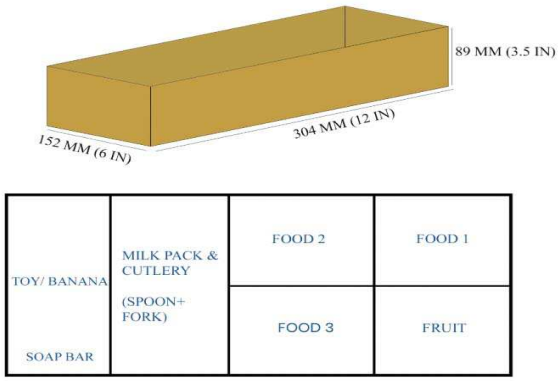

Fig. 3. Size of the Essential Emergency Kit.

Fig. 4. Components of the Essential Emergency Kit.

Fig. 5. Colour-coded Stickers for various age groups.

The meals would differ according to the age group of the child. Each box is colour coded to help in the segregation of meals. It is designed to make the process of distribution easy. Fig. 5 shows the exact age and colour accordingly. The quantities and types of food are measured according to the daily requirements of the child (see table IV). Infants start teething at the age of 6 months, and the orange sticker denotes food for these infants between the age group of 6-12 months [29]. The package for age groups of 1-3 years is labelled with a blue sticker. The diet for these children has been altered to allow them to bite, chew, and then swallow their food. The box marked with a purple sticker caters to kids between the ages of four and six. These foods have been specifically chosen to provide a balanced diet to the child with ideal proportions of protein, carbohydrates, vitamins, and minerals. They have the same food products as the blue sticker box, with increased quantities.

TABLE IV. FOOD ALLOCATION TO VARIOUS AGE GROUPS

Age Group	Qty.	Age Group	Qty.	Age Group	Qty.
6 months to 12 months		**1 year to 3 years**		**4 years to 6 years**	
Milk/ Lactogen	200 ml top milk	Milk/ Lactogen	200 ml top milk	Milk	500 ml
		Dal Khichdi, Rice Pulav, Curd Rice	90 g	Dal Khichdi, Rice Pulav, Curd Rice	150 g
Fruits and vegetables	100 g	Rice	60 g	Rice	125 g
Apples, Banana	100 g	Chapati	60 g	Chapati	125 g
Rice porridge	60 g	Vegetables	50 g	Vegetables	100 g
		Fruits	100 g	Fruits	100 g
		Dal	25 g	Dal	30 g

Ingredients

TABLE V. REQUIRED FOOD QUANTITY FOR A MOTHER

Food Item	Quantity
Chapati	330 g
Rice	330 g
Dal	75 g
Vegetables	200 g

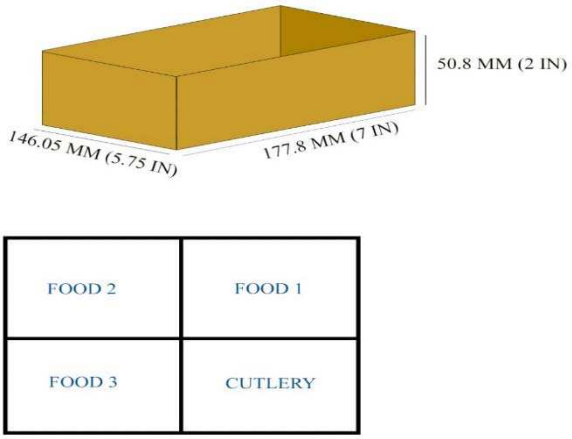

Fig. 6. Size and components of the food-only kit for children, mothers.

The food-only kits available for children is also labelled similarly with stickers for varying age groups and will have a

set of meals for daily consumption (fig. 6). The mother's food-only kit includes fresh, nourishing meals for daily consumption. It will contain basic staples like cooked rice, pulses, and lentils (see Table V). The quantity of these foods would fulfil the minimum daily calorie requirement of any woman whose physical activity is in the moderate range.

B. Proposed Supply Chain

A supply chain is a network structure between a business and its contractors that produces and distributes a product or service to the end consumer [23]. This network covers various activities, individuals, entities, information, and resources. The supply chain starts with the procurement stage, where raw materials are sourced. The scalability of this proposed scheme's supply chain is high due to its well-defined structure, as shown in figure 7. This PSS scheme could be scaled in any city across the globe. This is also because the supply chain uses local materials and indigenous produce to cook the food items for the kit.

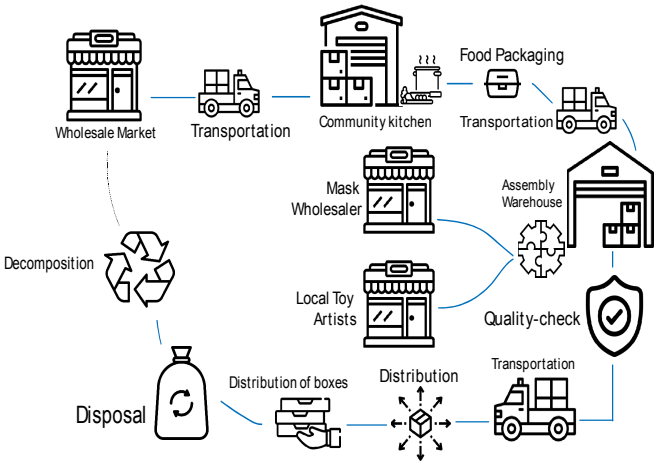

Fig. 7. Supply Chain Diagram.

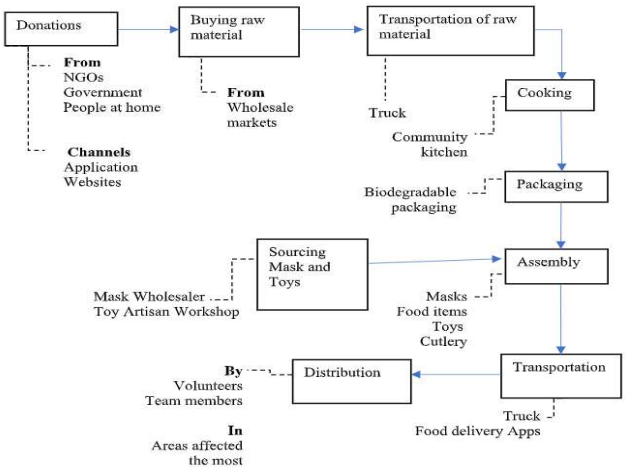

Fig. 8. System Flow Diagram.

The supply chain begins with the procurement of raw materials, which would be sourced daily from local wholesale markets (fig. 7). These raw materials would be then transported to the community kitchens. Here, cooks would prepare the meals according to the menu set at the start of every week. After the meal is cooked, it would be sent to the packaging room, where it is neatly wrapped by volunteers wearing N95 masks [30].

The packaged food would then be transported to the assembly warehouse. The toys would be transported from the artisans' workshop to the assembly warehouse. The masks and soap bars would also be procured from the distributor and be transported to the assembly warehouse. A quality check would then be carried out for all the items going into the kit. The kit contents would then be assembled, colour coded using stickers, and packaged according to the age group of children. The kit would later be transported to the selected slum locality, where the majority of the migrant workers reside [34]. The volunteers would distribute this box in the concerned area, as shown in fig. 8. The recruitment of the volunteers will be done through a round of online interviews.

Finally, the hierarchy of roles is defined for each subsystem, including the community kitchen, raw material procurement, and distribution system (fig. 9). Each subsystem will have an operations manager heading the activities. Co-ordination among volunteers will be helpful in the efficient functioning of the supply chain. Each volunteer would be given specific roles based on their corresponding team in the subsystem.

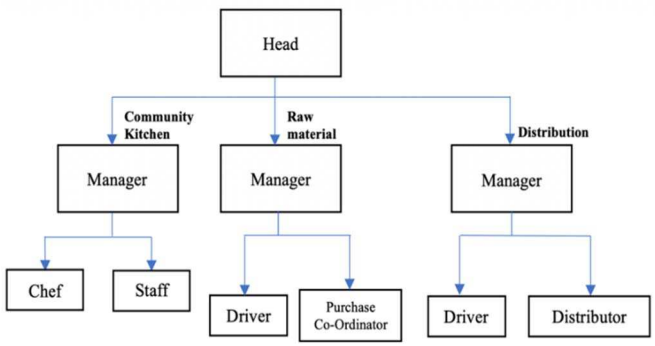

Fig. 9. Hierarchy of roles.

The localities would be chosen according to the population demographics and population density of the area. Data would be obtained from census data collected by the local governing body of the city. The names of the donors would be recorded under the number of boxes they have donated. When the box reaches the child or the mother, a text message would be sent to the donors, letting them know that the donation has been received. This increases the credibility of the PSS scheme, among the public, as a reliable distribution system.

C. Business Model

The *Shishu-Annapurna* scheme is based on a Public-Private Partnership (PPP) model [35]–[36], and relies on crowd-funding (fig.11). A website and smartphone app would be used as channels for funding (fig.12, fig.13). The team and the volunteers will also use the application to overlook the smooth working of the supply chain [37]–[38]. One's credentials would be used to log-in to the app. The SSL encrypted payment gateways would support the application and the website (fig.10). This way, the donor's navigation via the app would be safe and secure. Awareness about the initiative could be created through social media platforms by

sharing related content and engaging online audiences. Other marketing techniques—promotions, advertisements, and publicity through word-of-mouth—can boost the overall reach of the app [39]−[40]. The kits can be requested by using the calling feature on the app. Smartphone or feature-phone users can give a missed call to the number mentioned on both the webpage and mobile application. A call-centre would track the request; and will manage and respond to the order raised [41]. The call-centre decides priority areas for delivery based on GPS location details available on the app and frequency of missed calls.

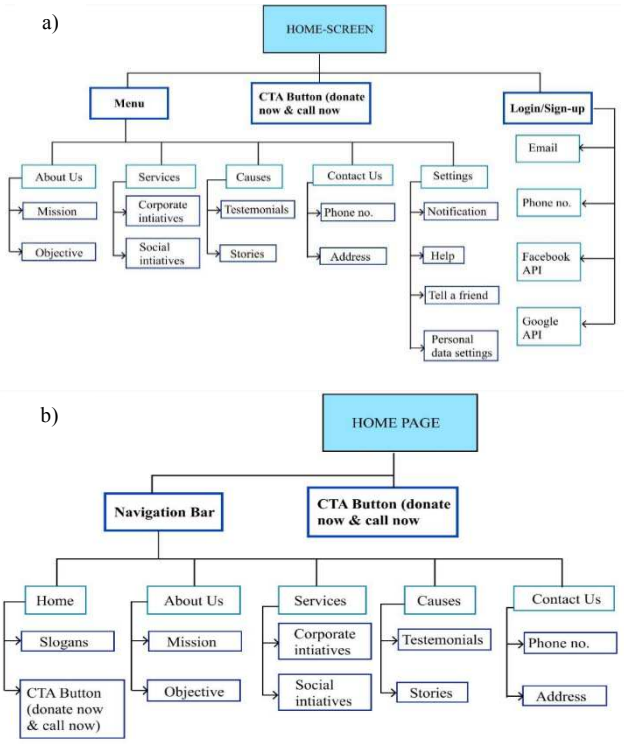

Fig. 10. Information Architecture for: a) Smartphone App, and b) Website

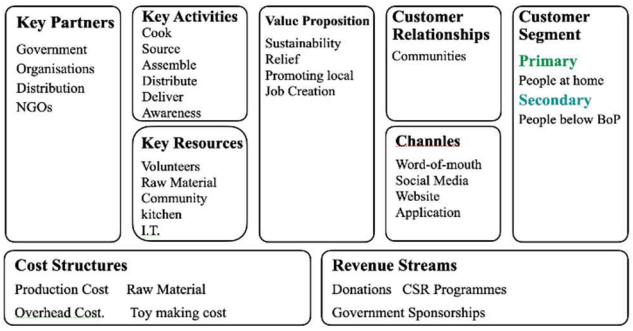

Fig. 11. Business Model for the proposed scheme.

IV. DISCUSSION

The proposed scheme operates on an ICT enabled PSS framework for timely delivery by volunteers as and when the need for the kit arises. A few challenges in the system include lockdown restrictions on the movement of people and public transport, packaging and inventory management, and access to technology. Transportation from one place to another could be difficult due to various prohibition imposed by the government. In case the lockdown restrictions persist, volunteers may be unavailable to distribute the kits.

Fig. 12. Webpage Home Screen for 'Shishu Annapurna' scheme.

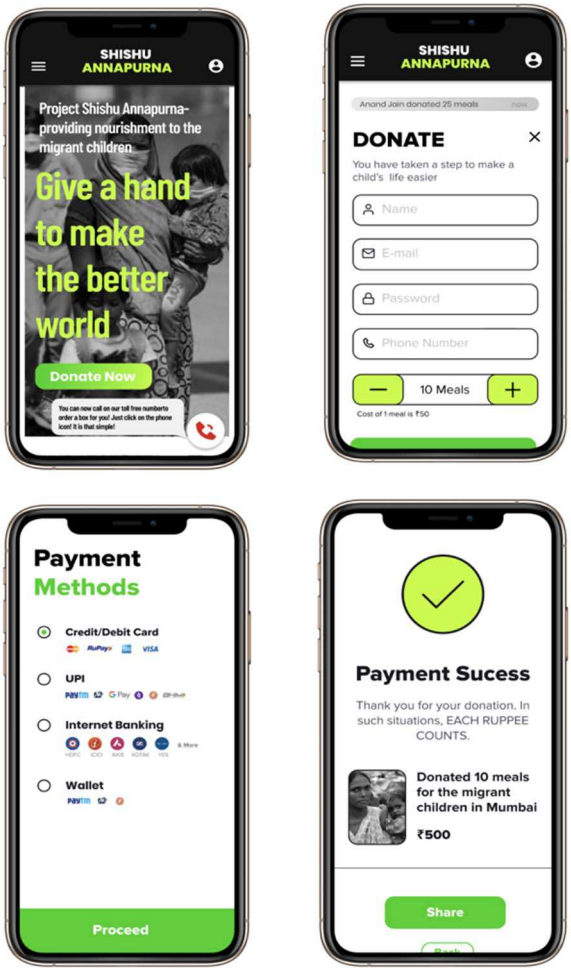

Fig. 13. App screens for 'Shishu Annapurna' scheme.

However, when lockdown restrictions are eased, setting up food-stalls at stations, highways, bus depots would also help in catering to a broader audience. The second challenge which may be encountered is of safe packaging. Before delivery, the food items need to be tightly packed to ensure zero-spillage at the delivery site. The food reaching the children must be warm and fresh for immediate consumption. The problem of inventory management concerning the toys is another issue to address. Availability of raw material and human resources could affect the number of toys produced. A gap in demand and supply could also be a huge challenge and would vary

regionally. Lastly, there may be a few users who do not possess smartphones and do not have access to the mobile application. In these cases, a regular call can be placed to a toll-free number, when a kit is requested for. A call centre at the back-end would handle and respond to these calls. The toll-free number would be available to them through word-of-mouth, posters, and weekly SMS. The smartphone users registered on the application can also place orders for kits on their behalf. Migrant workers in each locality are encouraged to spread the word to their fellow community members to place bulk orders to save multiple delivery trips and ensure a prompt response from the supply team.

An alternative solution for the scheme would have dry ingredient kits which would be distributed in the rural areas and villages with the help of local bodies including *panchayats*, ASHA workers and volunteers. Staples like rice, lentils (dal), Spices (masalas), cooking oil, and other essentials would be included in the box, based on family preferences. This will further allow mothers to prepare meals according to their families' local tastes. Providing dry, raw ingredients which have a longer shelf-life would sustain a family for at least five days. For Instance, instead of milk, milk powder can be provided. The box would contain a toy for the children. The secondary package, i.e. the cardboard box, will have games like snakes and ladders, Ludo, and so on (see fig. 14). The box would include all items, including the toy and will be provided if the same person requests for another box.

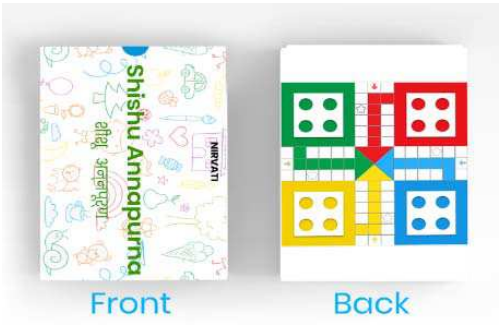

Fig. 14. Secondary package mock-up for the essential emergency kit.

Due to a rise in global temperature, there is a sharp increase in the number of natural disasters occurring around the world. In future, this essential emergency kit could also serve as a disaster relief kit and be distributed across India and the world. These kits could also be distributed in homeless groups, refugee camps and war zones around the world. In future, collaboration with popular food delivery platforms can speed up the delivery process. Coordinators and volunteers can self-sanitise and wear PPE kits during delivery to ensure safe hygiene standards in a pandemic scenario. Governmental organisations like ICDS (Integrated Child Development Services) have taken the initiative to combat child hunger and malnutrition through various schemes. Ministry of human resources development (MHRD) provides mid-day meals to school-age children nationwide. A PPP model could be pursued to work with governmental (ICDS, MHRD) and non-governmental organisations (UNICEF, Give India) to increase the reach and effectivity of this PSS scheme. Rural training programs could be offered to volunteers, who distribute food packages to children locality-wise. Stakeholders, start-ups, food vending companies and private companies can get credits for CSR (Corporate Social Responsibility) through tax incentives and rebates granted by the government. Partnering with such organisations would help in leveraging credibility among the masses and have a wider reach during emergencies and pandemics.

V. Conclusion

To conclude, *Shishu-Annapurna* is an ICT-based PSS scheme that provides packages with food, toys and hygiene essentials to children and their mothers living at the base of the pyramid. This scheme aims at reducing food insecurity among families while promoting sustainable lifestyles. Moreover, it serves as a tool for improving a child's cognitive and physical development. This provides organisations, companies, and citizens an opportunity to give back to the communities that are vulnerable during adversities. They could choose to give back via monetary aid or volunteer services. A smartphone application and a corresponding website are used to crowd-fund the essential emergency kits. The supply chain is monitored by connecting various stakeholders to the end-users. *Shishu-Annapurna* also helps in creating jobs in the local economy. The kits can provide necessary relief to families hit with famine, natural disasters, war and future pandemics. The smartphone app could be extended to the supply chain management system for real-time tracking of distribution and inventory management. Essential emergency kits are a mandate for communities in many developing countries too. This scheme can be implemented in developing countries across South-East Asia, in parts of the Middle-East, in the continent of Africa and South America to provide relief to victims of natural calamities and pandemics. The possibilities of deploying this PSS based schematic framework, globally, are endless.

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