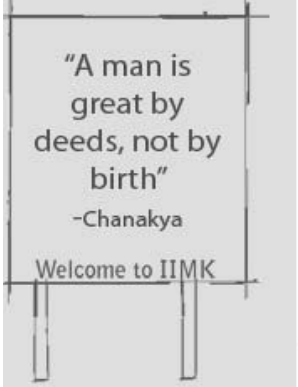

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Technology and Inequality across Three Eras: An Investigation of the Green Revolution, Yellow Revolution, and the Mobile Payments Evolution

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Abstract

With the use of technologies for development, often the societal perils like inequality creep into the technology interventions too. Time and again, researchers have noted the socially backward groups, the intended beneficiaries, continuing to be marginalized in ICT for development projects. Technology initiatives have undoubtedly resulted in economic benefits, but their developmental roles must be examined critically. Since technology fails to eradicate the existing inequality in societies, we must examine its extent in obstructing human freedoms by the marginalized sections. Using Sen's capability framework, we analyze technologies from three eras – technologies used in Green Revolution, eChoupal telecenters during the yellow revolution, and UPI-based mobile payments during the post-demonetization era. Secondary data from the literature have been used for the past eras, whereas primary interview data is collected for mobile payments. The analysis gives mixed results – while certain freedoms are provided by the technologies, these freedoms are not equally accessible to all beneficiaries across the different sections of the society. The study holds policy implications to equal participation of beneficiaries from marginalized strata.

Keywords: ICT4D; social inequality; mobile payments; telecenters

1. Introduction

Globally, public sectors in developing economies allocate resources to promote technological advancement and achieve economic efficiency through greater citizen participation (Obedait, Youssef, & Ljepava, 2019; Pereira et al., 2017). Recent years have witnessed the implementation of information and communication technology for development (ICT4D) projects, like telecenters, mobile phones, and other ICTs, to facilitate socioeconomic development (Heeks, 2008; Tassabehji, Hackney, & Maruyama, 2019; Venkatesh, Sykes, Rai, & Setia, 2019). Public engagement is at the core of all such technologies used for public services endeavoring for socioeconomic development. The involvement of all citizens as stakeholders, and not as mere consumers, is indispensable for the creation of public value (Osborne, Radnor, & Nasi, 2013). On the other side of the story, social hierarchy and power asymmetry get replicated into the collaborative processes of technology diffusion (Pedersen, Sehested, & Sørensen, 2011). Particularly, ICTs have often been criticized for their role in further widening the digital divide, rather than bridging it (Hargittai & Walejko,

2008; James, 2011). To examine this dichotomy of the participatory role of technologies, we investigate those technologies that held the promise of citizen empowerment across various strata but have questionably achieved so due to existing socioeconomic disparities. We draw historic evidence from technological advances from three eras, during the Green Revolution, followed by eChoupal telecenter for empowering farmers during the Yellow Revolution period, to comparatively analyze a recent emerging financial technology, the mobile payment technology promoted by the government to facilitate financial inclusion (Donovan, 2012). We suggest that decades apart, *the three technologies operationalized in India for socioeconomic development through public empowerment, tell and retell stories of unavoidable social divisions.* To theoretically examine this, we use the human empowerment freedoms identified Sen as the lenses for understanding how the technologies offer (or do not offer) these freedoms to all the sections of the society (Sen, 2001). The choice of the three technologies is driven by their direct roles towards enhancing freedoms and their scope for offering protective security as they thrived in crisis periods – drought (for technologies in Green Revolution and eChoupal); and cash crisis triggered by demonetization and Covid-19 (for mobile payments).

Our first historic evidence is drawn from the agrarian technology implementation during the Green Revolution, initiated in 1967 to increase productivity and attain food self-sufficiency using modern agricultural mechanisms (Freebairn, 1995). However, the techniques involved a good amount of capital investment that exceeded the affordability of the small-scale farmers, leading to a lack of participation of poorer farmers (Dhanagare, 1987). A repeat of history was witnessed when the eChoupal system was launched in mid-2000 for farmers to sell their agriculture products directly through telecenters. At a first glance, the eChoupal system increased the financial profit of farmers who were able to sell their goods at a higher price, instead of unfair prices offered by middlemen at local markets (Kumar, 2004; Rani, 2014; Varman, Skålén, & Belk, 2012). However, a critical investigation reveals that eChoupal's participatory processes were not free from inequality towards socially backward groups (R. D. Gupta, Arora, & Gupta, 2014). Our third evidence is from another technological innovation two decades later, when India observed the inception and rapid proliferation of the mobile payments late 2016 onwards. Mobile payment services promised significant financial inclusion by providing an alternative digital banking (Au & Kauffman, 2008; Rana, Luthra, & Rao, 2019), and has claimed for alleviating poverty and promoting development (Asongu & Nwachukwu, 2018). However, it is unclear if mobile payments were accessible to the marginalized who did not have a smartphone or Internet to support mobile payment apps (Pal, De', & Herath, 2020). Therefore, we evaluate the status of the participation of the citizen in the financial technology through Sen's capability theory (Sen, 2001) and comparatively analyze it with technologies of the Green Revolution and eChoupal.

Past literature in ICT4D have examined ICTs in terms of their social impacts (Bowonder, Gupta, & Singh, 2002; Dattatraya N Dhanagare, 1987a; Masiero & Prakash, 2019; Pal et al., 2020), but the three-tier comparative analysis in this paper accentuates the significance of technology as a social construct (Prakash & De', 2007). Additionally, mobile payment literature in developing countries focuses on its role in financial inclusion in isolation of the social issues (e.g., Donovan, 2012; Mbogo, 2010), which we argue is essential for studies based in countries with an old heritage and predefined social norms. We speculate that due to the unequal participation by different sections as iterated by Sen, capabilities provided by the technologies, like social opportunities, transparency, and crisis protection, cannot be availed by all (Drèze & Sen, 2002). Our research helps examine this concept in depth.

We conduct a field study to understand the relational roles of mobile payment users and then examine the existing social inequality leading to financial exclusion. The data is collected from six cities across the country to ensure generalizability across locations with significant infrastructural differences (Lee & Baskerville, 2003). We then discuss our findings in comparison with secondary data evidence from the Green Revolution and the eChoupal system. We use critical research methodology for a deeper understanding of the socio-political phenomenon using theories by social theorists (Myers & Klein, 2011). The evidential findings show that while mobile payments have offered to empower freedoms to a section of its users, social inequalities are still recreated.

The remaining part of the paper first discusses the background of three technologies in the light of citizen participation, followed by a literature review. Next, we discuss Sen's freedoms, the theoretical lenses for analyzing both the primary and the secondary data, as elaborated in the methodology section. We conclude by discussing the findings showing social disparities exist through the history of technology.

2. Background and Motivation

Endeavors of technological modernization for providing public services are principally directed at improving the quality of life of citizens (Zygiaris, 2013; Dameri, 2012); the agenda is to modernize the society in economic terms (Fabian, 2010). By stimulating technological innovation, a government aims to provide necessary public services to promote participatory practices and foster socioeconomic development (Meijer and Rodríguez, 2016; Rodríguez, 2018; Alcaide and Rodríguez, 2019). Interestingly, technology does not erase off the unequal social structures since it involves the networked interaction of different actors (Pedersen et al. 2011: 387). In this paper, we draw lessons of social inequalities from the past episodes of the Green Revolution and eChoupal, to foresee the social moorings of yet another technological advancement- mobile payments.

2.1 Technological Intervention during the Green Revolution

As a policy, the Green Revolution was optimistically estimated to bring forth lasting results to the perpetual question of rural poverty (Dhanagare, 1987), it marked the transition of agriculture from traditional to a modern state. The ideological underpinning of the Green Revolution was institutionalized modernization involving extensive implementation of advanced production technology. This was done through high-yielding varieties of crops, modernized pesticides and fertilizers, and innovative farm machinery with energized well-irrigation. However, for technology to accelerate development, initiatives must be capable of wrenching technology from its social issues. The Green Revolution had faltered because technological advancement was corrupted by existing social stratification leading to unequal distribution of its benefits (Saini, 1976a).

An inherent pro-rich farmer bias manifested itself as the big farmers became the early adopters of the new technology (Paul, 1990a). The benefits offered by the novel technology were distributed differently to different categories of farmers, with the poor and marginal farmers at a relative disadvantage (Dhanagare, 1987). The new technology was highly contingent upon innovative irrigation, thereby excluding the poorer farmers who couldn't afford sophisticated irrigation mechanisms (Paul, 1990a). Furthermore, there were criticisms that the dominating upper-class continued to hold the responsibilities for the distribution of anti-poverty programs aids like subsidies, leading to an avenue of social discrimination (Dhanagare, 1987). Therefore, the green revolution did not attend to the question of socioeconomic development but focused solely on production (Oommen, 1971). One of its major limitations is that the unequal distribution burdens those who gain the least from it (Srivastava, Crown, & Heady, 1971a). This inadequacy led to a rise in economic inequalities which were a reflection of the existing social disparities.

2.2 Lessons from eChoupal in the Yellow Revolution

Launched by ITC[1] in June 2000, eChoupal facilitated IT infrastructure to the farmers for an easier network with the market (Upton & Fuller, 2004). The eChoupal system included kiosks for the farmers to sell their produce directly to ITC at a fair market price. This helped farmers overcome financial losses from selling their produce at unfair rates to middlemen in the local markets, displacing the middlemen's negotiating power (Kumar, 2004). To promote its pro-technology agenda, the government even amended the legal system to permit eChoupal's operations (Vijaybaskar & Gayathri, 2003). The eChoupal system was recognized as one of the instrumental interventions during India's Yellow Revolution or the period marked by an upsurge in edible oil production (Kumar, 2017; Kumar, 2016). ICT4D researchers noted the various development goals achieved by eChoupal including economic, sustainability, and social growth

[1] ITC stands for Imperial Tobacco Company, once of the leading conglomerate in India in the FMCG sector.

(Bhowmick, 2016; Kumar, 2004; Mukerji, 2013). However, a deeper observation of the glorified ICT raises the question: does eChoupal benefit all the sections equally?

The major challenge in achieving the goals of eChoupal lay in the absence of resources like electricity, internet connectivity, telephone network, and other basic infrastructure in many rural regions of India (Rao, 2008). This puts the relatively modernized villages at an advantage, leaving out the under-developed areas from the benefits. Moreover, the eChoupal kiosks are set up in a house with supporting infrastructure, therefore belonging to someone from the richer community and typically from a hierarchically upper class (Upton & Fuller, 2004). In a country with deep social structures embedded with evils of class and caste discriminations (Dhesi, 1998), the access to this house with eChoupal kiosk is likely to eliminate the neediest farmers belonging to the discriminated sections. Resultantly, the benefits of eChoupal are enjoyed differentially by different sections of society. What we have witnessed in the Green Revolution and subsequently in the Yellow Revolution is counterproductive to the revolutionary potentials of technological intermediation.

2.3 The Payment Revolution- Rise of Mobile Payments

The revolutionary power of mobile payment technology is in its promise for financial inclusion of the masses, hitherto unable to access banking institutions or participate in formal banking channels (Donovan, 2012; Kim, Zoo, Lee, & Kang, 2018). Though Kenya witnessed a transformation through M-Pesa's mobile payments serving 80 percent of the unbanked people in 2007 (Hughes & Lonie, 2007), it took India a currency note crisis triggered by the demonetization in 2016 for mobile payments to reach to the cash-centric masses (Chakravorti, 2017). The unorganized sectors, including the local vendors, who were historically dependent on cash for daily transactions used mobile payments as a safety net to continue business during the banknote crisis (Bureau, 2016; Firstpost, 2016). This was further catalyzed by government policies for greater inclusion (e.g., Jan Dhan Yojna) and digital India (Dave et al., 2017). The four years between 2016 of the first push by demonetization, to 2020, witnessed the greatest digital finance transformation which can be recognized as the payment revolution. The unified payments interface, popularly known as the UPI, enabled individuals to directly transfer funds across banks through mobile phones (Wright, 2017). Between 2016 to 2020, the monumental growth of UPI can be seen with steep growths in volumes and amounts of transactions, that can be attributed to numbers as high as 20,000 percent (NPCI Website, 2020). Such numbers show significant participation of the citizens in the modern payment system. However, there is skepticism about the benefits of mobile payments reaching the truly marginalized population of the unbanked and illiterate population (Pal et al., 2020). A majority of the poorest citizens do not own a smartphone or do not have adequate digital literacy to transact digitally (Dutta, 2018). Despite its strong apparent benefits, there is evidence that local people and smaller vendors are migrating back to

cash (Jaleel, 2016; Kwatra, 2019). To find an answer as to why this is happening, in this paper, we investigate if this digital payment revolution, driven by UPI, was also reinforcing the existing social inequalities, as seen in the cases of green and yellow revolution.

3. Literature

3.1. ICT4D and Participation

ICT4D and citizen participation intersect as stakeholders access the technology through various participatory mechanisms (Singh & Flyverbom, 2016). To ensure the developmental success of an ICT4D project, the participation of all the sections of the community becomes particularly critical (Colle, 2005; Maail, 2011). However, ICT4D technologies and projects are frequently faced with challenges related to participation from various categories of users including rural population, digitally incompetent users, and the elderly (Bailey & Ngwenyama, 2011; Pal et al., 2020).

> "Issues of inequality and participation are particularly crucial in India, where social divisions … are pervasive and have tended to take a heavy toll on both economic development and social opportunities"
>
> -(Drèze & Sen, 2002, p. 10)

The purpose of this paper is to evaluate the role of technologies over the ages in achieving socioeconomic development through citizen participation, thereby, reducing inequality. Researchers have often considered participation as the key concept for engagement in projects in rural communities (Winschiers-Theophilus, Zaman, & Yeo, 2015). The process of participation through ICT4D projects depends on the representations of the actors in the hierarchical structure of the technology (Singh & Flyverbom, 2016). There are multiple complications involved in community participation of ICT4D projects as a result of the divides in the society between the rich and poor, or the technically competent and the digital illiterates (Heeks, 2008). Complications are also related to the cultural values in the communities that may reinforce social rules in the systems (Thapa & Sæbø, 2016). Therefore, it is worthwhile to study how ICT4D fails the underprivileged sections of society from equal participation (Harris, 2016).

To study participation, we use Sen's capability approach as a theoretical principle that states that individual freedom for participation leads to development (Sen, 2001). Scholars working on ICT4D have repeatedly recognized Sen's capability approach as a theoretical principle for the study of socioeconomic development facilitated by the ICT projects. Authors prescribe providing the power to each individual towards the decision-making for their development and growth (Andersson et al., 2012). Freedom of choice, a core aspect for participation, take a predominant role in the technology that follows Sen's development (Kleine,

2011; Prakash & De', 2007). Technology should provide opportunities for participation resulting in empowerment and emancipation (Hamel, 2010). It should provide social support in a way that expands the freedom through individual participation of all sections, including the underprivileged (Buskens, 2010). This eventually leads to societal emancipation as the people control the decision-making for the society (Hatakka & De, 2011). However, in this paper, we question this assumption and investigate critically if technologies, including ICTs and mobile payments, have promoted Sen's freedoms through better participation or the prevalent social inequality persists even as the technology diffuses across the community.

3.2. Participation and Development: Evidence from Telecenters and Mobile Payments

Studies on telecenter often focus on user participation, particularly across communities and categories, to enhance contribution from a wider range of stakeholders (e.g., Bailey & Ngwenyama, 2011; Macintosh, 2004). Participation and social inclusiveness form two leading concepts used for evaluating telecenters' role in development (Reilly & Gómez, 2001). Stakeholder participation serves the sole purpose of telecenters' role in socioeconomic development through technology access (Rothenberg-Aalami & Pal, 2005). Despite the basic developmental goals of telecenters, they often do not serve its purpose and exclude marginalized and rural communities from participation, further accentuating the digital divide rather than reducing it (Benjamin, 2001). Similarly, eChoupal has been identified to be an object of the digital divide, leading to the income divide between the participating and the non-participating communities (Dangi & Singh, 2010). We delve deeper into this issue and understand how social inequality through uneven participation systematically creeps into the telecenters of eChoupal.

Mobile phones are technologies that expand human freedom and capabilities in developing countries (Smith, Spence, & Rashid, 2011). The participatory role of mobile phone extends beyond offering its users with the technology benefits, but also acting as a catalyst to help them participate in economic markets and political processes (Hellström & Karefelt, 2012; Zanello, 2012). Mobile payment, one of the services provided by mobile phones, has enabled the participation of masses of the unbanked population in Kenya and acted as a driver for financial inclusion (Donovan, 2012). Recently, mobile payments spread in India and claimed financial inclusion through widespread citizen participation (Kumar & Kumar, 2016; Mahajan & Singla, 2017). However, we argue that the deeply hierarchical social structure reinforces the inequality across the mobile payment users in India and obstructs the participation of the underprivileged and suppressed communities of the society.

4. Theoretical Background: Citizen Participation and Social Equality

The five freedoms developed by Amartya Sen are critical concepts for socioeconomic development through building individual capabilities (Sen, 2001). Sen challenged the pure economic measures and suggested human-centric development as key to individual emancipation in a society (Prakash & De', 2007). Drèze and Sen (2002) further suggest that as individual empowerment leads to national development, and participation of the citizens plays a key role to ensure equality. Researchers have often examined the participatory role of ICT4D through Sen's freedoms (Díaz Andrade & Urquhart, 2012), with mobile payment in Kenya providing opportunities for individual (financial) freedom to its users (Donovan, 2012). Following the guidelines by Drèze & Sen (2002), we develop a theoretical framework to analyze the technologies in terms of Sen's freedom with participatory lenses. The three freedoms/capabilities relevant to the participatory role of the technologies studied include 'economic facilities', 'transparency guarantees', and 'protective security' (Sen, 2001). The capabilities are discussed briefly below:

Economic facilities allow people to freely exchange goods and services, and be able to avail facilities that help in their economic welfare (Sen, 2001). ICT4D initiatives have often offered individuals to freely participate in the market, thereby offering better economic facilities (Díaz Andrade & Urquhart, 2012). We would examine how the technologies in the green revolution, eChoupal, and UPI payments, offer economic facilities by enabling various sections to participate in the market.

Transparency guarantees make transactions visible such that the individuals are not victims of dishonesty by more powerful actors in the market (Sen, 1999, 2001). In ICT4D research, researchers point how e-government portals and systems reduce the scope for corruption by government official processing citizens' applications provide 'transparency guarantees' capability to the participants (Akingbade, Navarra, & Georgiadou, 2010; Díaz Andrade & Urquhart, 2012). We evaluate if the technologies of our study helped all the sections of society to avail of the transparency offered by them.

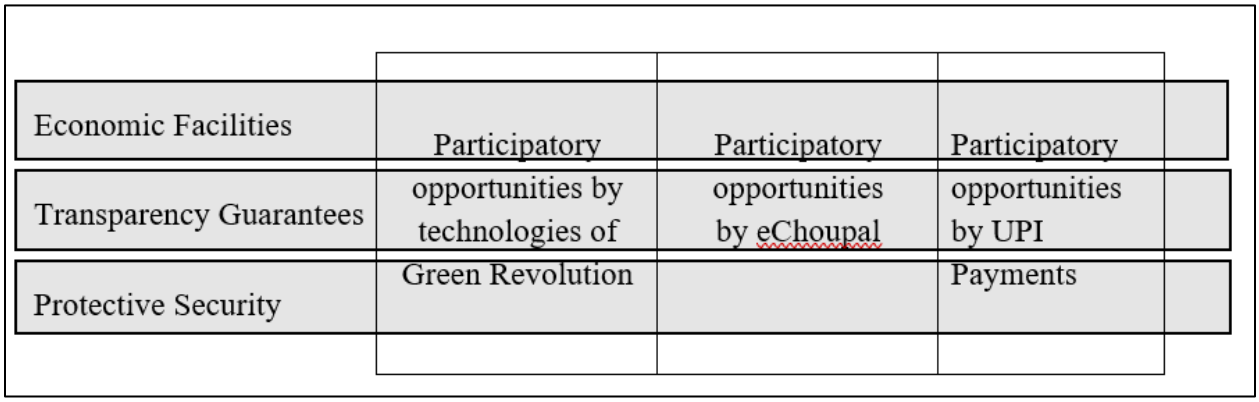
Protective security concerns how well the citizens are protected at times of crisis situations (Sen, 2001). Mobile payments have often served as safety-nets for fund transfer during ethnic violence in Kenya or the banknote crisis triggered by demonetization in India (Morawczynski & Pickens, 2009; Pal et al., 2020). We analyze if the technologies in our study have provided protective security to all the sections of the society equally, through understanding how they were able to participate during crises.

(We are not examining the two other freedoms- 'social opportunities' which includes education and healthcare provisions; and 'political liberties' which involves free opinion on government policies. Either of these freedoms is not related to the domain of the technologies examined.)

For the analysis of participatory opportunities by the technology, the underlying assertion is that the focal point of control is internal as citizens in community consent on predefined norms (Putnam, 1993). Relational roles are recreated from the existing power structures, technology does not erase off the unequal social roles of the actors and participation remains unequal as the societal structures (Pedersen et al. 2011: 387). Therefore, we investigate citizen participation in technology usage by analyzing the three dimensions of the capabilities availed by the actors from various strata.

The framework for the study is represented in figure-1.

Figure-1: Theoretical Framework



5. Research Methodology

We employ critical research methodology for the analysis of both the primary and secondary data, as discussed in this section.

5.1. Critical Research

"For more than thirty years of critical research in information systems (IS) has challenged the assumption that technology innovation is inherently desirable and hence to the benefit of all" (McGrath, 2005). With unequal benefits for individuals across domination categories as our underlying assumption, critical research provides the appropriate ontology for the data analysis (Brooke, 2002). As critical research unveils social realities to promote emancipation, there is an ethical and moral nature of this methodology (Stahl, 2008). To analyze our claims of social inequality fostered by technology interventions across three eras, we employ critical research methodology, by following the guidelines for IS critical research by Myers & Klein (2011). The key principles include the selection concept by a social theorist for both data collection and analysis. We use Sen's freedoms as the theoretical concept chosen. The second and third principles are influential for our study as it involves taking a value position and challenging the status quo beliefs. This

would lead us towards investigating our claims challenging the developmental and inclusive role of the technological interventions in the three technology revolutions. The next set of principles provides guidelines for individual emancipation and social improvements, as understood from the research data. Promoting individual emancipation forms the most distinguishing principle for critical researchers in IS (Stahl, Doherty, & Shaw, 2012), and the choice of our social theory – Sen's capability approach – states individual freedoms for emancipation and development.

The primary data collection for understanding inequality in UPI payments is done through field studies involving in-depth interviews with both mobile payment users and non-users. The social inequality for the other two technologies, agrarian technology for Green Revolution, and eChoupal system, is analyzed through secondary data from past research and market studies databases, as explained in the next section. The data from the primary and secondary data sources are analyzed through the guidelines of critical research for drawing insights.

5.2. Data Analysis

This section discusses, in brief, the origin and background of the Green Revolution's technologies, eChoupal system, and UPI payments, followed by the details of the data collection sources and techniques.

5.2.1. Analysis for Technology in Green Revolution

To investigate the social inequality in the case of the technologies in the Green Revolution, we drew evidence from secondary data from databases and academic papers. The data collection process involved a thorough search of national databases and academic papers on the Green Revolution, to extract the relevant datasets that would reveal the possible social inequality, which forms the baseline of the paper. A chief source of our secondary data was the databases by the National Sample Survey Office (NSSO) under the Ministry of Statistics and Programmer Implementation, the Government of India (NSSO Website, 2020). NSSO conducts various national surveys on various socio-economic subjects like unemployment, citizen health, and public healthcare, agricultural economy, etc. In addition to NSSO data, we also examined the data reported in publications from Economic Political Weekly, a prominent journal in the field of public policy in India with a critical view of various government initiatives ("Economic and Political Weekly," 2020), and other outlets. For the initial analysis, the overall themes of the datasets were noted. The details are given in the Table-A1 in the Appendix.

Next, for the thorough analysis, critical research guidelines were followed as prescribed by Myers and Klein (2011). First, the three freedoms by social theorist, Amartya Sen, were chosen as the core concept (Principle-1) as elaborated in the theoretical background section above. As we carry out the analysis, we

challenge the prevailing belief of technology aiding the rural population equally and take a value position against social injustice (Principle-2 and 3). Finally, our findings, combined with the findings of the other three technologies, help us suggest policy recommendations for the individual emancipation of the marginalized citizens and therefore suggest improvements in the society. This is discussed in depth in the 'discussion of findings' below.

5.2.2. Analysis of eChoupal

The secondary data source for eChoupal's analysis in terms of the aim of this paper consisted of academic research papers. eChoupal being a private-sector venture, its data was not available on the government databases. Therefore, we used the data reported by other academic articles for the analysis. They were from prominent outlets including the Economic Political Weekly (as discussed above), American Economic Journal: Applied Economics (American Economic Journal, 2020), and articles by reputed publishers like Oxford Publishing. These articles were chosen based on the richness of their data reports and the critical take on the social issues existing for eChoupal. Refer to Table-A2 in the Appendix for the details on the data.

The available textual and numeric data was first extracted from the articles and then analyzed to understand the critical issues. During the critical analysis, principle-1 related to concepts by social theorists continues to be the same theoretical lens throughout the three cases, i.e. Amartya Sen's freedoms (Sen, 2001). Next, for principle-2 and 3, taking the value position for 'equal opportunity' (Myers & Klein, 2011, p. 25), we challenge the prevailing belief of ICT4D aiding the marginalized (Heeks, 2008). This can be seen in the field, as many researchers have challenged the core assumptions of ICT4D helping the truly underprivileged and marginalized communities (Díaz Andrade & Urquhart, 2012; Prakash & De', 2007). As we examine the social inequality, we suggest improvements through ways of achieving better participation for not just telecenters but ICT4Ds in general (Principle 4 and 5). The findings of the analysis are discussed later.

5.2.2. Analysis of Mobile Payments

Mobile payments in India is supported by UPI, an innovative interface developed in 2016 that enabled convenient transactions across bank accounts and mobile money wallets, through mobile devices (NPCI Website, 2020). The analysis of mobile payments is performed using primary data from user interviews. In contrast to the historic technologies, mobile payments are at the peak of its diffusion in 2020. For the data collection, we conducted a total of 24 interviews in various cities in India, across northern, eastern, western, and southern parts of the country, to establish generalizability of the results obtained. The locations for the study include NCR region (New Delhi, Noida, and Gurgaon) in the north; Ahmedabad in the west; Kolkata

in the east; and Kozhikode and Bangalore in the south. All the interviews were telephonic due to the Covid-19 guidelines for social distancing and travel restrictions in lockdown (Agrawal, 2020). The interview duration ranged from 15 to 25 minutes, based on the willingness of the respondents to discuss. The interviewees were assured of the confidentiality of their identity (Myers & Newman, 2007). Besides English, the interviews were conducted in two native languages of the respondents, Hindi, and Bangla, based on the preferences of the subjects. The subjects included younger technically competent participants, as well as, older digital immigrants (Guo, Dobson, & Petrina, 2008), and users from various income categories and educational backgrounds. This helped us understand the access inequality across the different strata of the society, particularly from three dominant classes of the digital divide – age, income, and education (Cohen, 2011).

We collected data through in-depth interviews over three months starting from March 2020 through May 2020. Owing to the absence of a validated questionnaire to capture Sen's freedoms related to mobile payments, we designed specific qualitative design techniques that would capture a rich understanding of the phenomenon within the social context (Kaplan & Maxwell, 2005; Myers & Avison, 2002). The choice of the semi-structured interview is driven by the need to provide direction while not confining the interview within preset boundaries; to allow for a progressively improvised conversation (Myers & Newman, 2007). Interviews followed deductive reasoning, as interviewees were asked generic questions to capture their views in an unstructured way. For instance, a set of preliminary questions asked to all interviewees was- Why they do/do not use mobile wallets? As the conversation progressed, we enquired about specific themes related to the theoretical model, in a semi-structured fashion, to encourage discussions related to the predefined characteristics.

Table-II presents the number of interviews conducted in different languages and locations.

Table II: Languages and locations of the Interviews

	English	**Regional Language (Hindi/ Bengali)**	**Total**
New Delhi	6	3	9
Gurugram	3	3	6
Noida	2	-	2
Kolkata	1	1	2
Bengaluru	1	-	1
Ahmedabad	-	2	2
Kozhikode	2	-	2
TOTAL	15	8	**24**

6. Findings

We critically analyzed the data collected for the three technologies through the lenses of Sen's three freedoms- economic facilities, transparency guarantees, and protective security, and understand the participatory opportunities. We discuss the results for each of the Sen's freedoms comparatively for the three technology and then draw combined conclusions.

6.1 Freedoms provided by the Technology in Green Revolution

The analysis of secondary data pertaining to the Green revolution revealed patterns of exclusion and differential spillover of technological intervention. The findings are discussed in coherence with the three freedoms.

6.1.1. Economic Facilities

Green Revolution led to an overall increase in agricultural productivity and the resultant increase in farm incomes across the various categories of agricultural products and farmer categories. As per the study done by Saini (1970), using the National Sample Survey- 16th and 17th round, it was revealed that the levels of absolute poverty per capita had reduced. However, the increase in productivity, increase in disposable income, and decrease in poverty was not uniform and was directly contingent upon several factors in favor of large and medium farmers over small farmers. While the initial phases of the Green Revolution were marked with a rise in absolute poverty (as seen in the analysis by Paul, 1990), the disposable farm incomes began to rise. This rise had certain remarkably differential characteristics. Incomes increased disproportionately which led to a rise in economic inequalities. The study by Saini (1976) suggests that inequalities aggravated in proportion to factor endowments leading to a further widening of the income gaps. "*Green Revolution was limited to a few pockets and also to the affluent sections only, has created a wide economic gap in the rural society and aggravated the tensions*" (Das, 1970). This formed a vicious cycle further widening the economic divide. Additionally, the access to irrigation facilities, again confined to the richer section, also determined the degree of positive effects of the technologies in that period.

This shows that economic gains from technological modernization in the context of the Green Revolution have not been evenly distributed across various classes. Similar results have been found in the study by Srivastava, Crown, and Heady (1971). Instances of poverty were related to per capita income and hence were highest among the small farmers, followed by medium farmers.

6.1.2. Transparency Guarantees

Transparency guarantees pertain to the transparency presented to the citizen by the technology adopted as a part of the Green Revolution. Green Revolution fared relatively lower on this freedom. Transparency guarantees are expected to work towards creating trust in technological innovation. As the economic disparities continued to grow even after the initial stages of technological adoption, technology did not even out the inequalities rather reinforced it questioning the trust towards the technology. Using data from the National Sample Survey- 30th round, Dhanagare (1987) asserts that technology of the Green Revolution widens the income disparities between small and large farmers with the medium farmers, and continues to increase inequalities across production cycles. This reiteration of lopsided benefits created adverse trust issues towards technology. The farmers from poorer sections could not experience transparency guarantee towards the technology and non- land production factors. Reportedly, *"it was found that users came only from among landowners and high caste farmers and not even one came from among tenants or low (scheduled) caste ones"* (Deva, 1980, p-268). To avail the benefits of the resource-intensive mechanization, small and medium farmers had to resort to hiring the technology that was not affordable to them for purchasing. The growing inequality was reinforced by technological intervention even when levels of absolute poverty per capita showed the reverse trend (seen in the studies by Srivastava, Crown, Heady (1971) and Junankar (1975)).

6.1.3. Protective Security

Post-independence, India witnessed major drought periods between 1937-1945, 1965- 1966, 1982-1990, 1997-2004, and 2011- 2015. Further, the 1960s were characterized by extensive reliance on U.S. food aid. These cycles of drought are periods of crisis for all the citizens and more so for the farmers. Considering that the Green Revolution was a policy initiative to respond to farm crises, findings suggest that protective security was not available because the mechanization did not benefit everybody. Dandekar and Rath (1971) note that *"the process of rural development during the 1960-69 decade [drought period] has benefited the upper-middle and the richest sections more than the middle, lower-middle and the poorest sections"* (p-70). Class differences accentuated as the condition of agricultural laborers and poor peasants worsened during the crisis as seen in the analysis by Athreya, Boklin, Djurfeld, and Lindberg (1983). In the Green Revolution period, supplementary State institutions like the electricity board, official credit facilities, and co-operative banks were guilty of extending preferential treatment to large farmers, in contrast to, the small and medium ones. The study by Bhalla and Chadha (1983) reveals that the high installation costs were borne by wealthy farmers better than the poorer farmers, who failed to exploit these infrastructures necessary to revive during a crisis. In terms of the need for agricultural loans during the financial crisis or events like droughts, *"the richest could easily get loans from co-operative societies at an official rate of 6 percent interest which was*

just half the rate of private moneylenders charged. The rich peasants were also reported to be in a much better position to buy large quantities of fertilizer on credit and thereby ensure good harvest than were poorer farmers" (Epstein, 1978, p-108). Hence, protective security during a crisis was available to a few but not all.

6.2 Freedoms provided by the eChoupal System

Our findings suggest that while eChoupal ease out some of the financial constraints for soya farmers, eChoupal did not alter the existing inequalities in the social system. Our findings contest the dominant rhetoric that technology reduces social inequalities.

6.2.1 Economic facilities

The introduction of eChoupal resulted in better economic, as well as, developmental goals for everybody involved. Farmers experienced a rise in disposable income due to an increase in overall yields and a considerable reduction in transaction costs while selling their produce in the normal mandi[2], as seen in the study by Sharma (2002), Bhatia (2007), and Goyal (2010). While the technological intervention created suitable conditions "*for large-scale diffusion of technology, it also narrowed the gaps between technology and people's needs*" (Sharma, 2002). However, infrastructure inadequacies like the non- availability of electricity connection, internet, and computer literacy meant lesser participation of the small and medium farmers. This also made the small and medium farmers dependent on large farmers who could avail of the benefits of the technological modernization. It is pertinent to note here that often economic class and caste have considerable overlaps in Indian peasantry (Gupta, 2000). Therefore, the eChoupal telecenters placed in the household of the upper class/caste farmers could not be accessed by farmers from lower sections with restrictions on entry inside the premises. Once again, the class and caste structure reinforced the existing unequal social system, and the economic facilities offered by eChoupal was partially beneficial to certain sections.

6.2.2 Transparency Guarantees

Transparency was integrated into the design of the eChoupal system as farmers could directly contact ITC, crop prices were universal and transparent, and selling information was available to all users. Thus, eChoupal can be credited for the removal of middlemen for empowering the farmers, though the extent of this empowerment was skewed. This impacted the transformation of agrarian markets because the technological interventions are biased towards the rich farmers. Depending on the technological

[2] Mandi is a regional term for local markets in India. We have used this term to preserve the relevance of the context

requirement and eChoupal kiosks, no generalizations can be made about the impact if eChoupal on the transparent functioning of the rural agricultural procurement markets. The benefits of improved information on wages, investment incentives, and reduction in poverty was different for farmers of different strata. While there was an improvement in procurement efficiency and a reduction in transaction costs for farmers with access to telecenters and kiosks, the same cannot be asserted for farmers without access. The access to the telecenters was restricted for the low-caste farmers, as discussed in the previous section. Owing to the unequal and counter-revolutionary impacts of eChoupal presented by Kumar (2016), the transparency guarantees extended by eChoupal were secondary to the existing power structures in the agrarian society. Hence, no conclusion can be made about the role of technological innovation in enhancing transparency across the sections of the society.

6.2.3 Protective Security

Launched in 2000 during the drought crisis of 1997- 2004, eChoupal being a private initiative bolstered by public policy showed variable results. Most farmers experienced a surge in disposable incomes and unlike the Green Revolution, widening of income gaps has not been reported. As asserted by Sharma (2002) the Yellow Revolution has brought to the fore an important manifestation of globalization – the role of private players in responding to public problems. The success of eChoupal revealed the inadequacies of public funding in resolving the multifarious demands of the farm crisis. The inadequacy on the part of public policy to respond to the farm crisis was only partially catered to by eChoupal. A study by Siegel (2017) also reinstated the need to a couple of private initiatives with multiple institutions to cater to the requirements of parity and equity. Situated in the sociotechnical arrangements, it is apparent that the outcomes of the eChoupal initiative are not an arithmetic sum of well-intended policies of the State or market. Unquestionably, eChoupal promoted business during the agricultural crisis related to drought, but only for certain sections, and certainly not for the truly marginalized belonging to the lower class/caste groups (as analyzed by Kumar, R. (2016)).

6.3 Freedoms Provided by UPI-based Mobile Payments

The respondents were both UPI-based mobile payment users and non-users. While the users discussed the benefits and barriers, the non-users brought focus to the serious issues with the technology. The analysis revealed many nuances regarding Sen's freedoms offered, as well as, hindered by mobile payments. See Table A3 in Appendix for the summary of the themes identified from the analysis of the interview transcripts.

6.3.1. Economic Facilities

The majority of the users said that they used mobile payments for a variety of purchases including daily groceries and food outlets, online food deliveries, cab sharing, and paying to others. The wide range of purchases portrays the proliferation of technology and its availability with the smaller vendors. The 'economic facilities' offered by mobile payments are considerable, as multiple respondents noted, "*I use it for lots of things, like buying from grocery stores, ordering food online*."; "*…for food ordering, I make UPI payments, then in the office cafeteria I've a QR code that I scan for payments*". The findings also show that citizens are embracing the UPI-payment facilities wherever available, as an alternative to cash, ("*So I use them [mobile wallets] everyday, I don't carry a wallet anymore*"), or in place of transactions through traditional bank transfers, ("*…for transferring money or paying a friend I use*[3]"). A very interesting trend of availing the facilities of mobile payments by both users and non-users was asking friends or family with mobile payments to make the transaction on their behalf. A user noted, "*If I don't have cash and the shop accepts Paytm, I pay through it or I ask my friends to send me money on Paytm*[4]". An elderly non-user, who was not confident to adopt the new financial technology in the worry of mistakes from her technical incompetence, said, "*if I need [to pay through mobile payments], I get help from my family members. They pay through mobile payments for me, and I pay them cash*."

However, the story was not entirely on a positive note. As some of the users were discussing their mobile payment usage habits, the dominance of cash was evident in the conversations. For example, "*If there are 10 transactions, out of those 1-2 will be through digital medium and rest will be preferred through cash"; "Cash, I usually use at the grocery stores mainly for food*." And, the reason for this cash usage was "*Some people [vendors] have, and some don't have. Lot of temporary-type shops do not have Paytm*[1]*"*; " *If more shops and people adopt it, it would become better*". To further understand the issue of lack of mobile payments in the age of growing smartphone user base in India (Economic Times Telecom, 2020), we delved into the responses of the questions related to problems and issues with mobile payments. Invariantly users stated the unavailability of the Internet as a major disruption to usage, "*the vendors/ shop owners should have wifi or there should be way to do payments without internet because such situations do arise*".

While we did have evidence of various facilities availed by users, who were already smartphone users, the unavoidable need for the Internet or smartphone as an infrastructural requirement for the vendors to adopt mobile payments highlights the participatory divide. The implications of such a digital divide are beyond the facilities provided only by the technology, but to more serious outcomes like economic losses due to

[3] Google Pay and Paytm among the leading mobile payment services in India in terms of market share (Dash, 2020)

loss of business. This grievous outcome was identified by a user, who said, *"If there are two shops, as simple as that, if I wanna buy a cold drink I'll choose the one that has a QR code and accepts digital payments."* This comment, bringing out the disadvantaged situation of the non-participant, raises the question of the developmental role of UPI payments.

6.3.2. Transparency Guarantees

Transparency guarantees concern the transparency offered to the citizen by the technology causing trust towards it. This was a distinct feature by mobile payments as users said, "*I'm not able to keep a track of my expense by cash… I keep a track on Paytm and google pay through transaction history*"; "*There is no threat of losing cash also. I have a list of my expenses on Paytm so I keep an eye on it*". The transparency offered extended to a crisis during the worldwide Covid-19 when users felt secured to transfer fund money through mobile payments due to the transparency offered. On this note, users said, *"[mobile payments] is more transparent as you get an acknowledgment for it and that makes you feel good about it. Donations otherwise make you feel like it might go to someone's pocket"*; *"It's transparent and you can see that you have donated."* Overall, transparency guarantees were met adequately by mobile payments and citizens appreciated the availability of this freedom through the technology use.

However, a fascinating phenomenon was identified as certain users pointed out issues with transparency because they were in the marginalized section through income dependency. These users were financially dependent on their family members, such as parents, or husbands, and, expressed a uniquely problematic concern. A dependent woman stated, "*That's [tracking] the problem. I don't have my own money, I am a housewife. My husband then keeps a track of where I spend his money*". A college student said, "*I've always preferred cash, and I think the reason is also because my account is linked with my mom's and so I just don't want them to be able to keep a track of me, especially the things I purchase that she necessarily approved of would show up in my statements*". These statements show how financial independence plays a major role in financial freedom, and mobile payment apps with its easy tracking feature can be a hindrance to the limited freedom enjoyed by financially dependent individuals. This issue causes a serious deterrent for the participation by the financially dependent individuals.

6.3.3. Protective Security

The interviews were conducted in the Covid-19 crisis, and therefore, we were able to capture its role in providing 'protective security' at the time of crisis. The findings revealed that among the three freedoms, this was the most unanimously recognized across the spectrum of the respondents since citizens were worried that the surfaces of cash could carry or spread the coronavirus. In such a situation, the UPI-payment

system offered a contactless option to pay to the merchants. In this context, users noted, *"[mobile payments are] definitely a safer option"; "there is a guideline from the government to decrease the use of currency because it travels in many hands and you can possibly get infected"; "it makes more sense to do contactless payments these days*".

Despite the awareness related to the safety of mobile payments over cash, users continued to transact using cash because, "*things like vegetables, chicken and things like that, half of it is digital and half of it is cash because there are so many cart-people, that sells fruits and they go across street selling things like that and small shop owners that do not have the facility to accept digital payments" ;"The shops are closed and the main transaction is carried out by cash only in my area*". A consumer explained the reason behind this as, "*But smaller shops, they have to go to bank or somewhere to convert the amount [from mobile money] to cash, so they don't want. Actually, they need cash during lockdown. Going to bank is very difficult during the lockdown"*. An elderly non-user regretted about the germ-related issue, "*there is the issue of virus. … But it's very difficult for me to use it"*.

These findings show that regardless of the undisputed awareness regarding mobile payments being a safer option during coronavirus, the marginalized local vendors did not have the option, or did not prefer digital cash due to the difficulty in visiting the bank for the conversion during the nationwide lockdown and restricted movement. The non-users acknowledged the coronavirus issue with cash but were unable to adopt the system suddenly due to prior conditions like incompetence or habit. It is, therefore, incorrect to conclude that mobile payments successfully provided 'protective security' during the Covid-19 pandemic crisis, since all the sections clearly could not participate equally.

7. Discussion: Comparative Analysis of the Technology in Green Revolution, eChoupal, and UPI-payments

A comparative analysis of the three technologies through the lens of Sen's freedoms framework reveals critical nuances about large scale diffusion of technology and its developmental implications for the society. Analysis of technological intervention in the Green Revolution constitutes the earliest period of our analysis, which fared poorly in all three dimensions of development. The inequality in participation resulted in the unfreedom of the disadvantaged groups. The eChoupal system, a comparatively modern ICT technology, shows improvements in terms of the freedoms it offered to the target beneficiaries. Rise in disposable income, and fair transparent pricing through the removal of middlemen from the supply chain were some of the benefits offered by eChoupal that led to freedoms like economic facilities and transparency guarantees. However, the inequality across the richer and poorer farming classes still

obstructed the marginalized from availing these benefits. The provision of freedoms for all continued to be questionable. As we investigated the recent technology, mobile payments, we delved deeper to analyze the interface of technology and social structures through a critical analysis of interview transcripts. Mobile payments are being promoted by the government of India for facilitating financial inclusion through this alternative banking channel (Anand, 2019). The question persists, does it offer the developmental freedoms to all?

Mobile payments showed significant support for the three freedoms of its users. It indeed was leading to individual empowerment, as users narrated its advantages over cash, in terms of economic benefits, tracking payments, and use during crises like demonetization and Covid-19. Nevertheless, the non-users expressed their problems that created a barrier for them to use the modern payment system. This caused unfreedom in their daily activities related to their inability to participate in a more convenient and beneficial option. The narratives of the users also revealed the non-participation of the smaller poorer merchants resulting in loss of their business, in addition to their inability to avail the technology. The inequal proliferation of the freedom-offering mobile payments practically widens the gap between the ones with the freedoms and the ones without them.

The results from the data analysis of all the three technologies show that though they were introduced for public welfare with a developmental agenda, they gravely failed to do so. It is, therefore, debatable if eChoupal and mobile payments can be labeled as ICT for development, or yet another technology responsible for the digital divide in low-income economies. See Table 2 for the overview of the comparative analysis.

Table 2: Comparative Analysis of the Three Technology in terms of Sen's Freedoms

	Technology in the Green Revolution	**eChoupal System**	**UPI-Payments**
Economic Facilities	• Increase in farm productivity, disposable income, and decrease in poverty. • Incomes increased disproportionately across classes, rise in economic inequalities.	• Farmers experienced a rise in disposable income, an increase in agricultural yields, and a considerable reduction in transaction costs. • Infrastructure inadequacies like the non- availability of electricity connection, internet, and computer literacy meant lesser participation of the small and medium farmers.	• The various payment facilities availed by the consumers. • Smaller shops and vendors lost business because they were unable to provide the option.
	• The transparency guarantee of the Green Revolution was	• eChoupal can be credited for the removal of	• The transparency by mobile payment

Transparency Guarantees	available to those who either bought or rented the machinery. • Disparities continued to grow even after the initial stages of technological adoption, technology did not even out the inequalities rather reinforced and aggravated it.	middlemen for empowering the farmers, and price transparency. • While there was an improvement in procurement efficiency and a reduction in transaction costs for farmers with access to telecenters and kiosks, the same cannot be asserted for farmers without these.	transactions was helpful for both tracks; trustworthy that the money was received by the lawful recipient (in fund donation). • The trackable transactions were problematic for financially dependent individuals. Their participation reduced as they lost their spending freedom with expenses tracked by their family's wage-earners.
Protective Security	• Drought periods (1937- 1945, 1982- 1990, 1997- 2004 and 2011- 2015) constitute the crisis periods against which the Green Revolution responded to as a policy initiative. • Class differences accentuated as the condition of agricultural laborers and poor peasants worsened during the crisis even after the adoption of the technology.	• Launched in 2000 during the drought crisis of 1997-2004, most farmers experienced a surge in disposable incomes after the eChoupal initiative. • The outcomes of eChoupal are resultant of a plethora of socio-technical arrangements embedded in a casteist society and were not evasive of the caste system.	• Mobile payments offered contactless transactions, which was safe during the Covid-19 pandemic since cash had the risk of carrying the coronavirus. • Smaller vendors did not participate during Covid-19– difficulty in visiting the bank for conversion to cash due to lockdown.

8. Developmental Implications

As discussed in the three examples, although value-neutral per se, a technological intervention cannot be expected to eliminate the highly unequal social structures of Indian society (De', 2009). Often the adoption of technology is expected to benefit everybody equally, which was challenged by this study. The technological intervention was subject to pre-existing barriers to access, resulting in non-availability to all. Our analysis equips us to proscribe certain prominent assumptions made while implementing policies premised on technology, as follows.

1. The policy design has to incorporate societal inequality and have enabling provisions so that the marginalized also get equal access to technology. For example, the M-Pesa mobile payment in Kenya is operable on a basic mobile handset, without the need for a smartphone (Hughes & Lonie, 2007). Similar technology for mobile payments in India would be inclusive to the marginalized unable to afford the cost of a smartphone and Internet.
2. Large scale technological diffusion cannot fundamentally alter the peculiar tenacity of caste in Indian society. As seen in the case of eChoupal, the telecenters did not erase out the caste differences and

homogenize society. Regulations ensuring participation of all castes in ICT4D initiatives could be a step towards reduced caste-based discrimination.

3. Technological intervention runs the risk of not only crystalizing the pre-existing socio-economic inequality but also widening the gaps. Policymakers should be sensitive about regulations discriminating against the sections unable to afford the new technologies. For instance, local government regulations during Covid-19 have prohibited cash transactions (Bhandari, 2020). This is discriminatory towards smaller businesses operating on cash and consumers who do not own a smartphone or afford Internet connection (Pal et al., 2020).
4. The market-based approach by private players, ITC for eChoupal, and mobile payment providers like Paytm, GooglePay, etc. have bolstered both technology adoption and fared better in terms of providing freedoms, in comparison solely public initiative of the Green Revolution. However, while private players have an innovative approach to greater involvement, their objectives are seldom aligned to social good. Therefore, we suggest that government intervention for the operation of private services is necessary to ensure developmental benefits.

While, it is a challenge for a technology to completely eradicate the inequalities incorporated by societal structures, but the conscious design of policy and regulations could reduce its impact. In this study, we bring out the social issues prohibiting the marginalized from availing complete benefits from the technology, to bring awareness towards the persisting issues.

9. Conclusion

ICT4D literature has reported the developmental role of information technologies (Masiero & Prakash, 2019; Tassabehji et al., 2019), with criticisms of how it failed the poor and the marginalized (Harris, 2016). In this regard, we investigate the recent technology of mobile payments, with claims of financial inclusion and socioeconomic development in the literature (Donovan, 2012). We compare it with the developmental role of historic technologies, technologies in the Green Revolution, and the eChoupal telecenters, in terms of Sen's freedoms offered by each of them to the different sections of the society (Sen, 2001). We recurrently analyze from the perspective of participation and find the inequality in terms of freedoms availed by the citizens. While mobile payments have unquestionably offered the three freedoms of economic facilities, transparency guarantees, and protective security, the doubt remains if they were offered to all the citizens equally. The elderly, the women without financial independence, and the smaller vendors without ownership of smartphones were left out from the freedoms offered by this modern financial technology.

A limitation of the study is the possible bias in the secondary data as obtained from the works of other researchers. Since the analysis of the historic technologies was central to our study to evaluate if the role of technology in socioeconomic development has evolved over time, we had to rely on the available sources for the secondary data. A second limitation was the inability to obtain interview data from small vendors using mobile payments. As the period of the study was during the Covid-19 pandemic where marketplaces were mostly under a lockdown or had major visitor restrictions. The time of the study, on the other hand, served well to understand 'protective security' freedom by mobile payments during the crisis. It would be interesting to extend the study to understand the vendor-side perspectives and the freedoms accessed by them or excluded from them due to the proliferation of mobile payments.

APPENDIX

Table A1: Data Analysis for Green Revolution

Inequality Dimension	Policy Outcome	Disadvantaged Group	Advantaged Group	Notes	Data Source
Economic Facilities	Concentration of farm incomes across different strata of farm households	Small Farmers	Large Farmers	1. As farm size increases, income increases disproportionately. 2- Inequalities grew in household incomes from agriculture post green revolution. 2. Inequalities aggravated by difference in factor endowments and resources across farm classes. 3. Green revolution has led to a widening of income gap between small and large farms.	National Sample Survey- 16th and 17th round. (Saini, 1976b)
	Distribution of farm Incomes	Small Farmers	Medium and Large Farmers	1. The gains from technological innovation are not evenly distributed across various classes of farmers. 2. Between 1955- 1970, the disposable income gap between the small and large farmers increased.	(Saini, 1976b)
	Temporal changes in absolute poverty	Small Farmers	Large Farmers	1.Increase in absolute poverty during the initial stages of technological innovation. 2. Poverty is inversely related to level of per capita income. 3. Incidences of poverty is highest amongst small farmers followed by medium farmers, while being absent in large farmers.	(Paul, 1990b)

				4. Poverty is inversely related to level of irrigation in the region.	
Transparency Guarantee	Changes in the relative income positions of farms in the different income classes	Small Farmers and Medium Farmers	Large Farmers	1. Technological innovation embodied by green revolution has an inherent tendency to widen the disparities between small, medium and large farmers. 2. The disparities continue to grow across production cycles and is not restrained to initial stages when there is unequal opportunities for technology adoption.	(Srivastava, Crown, & Heady, 1971b)
	Changes in factor shares	Small Farmers and Medium Farmers	Large Farmers	1. As a result of green revolution, average propensity to invest in non-land inputs increased as farm size increased. 2. Small farmers had higher marginal propensity to consume vis-à-vis invest in non-land input factors.	(Srivastava et al., 1971b)
	Farm income and farm size as an index of wealth ownership	Small Farmers	Large Farmers	1. Inequality of land ownership and farm size has increased from 1968 to 1970. 2. Farm income distribution is more unequal than farm size.	Farm Management Studies: 1968-1970. (Junankar, 1975)
	Pro-rich peasant bias	Small Farmers and Medium Farmers	Large Farmers	1. Expenditure on non-land inputs per acre of cropped area is inversely proportional to farm size. 2. Small farmers spend more on hiring machine inputs compared to medium and large farmers, who invariably buy the same. 3. Technological entrepreneurship of small and medium farmers do not help them substantially in reducing the growing inequalities.	National Sample Survey- 30th round. (Dattatraya N Dhanagare, 1987b)
Protective Security	Relative economic life in perennially irrigated v. dry regions	Farmers of dry areas	Farmers of irrigated areas	1. Polarization that accentuates class differences has been further intensified by green revolution. 2. There exist consistent disparities between the economic conditions of poor peasants and agricultural laborer's household. 3. Widening gap between economic conditions of farmers of dry and wet areas.	(Athreya, Böklin, Djurfeldt, & Lindberg, 1987)

				4. Rural proletariat in wet areas is more specialized, has less non- farm income and is more organized than workers from dry areas.	
	Iniquitous electricity distribution	Small Farmers	Medium and Large Farmers	1. Electricity boards cater to big farmers on a priority basis than small farmers. 2. High installation costs and service connections disallowed small farmers from getting electricity connections.	(Bhalla & Chadha, 1982)

Note: Analysis follows the land holding categorization: Small Farmers: 0- 2.0 Hectares, Medium Farmers: 2.1- 10.0 Hectares, Large Farmers: >10.1 Hectares

Table-A2: Data Analysis for eChoupal

Inequality Dimension	Policy Outcome	Disadvantaged Group	Advantaged Group	Notes	Data Source
Economic Facilities	Better economic and developmental impact of e-Choupal	Small Farmers	Large Farmers	Farmers have seen a rise in disposable incomes due to increase in yields and reduction in transaction costs. However, the small farmers and agricultural laborers have not been able to leverage the advancement in technology due to infrastructure inadequacies.	(Bhatia, 2007)
Protective Security	Reappraisal of existing agricultural extension systems	Small Farmers	Large Farmers	1. Public funding cannot adequately respond to the multifarious demands of agriculture systems. 2. Private extensions ought to be coupled with plurality of institutions so as to maintain parity and equity.	(Sharma, 2002)
Protective Security	Sociotechnical arrangements	Small Farmers and Medium Farmers	Large Farmers	1. The outcomes of yellow revolution are diverse and are the result of interplay between sociotechnical arrangements. 2. The outcomes are not an arithmetic product of intentional actions of either the market or the State.	(R. Kumar, 2016)
Transparency Guarantee	Impact on functioning of rural agricultural procurement market	Farmers without direct access to kiosks	Farmers with direct access to kiosks	1. No general comment can be made about the impact of improved information on wages, investment incentives and poverty faced by different strata of farmers.	(Goyal, 2010)

				2. Improvement in procurement efficiency reduces transaction costs for farmers with access to technology like internet, kiosks and tele- centres. 3. No conclusion about diminishing social inequalities can be made in light of the earlier two assertions.	
Transparency Guarantee	Concentration of farm incomes across different strata of farm households	Small Farmers	Large Farmers	1. Iniquitous and counterrevolutionary impacts of technological intermediation. 2. Yellow revolution's impact was subsidiary to the contingent assemblage of powerful social actors.	(R. Kumar, 2016)
Transparency Guarantee	Productivity in agriculture	Small Farmers	Large Farmers	1. Accelerated transformations in information technologies of agrarian markets are biased towards the rich peasants. 2. The removal of middlemen and the prioritization of corporations is instrumental for farmers' empowerment. However, this empowerment is skewed.	(Siegel, 2017)

Note: Analysis follows the land holding categorization: Small Farmers: 0- 2.0 Hectares, Medium Farmers: 2.1- 10.0 Hectares, Large Farmers: >10.1 Hectares

Table A3: Summary of themes identified from interview data for mobile payment technology

	Themes for Positive Support	Themes with None/Negative Support
Economic Facilities	1. Payment for goods and services- grocery, online food ordering, phone recharge, cabs, local merchants 2. Economic benefits -cashbacks, no need of exact exact change, international payments;	1. Unable to use without a bank account 2. Preference for cash usage 3. Mobile payment not accepted by some merchants and vendors 4. Preference for debit/credit cards 5. Unable to avail economic facilities due to Internet connectivity issues 6. No interoperability across payment apps 7. Inability to use smartphones for financial transactions
Transparency	1. Tracking past payments- budget, record for share expenses with others for splitting money 2. Refund of money due to technical issues 3. Reduction of bribery due to digital records 4. Transparency in donations due to acknowledgment	1. Transaction failures and errors leading to low trust 2. No tracking needed for small payments 3. Inability to completely eradicate bribery 4. Sometimes the merchant identity is not visible 5. Low trust due to security and privacy issues- Payment apps not always connected to legal identity documents, social hacking, fear of thefts

	5. Trustworthy- detailed record of transactions, traceable	
Protective Security	1. Adoption of mobile payments during demonetization 2. Easy donations during Covid-19 – trustworthy channel 3. Regulations to reduce cash usage due to chances of coronavirus transmission- no contact cashless transactions	1. Continued use of cash during demonetization 2. Preference of cash usage by merchants during Covid-19 to avoid bank visits 3. Trust issues with technology due to high financial fraud reports during Covid-19

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