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ARTICLE

Jugaad Infrastructure: Minor infrastructure and the messy aesthetics of everyday life

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Abstract

Jugaad is an Indian name for versatility and improvisation, a sensibility for improvisation, an ability for improvisation and an enabling of improvisation. This paper proposes the idea of Jugaad Infrastructure for versatile socio-material infrastructure arrangements that inhabit and thrive in the messy aesthetics of everyday life. It does so by extending the focus of infrastructure geographies from 'big stuff' to little devices such as solar lamps that gain significance when deployed in big numbers. The paper advances two ideas. First, it argues that *jugaad* circumvents the formal–informal boundary set by designers. By piercing this boundary, *jugaad* affords more fluid socio-material relationships involving infrastructures and their users. In so doing, *jugaad* affords versatility. Second, it develops the idea of Jugaad Infrastructure. Jugaad Infrastructure folds two things into it. First, infrastructures that are designed in ways that facilitate *jugaad*, albeit within firmly maintained boundaries and attempt to capitalise on people's aptitude for *jugaad* to take different forms, inhabit different spaces, enable different purposes and all this while somewhat retaining their shape. They are easy to maintain. This helps them travel to, function and stay in different places. In this way, small devices spread around in large numbers to become big infrastructure. Second, it represents the ensembles of fluid socio-material relationships and resources involving infrastructures and their users through which infrastructures are tailored to 'better' fit everyday lives and needs. Jugaad Infrastructure inhabits the liminal spaces of struggle between designers claiming *jugaad* as a limited practice that leads to stable innovations and users deploying unlimited jugaadas an everyday practice of socio-material flux. The paper is based on qualitative research conducted in India during 2012–2013, 2016 and 2017 using participant observations, discussions and interviews with users, entrepreneurs, market players and designers, in addition to documentary evidence from reports and websites.

KEYWORDS

development, India, Jugaad Infrastructure, postcolonial infrastructure, solar

1 | INTRODUCTION

This paper is about *jugaad*. In northern India, the term *jugaad/jugaar* variously refers to improvisation, making-do, hustling, frugal innovation and risky ways of circumnavigating formal/legal processes (Badami, 2018; Kaur, 2016; Kumar, 2021a; Narayanan, 2019; Roy, 2011a, 2011b). In southern India, other phrases point to similar ideas: '*thattikootu* (to "put together") or *oppeeru* ("fixing" or "getting") in *Malayalam*; or *mazhattu* (to distract) in Tamil' (Narayanan, 2019). Similar constructs are culturally embedded in many parts of the world. For example, the Krio term *dreg* in Sierra Leone points to hustling, while *kukiya kiya* in Zimbabwe speaks of making-do (Jones, 2010; Shaw, 2014). This paper is also about small infrastructures that aim to make big impacts. Two solar lamps, one enables *jugaad*, and the other does not. One is versatile, and the other is not. Versatility makes one lamp useful in different spaces of everyday life. In addition, these infrastructures, often 'deployed' in places not yet fully plugged into global networks of supply, repair and maintenance, need to be locally repairable. This paper establishes the importance of *jugaad* enabled versatility by using examples of solar lamps providing access to energy.

The material and moral effects of solar lamps are such that many occupy prominent spaces in imaginaries of the human past and future. d.light's Nova was part of the British Museum's exhibition, 'A History of the World in 100 Objects' (Cross, 2013) and Little Sun Diamond designed by artist Olafur Eliasson was part of V&A's exhibition 'The Future Starts Here' (Ball, 2018). According to the UN, there are about one billion people around the world without access to electricity. [1] The UN designated energy access for all as the Sustainable Development Goal 7 (SDGs) in 2015 and its sustainable energy for all initiative, with a motto of 'going further, faster – together',[2] demonstrates a sense of urgency in scaling up energy access projects. Alongside this, a wider discourse of a development marketplace has emerged. It puts faith in market-based humanitarianism and development to achieve these results (Davies, 2018; Ranganathan, 2018). This market ethos promises to transform citizens into stakeholders and paying shareholders. While the promise of 'improvement' falls in line with a 'will to improve' embedded in colonial and postcolonial development interventions, 'there is also a rupture … in terms of the use of market-oriented' nature, and deep embedding into neoliberalist and financialisation logics (Ranganathan, 2018, p. 16). Sitting in this milieu, this paper also sketches a story of a neoliberal co-option of *jugaad*. But as the paper reveals, *jugaad* almost always exceeds the limits of neoliberal co-option.

In the development marketplace, UN agencies, government bodies, non-governmental organisations and private companies often discuss barriers to upscaling, that is, making small infrastructure like solar lamps big through their deployment in large numbers. These barriers invariably point to a lack of finance and adequate policy frameworks (CLEAN, 2015; Malhotra et al., 2017). The designs of these small infrastructures seldom come up as if all energy infrastructures are equally useful. When the design is in focus, it is mostly about business models and project designs (Wilson et al., 2012). Yet, the field of design has long captured the human imagination (Latour, 2008; Schwittay, 2014). Most solar companies promise appropriate designs to bring access to sustainable energy, and with it, education, good health and livelihood opportunities. However, explorations of how designs of these small infrastructures come to matter in people's everyday life are few (see notable exceptions (Balls, 2016; Munro, 2020; Samarakoon et al., 2021)). This paper sets out to investigate how infrastructure design matters in everyday life.

This paper advances two ideas. First, it argues that *jugaad* circumvents the formal–informal boundary set by designers. By piercing this boundary, *jugaad* affords more fluid socio-material relationships involving infrastructures and their users. In doing so, *jugaad* affords versatility. Second, it develops the idea of 'Jugaad Infrastructure'. Jugaad Infrastructure folds two things into it. First, infrastructures that are designed in ways that facilitate *jugaad*, albeit, within firmly maintained boundaries and attempt to capitalise on people's aptitude for *jugaad* to take different forms, inhabit different spaces, enable different purposes and all this while somewhat retaining their shape. They are easy to maintain. This helps them travel to, function and stay in different places. In this way, small devices spread around in large numbers to become big infrastructure. Second, it represents the ensembles of fluid socio-material relationships and resources involving infrastructures and their users through which infrastructures are tailored to 'better' fit everyday lives and needs. Jugaad Infrastructure inhabits the liminal spaces of struggle between designers claiming *jugaad* as a practice that leads to stable innovations and users deploying *jugaad* as an everyday practice of socio-material flux.

Sections 2 and 3, with a discussion on geographies of infrastructure and an exploration into the idea of *jugaad*, provide the conceptual background and analytical apparatus for this paper. Section 4 explains the case study and methods. Section 5 presents empirical material from ethnographic research conducted on two specific solar lamps to illustrate situated acts of jugaad enabled or disabled by somewhat open or closed designs. Finally, Section 6 explains the idea of Jugaad Infrastructure to understand the role of *jugaad* within infrastructure studies.

2 | GEOGRAPHIES OF INFRASTRUCTURE: SMALL INFRASTRUCTURE, BIG DEVELOPMENT

At the Royal Geography Society Annual Conference in 2019, in a panel on infrastructures, I was struck by an audience member's surprise over the framing of bus stops as infrastructure as they had only ever thought of big, interconnected networks of electricity wires and water pipelines or big dams and power stations as infrastructure. Indeed, in normative and popular imaginations, infrastructure is 'big stuff' (Anand et al., 2018). For example, Cowen (2020, p. 481) sees infrastructure as one dominated by global 'finance capital, smart city tech companies, and logistics and extractive industries' and exemplified by China's One Belt One Road initiative. Similarly, Sundaram (2015, p. 3) understands electricity, roads and water pipes as 'infrastructures that were the hallmark of a new modernity'. The big or grand idea of infrastructure, networked or otherwise, speaks to grand narratives and designs of modernity, embedded within colonial and capitalist logics (Björkman, 1991; Jain, 2020). For postcolonial states and 'emerging' economies, big and grand infrastructure reflect prestige (Howe et al., 2015), as epitomised by Nehru's vision of Dams as modern India's temples (Guha, 2008). These big or grand ambitions articulated through an imaginary of infrastructure as big stuff have been critiqued for privileging 'imperial vision, grand territorial ambitions and the "mastery of nature"' while promoting 'masculine, Eurocentric and/or colonial and heteronormative imaginaries' (Siemiatycki et al., 2020, p. 301).

In this context of infrastructure as big stuff, anthropologists working on solar lamps and humanitarian healthcare interventions have proposed the idea of little development devices (Collier et al., 2018). Collier et al. (2018, n.p.) explain that these little devices are 'designed to produce immediate, measurable and testable outcomes, and to rely on individuals or communities as both agents of development and arbiters of value'. They target the 'infrastructurally marginal', that is, people and places that are not plugged into big infrastructure (Collier et al., 2018, n.p.). This question of small/little devices versus big infrastructure becomes relevant also because small devices like solar lamps gain prominence only when they show the capability to be deployed in big numbers (Kumar, 2021a). This is an outcome of the fact that policy-makers, funders and practitioners often look to deploy infrastructure that can work as fragments in infrastructural marginal spaces, yet are standardised and integrated into a bigger whole as part of various national and global networks (Brown et al., 2017). These infrastructures are valued as small but are valuable when their impacts become big. The solar lamps that appear in this paper are all fragmented in their deployment and the individual devices do not bring large-scale changes or radical transformation. They primarily empower individuals who gain benefits from stand-alone systems. However, their proponents aim to deploy them at large scales and make big societal impacts. With big impacts, these small infrastructures often show traits of high modernity and grand national ambitions once solely associated with big infrastructure. This tension between being small and 'becoming big'—individually small devices that gain meaning when deployed in large numbers—makes infrastructure a useful analytical lens.

A related point here is that infrastructures are deeply embedded in and infused with the idea of improvement. As Ranganathan (2018, p. 3) notes, the ideas of development and improvement embedded in infrastructure also manifest as 'betterment' and 'regularization', especially when targeting poverty. Yet, infrastructures are always a site of struggle, not only because infrastructure are often invasive but also because people expect different 'improvement' outcomes from infrastructure (Li, 2007). For Sundaram (2015, p. 3), infrastructure 'became locations for new conflicts and claim-making'. While people hold different meanings for and expectations of infrastructure they encounter, Simone (2004) persuasively argues that people and their networks could be understood as infrastructure. Simone (2004, p. 407) observes that the continuously 'flexible, mobile, and provisional' combinations of 'objects, spaces, persons, and practices' that help maintain subaltern spaces and lives, depend on people's ability to pull together these complex combinations. These alignments of objects, spaces and people 'become an infrastructure' (Simone, 2004, p. 408). These socio-material infrastructure often reveal different scenarios 'of putting together people and things' that might conflict; yet people let productive and not-so-productive scenarios play out (Simone, 2021, p. 3). In this way, a delicate dance of acceptance and resistance plays out within these socio-material infrastructure. Some infrastructures are more amenable to these scenarios and others resist or actively *attempt to* discourage them. The small devices becoming big infrastructure happens through a combination of material and people and involves spaces and different scenarios of/for *jugaad*. Small devices become big infrastructure when deployed with logics of *jugaad*.

3 | *JUGAAD*: AN AESTHETICS OF POSTCOLONIAL INFRASTRUCTURE AND MESSY EVERYDAY LIFE

Kaur (2016) informs that *jugaad*, a Punjabi word, popular across northern India, is a variation of the Hindi word jugat, itself derived from Sanskrit *yukti*, with roots in *yog* meaning union or joint. While *jugat* means contraption or idea and yukti means tactic, Kaur (2016, p. 314) explains *jugaad* as 'skillful reasoning, argumentation, trick, cunning device, adaptability, adjustment, being inventive, dexterous and clever'. Rai (2019, p. 6) defines *jugaad* as 'an everyday practice that potentializes relations that are external to their terms, opening different domains of action and power to experimentation'. *jugaad*, then, is an Indian name for versatility and improvisation, a sensibility for improvisation, an ability for improvisation and an enabling of improvisation. A wider socio-spatial structure embeds an infrastructure in ways that enable, foster and fester improvisation making infrastructure more versatile in myriad ways, some formal, some informal, some legal and some extra-legal (Rai, 2019). *Jugaad* is not limited to engagement of material infrastructure. It sits within the realm of the socio-cultural, with *jugaadu* people (improvisers) drawing on social, cultural, political and material resources to bend and twist unfavourable alignments into somewhat favourable ones. In many ways then, *jugaad* epitomises infrastructure: the subterranean, in the background and under the radar.

Badami (2018) explicates that *jugaad* inhabits a curious and uncomfortable space in which socio-material relationships are imagined and explained in two conflicting ways (see also, Narayanan, 2019; Rao, 2010). The first *jugaad* is a source of innovation, as imagined by management gurus and prized by companies. For example, Prabhu and Jain (2015), using several Indian examples like solar lighting solutions argue that *jugaad* leads to frugal, flexible and inclusive elements in 'innovations'. They translate *jugaad* as frugal innovation. Radjou et al. (2012) frame this as *jugaad* Innovation. For some, this 'innovation narrative offers an uplifting, potentially emancipatory discourse of mobility in a setting where... wealth gap and poverty stubbornly persist' (Kaur, 2016, p. 315). This idea of frugal innovations drives many solar lamp designers and energy access entrepreneurs (Balls, 2016; Sinha, 2011). The second *jugaad* is a source of social disruption, corruption and systemic risk. For example, Jeffrey and Young (2014) explain how owners and brokers of private colleges in Uttar Pradesh, India use 'shady' tactics to get ahead and legitimise these as *jugaad*. Similarly, Jauregui (2014), in their ethnography of police work in Uttar Pradesh, shows that citizens and police officers legitimise 'corrupt' practices by framing them as *jugaad*. These practices are inherent to the functioning of the Indian state and its everyday 'meetings' with citizens, a form of '*jugaad* state' (Chattaraj, 2019).

However, rather than being trapped in the dichotomy of valorisation of *jugaad* as innovation versus deriding of *jugaad* as risk and corruption, it is useful to look at Rai's (Rai, 2019, p. 4) suggestion that the 'minor practice of tweaking ... is called *jugaad*'. Here, *jugaad* is about 'vibrations between the is and the ought' to be (Rai, 2019, p. 5). As the following sections show, slick-looking solar devices with clean and neatly fitting aesthetics exemplify and embody modern innovations but their effective use in rural homes in the messy aesthetics of everyday life is premised on exceeding/receding boundaries of these slick innovations. Therefore, *jugaad* facilitates a heterogeneous set of practices (Simone & Rao, 2012). It sits between the formal and the informal and affords informal uses and practices of the formal and within the formal. Within the idea of *jugaad*, 'formality/informality and legality/illegality work together' (Narayanan, 2019, p. 13).

Concepts similar to juggad exist within infrastructure geographies scholarship. Heterogenous infrastructure represents the 'mixing of two (or more) kinds' of indeterminate socio-material infrastructure beyond the formal/informal binary (Lawhon et al., 2018, p. 725). This is different from the idea of hybrid infrastructure which primarily draws on science and technology studies to represent social and material components of technology and not necessarily their mixing, although still challenging the formal/informal binary (Lawhon et al., 2018, p. 725). Finally, the idea of bricolage is widely used to indicate arrangements that bring together modern and traditional, and formal and informal (Munro, 2020). In all these instantiations, there is a unified push to destabilise the formal–informal binary, which *jugaad* fits with. However, there are two main differences which make *jugaad* a different and useful interlocutor here. First, these three ideas primarily relate to infrastructural (and institutional in the case of bricolage) thinking whereas *jugaad* draws from and refers to a widely prevalent socio-cultural idea that permeates all manners of dealings in a person's everyday life. Second, although this paper relates to infrastructurally marginal spaces, *jugaad* is not limited to marginalised spaces and people. It is as much applied by elites as by the subaltern. Therefore, *jugaad* presents itself as a novel and more encompassing idea to further the repertoire of Southern Theory within infrastructure geographies.

4 | CASE STUDIES AND METHODS

Following Cowen (2020, p. 471), methodologically this paper is driven by the question: what could we learn when we take 'infrastructure as both an object and method of inquiry'? This paper follows small infrastructure—solar lamps—through the process of design, use and repair, illuminating moments of *jugaad* in action through the lives and afterlives of infrastructure. While Graham and Thrift (2007) argue that infrastructures become visible only when they fail or demand repair, here the 'resistance and refusal' of people to engage with particular infrastructure, especially in spaces of infrastructure marginality, keeps infrastructure consistently foregrounded (Cowen, 2020, p. 480). As Anand (2020, p. 52) explains, 'breakdown and infrastructural visibility are ubiquitous and particularly noticeable' on the margins. Everyday work involved in ways and provisions of hanging, positioning and hooking often mediate the socio-material infrastructure people engage with, the everyday work that falls under the idea of *jugaad*. At the same time, these situated acts of *jugaad* also illuminate 'the struggles over infrastructure' and thereby, reveal 'alternative intimacies based in alliance, mutuality and solidarity' (Cowen, 2020, p. 483).

This paper follows these situated practices of *jugaad* around two solar lamps/lanterns, Village Light (VL) and Sun King (SK).[3] VL is a start-up that makes solar kits through which entrepreneurs can charge and rent several solar lamps (Figure 1). It initially used SK lamps as part of its kits and then hired an Indian firm to design proprietary lamps. In 2016, VL gradually replaced all SK lamps with its lamps and from this point on, VL's new kits consisted solely of its lamps. If an SK lamp in the older kits broke down, VL replaced it with its new lamp.

FIGURE 1 Old VL kit with SK lamps in VL kit in 2016 (top left). VL kit after SK lamps were replaced and the villagers demanded stands in 2017 (top right). VL kit in a new village in 2017 where people had not experienced SK lamps (bottom). In the bottom picture from right to left—cube, router and lamps (Author, 2016, 2017).

The comparability of the two solar lamps goes further and speaks to the process of frugal innovation and dissemination of infrastructure in the off-grid solar sector. VL and SK follow similar innovation trajectories. Young, male, undergraduate engineering and design studies students developed ideas during research and humanitarian work in Indian villages. Rutger, a founder of VL, worked in an unelectrified village of Madhya Pradesh in 2013 while following his university degree in the Netherlands. A decade earlier, in 2005, three young, under 30, male students and friends at a US university set up Greenlight Planet (GLP), the makers of Sun King lamps. One of the founders, Patrick, developed village electrification solutions by volunteering with Engineers Without Borders in Keonjhar in Orissa. VL and SK have identical problem definitions centred on problems of education, health and livelihood created by a lack of access to 'modern' energy and both companies seize market opportunities created by global 'sustainable development' concerns. Normatively, solar is sustainable, and energy helps development (Kumar, 2018).

This paper is primarily based on qualitative research conducted in the Bihar state of India during February 2016 and September–October 2017 focusing on the set-up and operations of VL. During this time, I accompanied VL field agents to five villages where their energy kits were installed or were being installed. These kits had varied histories—having used SK lamps, gone through the transition to VL lamps and having never seen SK lamps—which informed the comparative understanding of the two lamps. I interacted with six entrepreneurs and formally interviewed four. I also interviewed two VL field agents and had several informal discussions as I shadowed them while selling new kits and troubleshooting and fixing old ones. The data collected for this paper builds on my earlier rounds of fieldwork on energy access infrastructure in Bihar from August 2012 to February 2013 and in other parts of India from September to November 2016. I first encountered SK lamps in 2012–2013. A research team member interviewed the Indian firm that designed the VL lamps and the kit in Bengaluru in 2017. Here, they focused on the choices and learnings that went into the design. The designers led this open conversation bringing up ideologies and issues important to them. Finally, I collected documentary material from reports and websites of both companies and drew on news articles and popular publications.

The analysis and writing were led by the empirical findings which opened the doors for conceptual reflections. In writing, I have tried to give voice and space to research participants and looked for convergences and divergences in them. All places and people associated with VL have pseudonyms.

5 | INFRASTRUCTURES OF *JUGAAD* AND MESSY EVERYDAY LIFE

Illustrating examples of everyday work of hanging, positioning and hooking-up that come under the idea of *jugaad*, this section explains how designs enable or disable *jugaad* and make infrastructure more versatile or less versatile. The discussion proceeds through three stages of the life of infrastructure. First, what is considered in the design process? Second, what happens to the infrastructure in spaces of everyday life? Third, how are questions of repair and maintenance addressed?

5.1 | Of sanitised, cleanly fitting aesthetics: design for standardisation and optimisation

VL designed its lamps in India to be closer to its users. Yet, the messiness of the everyday life which the lamps are supposed to embody and inhabit was decentred in the design process. Although, like every other infrastructure, VL aims to change the lives of its users, their preferences and practices went into the lamp's design superficially. VL has two different sets of designers. The founders of the company designed the overall concept in which the lamp works as a part of a larger kit owned by a village entrepreneur. An Indian design firm, ID, in conversation with the founders, developed the physical design of the solar lamp and other components of the kit. An ID designer explains the thinking process:

> What matters is that how much value this product can bring in.
>
> [....]
>
> Probably it has to do with solving the logistical problem, the sourcing problem, the sustainability problem. You know, creating technology benefit for them [VL]. So we found out that the value creation does not stay in a particular domain or for a particular stakeholder. Value creation should happen across multiple

> stakeholders, and for me, the stakeholders are not only the buyers of the product. It's the manufacturers, the producers, the logistics guy, the maintenance guy, the sourcing, the after-sales service guys.

The design firm's concerns are very different from that of the solar lamp users. Due to their familiarity with SK lamps and SK's market success, VL asked ID to use SK lamps as an inspiration (ID Interview, 2017). This was also evident on ID's website, which uses many photos of SK while describing the VL design process. The designers spent considerable time explaining how numerous concerns beyond the use of the lamps mattered for the design process. They made several design choices to reduce manufacturing costs and complications. While considering a holistic picture is important for infrastructure like solar lamps that need to travel to distant and marginal (and marginalised) places and maintain low costs, in the VL lamp design process, concerns other than user needs end up weighing more and the room for thinking about the spaces of people's everyday lives is constrained. The focus is on the optimisation of design, so the lamps perform in a narrow, standardised setting rather than a wider versatile range.

Designing lamps to achieve clean and neatly fitting aesthetics of standardisation and uniformity was also key for the lamp designers. The VL router and cube, designed before the lamps, were rectangular (Figure 1). SK lamps are circular. The designers explained that VL lamps needed to have the same form factor as the router and the cubes, making them 'siblings'. As a result, the same packaging could be used for all products, minimising logistics expenses and complications.

> We were adamant that the lamp has to be the form factor of the cube because sometimes you charge the cube and the lamp. So, the cube and lamp are nothing but two objects which can be charged.
>
> [....]
>
> He [VL founder] was trying say make it like that [SK], sleeping product.[4] So, we were saying that no, no, the lamp has to be a standing product.
>
> [....]
>
> We felt that if stackability is taken care, then there is a delight. There is a design delight you get when you discover that this is possible.

The ID designers explained the advantages of stacking. VL lamps can be kept close to each other and due to the rectangular standing design, their lights combine to form a bigger light. This is not possible with round-shaped sleeping SK lamps. However, in villages, most people could afford to rent only one lamp at a time, and while stacking multiple lamps to make different size lights theoretically makes VL somewhat versatile, practically the everyday economies of the spaces it inhabits rule this out. ID designers explain the logistical advantages of stacking in VL cubes:

> The cube as a product itself can stack one over the other. Four cubes can stack on top of the router. It is quite intuitive for somebody to take a smaller cube and put it on top of the larger router.
>
> [....]
>
> I felt that in the market when somebody is handling more than 8 or 9 battery cubes, they will have a problem of how to...it's like managing couple of bottles which are circular.

Crucially, the designers explain that they saw cubes and lamps as interchangeable and that replacing a cube with a lamp would not disturb the 'family'. From a design aesthetics perspective, both objects charge from the router, look similar and can replace each other. Indeed, aesthetics and beauty have become key features for 'responsible' designers working towards 'user-centred, humanitarian design' (Redfield, 2015, p. 163). To achieve the clean and neatly fitting aesthetics of design uniformity and facilitate easier logistics, the lamp ended up being rectangular rather than circular. But this is a particular kind of aesthetics, an aesthetics of sanitised, cleanly fitting objects. This is very different from the aesthetics of the villages and aesthetics with *jugaad*, an aesthetics of messy everyday life in motion.

Within this messy aesthetics of everyday life, lamps and cubes differ enormously. While lamps provide only lights, cubes can light bulbs, charge phones and run TVs and fans. Cubes can replace the lamps, but not the other way around.

While the aesthetics, design harmony and logistics elements of VL lamps are useful, the design of these lamps, as the next section explains, is not ideal for their actual use. Harmony, aesthetics and logistics are important factors but here they come at the cost of usability. This decentring of the main users follows Latour's (Latour, 2008, p. 2) proposal that design 'has grown in comprehension' and come to represent various acts ranging from planning, calculation and arrangement to packaging, projection and disposal.

I first encountered SK in 2012 during fieldwork in Bihar. Although SK was not the prime case study for my research, it was almost impossible to ignore its presence in the villages. After about six months of fieldwork and an interview with an SK entrepreneur, I wrote in my field diary on 6 February 2013:

> He brought it to me and hung it to the ceiling. I think SK lanterns are the most versatile, minimalist, and strong among the lanterns I have seen until now. They can and are being used as cycle headlamps too.

SK lamps provide a good example of the trade-offs between aesthetics and logistics, and use. The lamp and solar panel fit with some difficulty in a square box supplied by the company. The round lamp sometimes bulges out. The lamp comes with a long, curving metal stand that does not fit in the box and is given separately to the customer. The stand is awkward and inconvenient to transport, and aesthetically not very pleasing, but SK does not let go of it (Figure 1). There are five different sizes of SK lamps, and the stand is part of every lamp. It affords the lamp some of its versatility by encouraging informal uses and practices within and around the formal design. This is evident on the lamp's packaging where images illustrate various suggested uses (Figure 2). With the stand, one can use the lamp as a reading light, place it in a corner and direct the light to the whole room or hang it from the ceiling. One can remove the stand easily and carry the lamp. The use of the stand is evident from the fact that VL was forced to provide stands with their lamps when they replaced SK lamps in their kits. While the square shape and compact size of VL lamps make them logistically easier and cost-effective to travel to new places as part of the kit, this happens at the expense of their local mobility and capability to inhabit different spaces in these places. SK's design encourages *jugaad* to afford multiple purposes and helps occupy multiple spaces. Such encouragement could be understood as a neoliberal co-option of *jugaad* where SK, a private company in the development marketplace adopts logics of *jugaad* within carefully managed parameters to sell 'better' products.

5.2 | Of messy aesthetics of everyday life: socio-material infrastructures of *jugaad* I

> A: could you make various uses with that [SK] one?
>
> R: we cannot do that we this [VL] one. That is why many people liked that [SK] one more.
>
> Rajni, VL field executive

> [Pulls out an old SK lamp and demonstrates different functions]
>
> The special feature (*khaasiyat*) is that this [SK] goes up to a distance and works like a torch. And of course, it's good for studying [switches to another setting of the lamp]
>
> If one has to go to the fields or granary or has to do some work, this works like a torch.
>
> [....]
>
> If one had to change this [VL lamp] then the system from the old light, the torch system, something like that will make this system better.
>
> Babu Bhaiya, Entrepreneur, Minabazar

Solar lamp companies often target unelectrified rural areas with pitch-dark environments and without any other bright sources of light. In such environments, bright lights from solar lamps produce pronounced cultural and material effects (Kumar, 2015, 2021c). To understand how *jugaad* helps solar lamps inhabit different spaces and create different

FIGURE 2 SK Pro box with images of suggested uses.

effects, I take examples of three everyday spaces that came up frequently during the 2016–2017 fieldwork in the villages: spaces of focused work like studying or stitching, mobility space and ambient spaces like rooms, shops and fields. The following subsections together illustrate how SK lamp's design fosters *jugaad* by hanging, positioning, hooking up, rappelling down and helping it inhabit multiple spaces of messy everyday life. VL lamp fails to do this, a sentiment reflected in Rajni's quote above.

5.2.1 | Spaces of focused work

A source of light can easily dazzle the eyes owing to its design and placement in a space. The dazzling effect is more pronounced if people are close to the light source. For focused work, like stitching, sewing or studying, people need to place solar lamps in close proximity to benefit most from the limited light. Research participants explain that to avoid dazzling, the design of lamps needs to be such that the light focuses on the workspace and away from the eyes, as one regularly experiences with table lamps or reading lamps. Mohammad Yusuf, a VL entrepreneur and user in Rampur village, explains:

That [SK] was convenient for studying. One could fix it on the stand, place it in front, and keep studying. Even if you tilt this one [VL], the light keeps coming (to the back) and dazzling the eyes.

[....]

People place the lamp on one side of the sewing machine. They used to tilt [SK] towards the machine, and the light did not come to the face. Wherever you hang this one [VL], the light comes to the face. If the light comes to the face then you cannot see anything below that [due to dazzling].

A: but why do you need to keep it so close? You can hang it on a side.

The light does not travel that far. You cannot see the stitching properly.

Dazzling relates to the lamps' design. Solar lamp companies refer to lamps meant for such focused work as task lights. This market segment has solar lamps with wider bases or smaller light-emitting parts to direct the light. Many solar lamp companies like d.light[5] manufacture separate models of task lights to capture the spaces of focused work. SK lamps have wider bases than their light-emitting parts. A wider base directs the light forward and stops it from coming backwards (Figure 1). This prevents the eyes of a person sitting behind the lamp from dazzling. The base of the VL lamp is roughly the same width as the light-emitting part (Figure 3). In addition, the size of its light-emitting portion is considerably greater than the base.[6] This means that the light dissipates in all directions, including behind the lamp where the person studying or working might be sitting. It dazzles the eyes and makes focused work like studying or sewing difficult.

5.2.2 | Mobility spaces

A solar lamp is not a bicycle headlamp. Using solar lamps as cycle headlights is a *jugaad* afforded design.

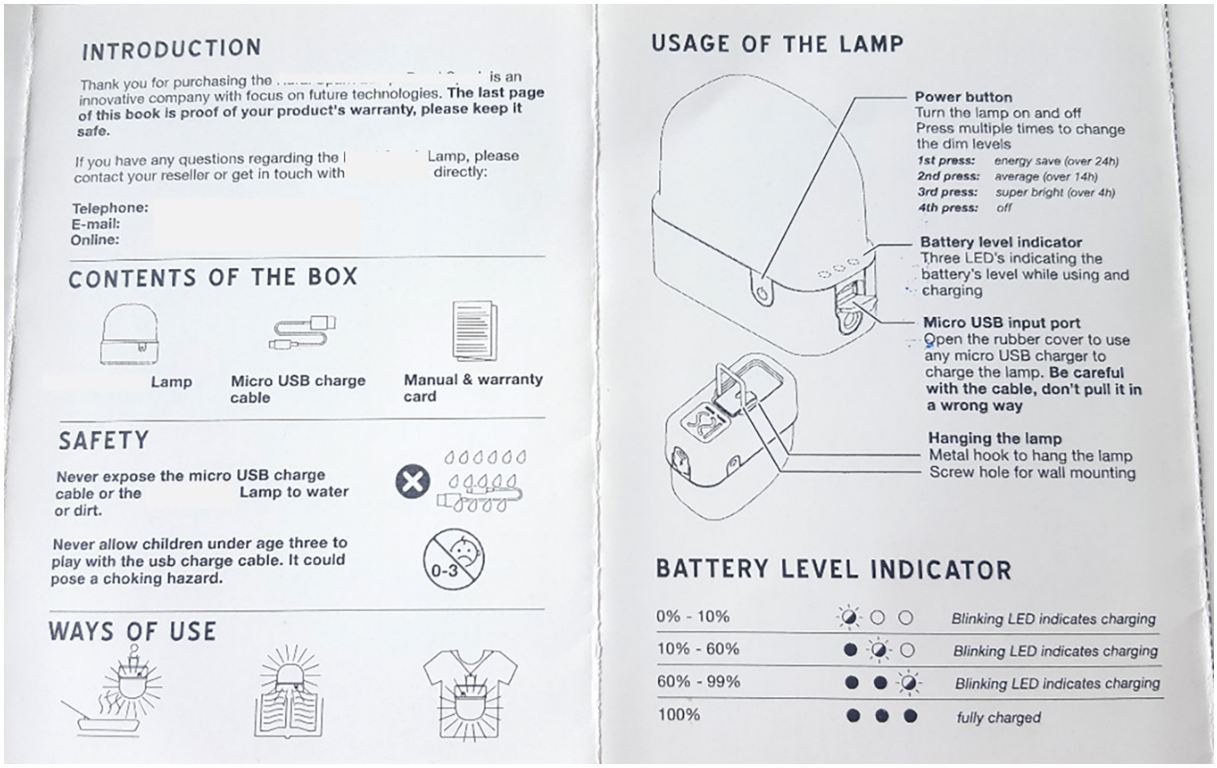

FIGURE 3 VL instruction manual explains different ways of using the lamp. The small foldable hinge can be seen on the right. Most lamp users never see this manual as the kit comes with only one manual for the entrepreneur.

> The old [SK] lamp was better because it had provisions that facilitated its handling in different ways – the strap at the back, the long stand that people put around their neck while cycling and used the lamp as a torch.
>
> Radheshyam, lamp user, Minabazar (paraphrased)

SK lamp's long, unwieldy stand comes into play. Cycles are the most common mode of transport in Indian villages, most often used by men. As Mr. Radheshyam explains, people put these stands around their necks and used SK lamps as headlamps by pointing them forward. This is not possible with VL lamps, as they do not come with stands. VL advises in its user manual that lamps can be hung to the neck like lockets (Figure 3). SK lamps have a strap at the backside, which helps attach the lamp to the cycle handlebar or the rider's palms. The light points forward and one can ride comfortably. The wide back of the lamp helps too. Mr Yusuf explains:

> If one has to go on cycle somewhere at night then they can slide that [SK] onto their palm. Then ride comfortably while holding it. There was no light coming back to the eyes. The light used to go straight ahead. Even if you hold this light [VL], it comes back. It is open [at the back] you see.
>
> [....]
>
> I ride with this [VL] also. Then I have to keep it on a side. If you put it on the steering, then you get a glare in the eyes. Then you cannot see ditches on the roads. I keep my hand low and rid with one hand [on the steering].

Like the spaces of focused work, the wide bottom directs the light forward and saves the eyes from glares. Glares are especially dangerous in mobility spaces. Village roads are often littered with pot-holes. Mr. Yusuf is a travelling salesperson who loads bags full of biscuits on his cycle and rides to faraway villages, usually returning after nightfall. In this situation, having a headlight while also managing to keep both hands on his handlebar is very useful. He explains that due to a lack of a strap or stand, and its light spreading in all directions, this is not possible with a VL lamp. SK's design facilitates *jugaad* solutions to occupy the mobility space better than RS.

5.2.3 | Ambient spaces

In ambient spaces like domestic living rooms and shops, the use of light is very different from the spaces of focused work and mobility spaces. Here, light needs to spread in all directions and illuminate the wider general area. Such ambient lighting helps people see each other's faces and locate things. In a living room, where a family might gather to chitchat or have dinner, glare is less problematic as people often do not need to put concerted focus on things. Similarly, in village shops, shopkeepers not only need to light up the general space to locate items, but also to indicate that they are welcoming customers and visitors (Kumar, 2018).

In such spaces, both lamps perform well. If hung from the ceiling, or placed in a corner of the room, SK lamps light the whole space. Due to their uniform design, and a proportionally bigger light-emitting part, VL lamp light also spreads in all directions. However, acts of *jugaad* facilitated by SK's awkward and unwieldy stand play a role here. Mr. Yusuf explains:

> There is a difference. Although both lights are good. But we have to look for facility/provisions (*suvidha*) for hanging this (VL). That [SK] had a stand [which could be easily hung from the ceiling].

The stand works as an instrument that readily converts itself into a long hinge to hang the lamp from the ceiling and turn it into a light bulb. VL lamps also have a hinge for hanging and a screw hole for wall mounting. This small foldable hinge cleanly and beautifully disappears into the lamp's body (Figure 3). VL 'offers the beauty of clever design' (Redfield, 2015, p. 165). This makes the lamp compact, and easy to pack and travel with. However, the hinge is not very handy for hanging. Due to its small size, people must hang it too close to the ceiling, which requires more everyday work like standing on a chair or a table to reach the ceiling to hang the lamp. SK's longer stand helps reach the ceiling more readily, with the lift of an arm. To hang the VL lamp to the ceiling, most people tie a rope to the ceiling that hangs down to a convenient height. Alternatively, they tie a rope to the hinge of the lamp and then tie the rope to the ceiling. While

both lamps light this space equally well and facilitate various practices of *jugaad*, SK's stand makes it more readily and conveniently amenable to *jugaad*.

5.3 | Of maintaining (in) the messy aesthetics of everyday life: socio-material infrastructures of *jugaad* II

Repair is invariably improvisational when carried out in 'infrastructurally marginal' places like the far-off villages where solar lamps end up (Collier et al., 2018, n.p.). This makes repair a double-edged sword. On the one hand, improvisational repair helps things go on, and on the other, it subverts systems (Badami, 2018). Repair is political as its legitimacy depends on who repairs and how (Kumar, 2021b). It sits in a struggle between designers trying to protect and police the boundaries of infrastructure and its repair, and people attempting to subvert those boundaries (Kumar, 2021a). However, what if infrastructure designs have 'somewhat open' boundaries that engage with *jugaad* to repair, maintain and remodel infrastructure? Yet, modalities of repair show *jugaad*'s capacity to exceed its neoliberal co-option by empowering people to reconfigure the infrastructure to 'better' fit their lives and needs, rather than buying more and different products.

Cross and Murray (2018) note the importance of sustainable design for solar lamps that can make use of existing economies of repair and maintenance in marginal and marginalised places. In their influential work on Zimbabwe Bush Pump, de Laet and Mol (2000) show that a key element that gave the pump fluidity to work in different places was its easy local maintainability. Solar lamps are not fluid like the Bush Pump, but they can still have designs that afford easy and local maintainability,[7] even if within carefully managed bounds. Some parts of SK lamps, especially the outer shell, are screwed together which people can open and carry out minor repairs. When VL used SK lamps, local entrepreneurs, VL field staff and users often fixed small problems (Interviews, 2017). Now, even though VL has discontinued support for SK lamps, some lamps remain in use due to their reparability.

VL lamps are the opposite. They do not have screws and need to be broken open. VL designers explain their reasons:

> Because this is a set of people who probably would attempt opening, and maybe, modifying...
>
> [....]
>
> We felt that, because you know, as we move towards the rural segment there is no other alternative but to self-fix things. But there is nothing to fix inside the lamp, so I thought, you know because there is nothing, no serviceable elements inside any of these products.
>
> [....]
>
> Right now, it's a planned move because ... once they [lamps] show that they are almost settled, then they would just seal it. They would not just screw it anymore.

This reflects the tension between the ideas of *jugaad* and innovation (Irani, 2016). *Jugaad*, often seen as a provisional workaround and innovation as a settled, concrete product, stand opposite to each other. This is the same tension that exists within the idea of design itself. As Rao (2010, p. 2) puts it, 'renovations too must be considered in the realm of design rather than viewing design as finally constituting fully formed and normed objects'. Indeed *jugaad* comes as '"small acts" of design' that constantly renovate, fix and maintain (Rao, 2010, p. 2). Following, Rao (2010, p. 2), *jugaad* brings 'new imaginaries of infrastructure-making ... and introduce new forms of political claims'. As the empirical material presented in earlier sections shows, the philosophical and ideological differences that designers hold do not stand the test of users. Irani (2016, p. 173) argues that we need to move away from granting innovation the 'concreteness it does not have in practice'. The practice is more about versatility and fluidity. Rather than set in an aesthetic of clean, neatly fitting designs, the practice is embedded in the aesthetics of messy and fluid everyday life. It demands versatility and *jugaad* rather than standardisation and fixity (Kumar et al., 2019). The arguments that the designers make are at odds with each other, reflecting the tension within the idea of design. They recognise the messiness of everyday life and the ubiquity of *jugaad* (referring to self-fix) practices but rule them out in their design philosophy taking the side of 'anti-jugaad' (Rai, 2019). During research in the villages, entrepreneurs and VL field staff regularly complained about the VL lamps and kits that could not be opened anymore, thereby blocking *jugaad*-based and flexible repair. They compared the new VL lamps

with the old SK lamps and explained that they now need to send the lamps back to VL even for small problems that they could earlier fix locally. SK design facilitates situated acts of *jugaad*, VL blocks them. The versatility of SK and the lack of versatility of VL are apparent again.

Yet, SK's plans for the repair of its lamps did not include local repair. In my 2013 meeting with the SK entrepreneur, he informed that one of his SK lamps had broken down and was sent to the provincial capital for repairs or replacement. He was not fully sure when the lamp might return. Like most other solar companies, sending lamps back to authorised service centres is the standard operating procedure for SK. Opening the lamp and repairing it circumvents the carefully managed boundaries that the company wants *jugaad* to operate in. They offer a one-year warranty which is void by local repair. In 2017, I bought an SK lamp from one of the VL field executives who doubled as an SK entrepreneur. As I was leaving the village, I asked her how I would claim my warranty. Her answer was simple: Why worry about that, you can pay a local shop INR50 (£0.5) to get it repaired. Indeed, it is common to find defunct SK lamps in rural areas in other parts of the world (Cross & Murray, 2018) as local repair economies are often sidelined (Baraille & Jaglin, 2022; Munro et al., 2023).

Due to its somewhat open design, SK also displayed an ability to become other things that the designers never envisaged or encouraged. In 2012, I found people connecting wires to SK lamps that were only meant to be used for lighting and used them as mobile phone chargers in addition to lights (Figure 4). SK manufactures lamps with the ability to charge phones, but these are more expensive than light-only lamps. While SK, like other solar lamp companies, encourages *jugaad* in carefully managed boundaries to sell 'better' multi-purpose products, *jugaad's* capacity to exceed the neoliberal co-option by empowering people to reconfigure these 'better' products to 'better' fit their lives and needs, rather than buying more and different products becomes apparent here.

6 | *JUGAAD* INFRASTRUCTURE: A POSTCOLONIAL THEORY OF MINOR INFRASTRUCTURE OF MESSY EVERYDAY LIFE

What does all this tell us about the role of *jugaad* in infrastructure? And how do we conceptualise the idea of jugaad Infrastructure? *Jugaad* is an Indian name for versatility and improvisation, a sensibility for improvisation, an ability for improvisation and an enabling of improvisation. Building on the idea of *jugaad*, this paper progresses two ideas.

FIGURE 4 Mobile phone being charged after modifying a SK lamp meant to produce only light into a solar phone charger (Author, 2012).

First, it argues that *jugaad* circumvents the formal–informal boundary set by designers. By piercing this boundary, *jugaad* affords more fluid socio-material relationships involving infrastructures and their users. In doing so, *jugaad* affords versatility.

Second, it develops the idea of Jugaad Infrastructure. Jugaad Infrastructure folds two things into it. First, infrastructures that are designed in ways that facilitate *jugaad*, albeit, within firmly maintained boundaries and attempt to capitalise on people's aptitude for jugaad to take different forms, inhabit different spaces and enable different purposes, and all this while somewhat retaining their shape. They are easy to maintain. This helps them travel to, function and stay in different places. In this way, small devices like SK solar lamps spread around in large numbers to become big infrastructure. Second, Jugaad Infrastructure represents the ensembles of fluid socio-material relationships and resources involving infrastructures and their users through which infrastructures are tailored to 'better' fit everyday lives and needs. SK designed a solar lamp that was a 'better' product for people, compared to, for example, VL lamps. Yet, people modified SK lamps to charge mobile phones and make them a 'better' fit for their everyday lives even if against the company's wishes.

Embodying product design ideas of for-profit companies influenced by ideas like *jugaad* Innovation, Jugaad Infrastructure reveals *jugaad*'s neoliberal co-option where private companies in the development marketplace adopt the logics of *jugaad* within carefully managed design parameters to sell 'better' products and make money from marginalised people and places. Yet, Jugaad Infrastructure also shows *jugaad*'s capacity to exceed the neoliberal co-option by empowering people to reconfigure these 'better' products to 'better' fit their lives and needs, rather than buying more and different products. Jugaad Infrastructure inhabits the liminal spaces of struggle between designers claiming *jugaad* as a limited practice that leads to stable innovations and users deploying unlimited *jugaad* as an everyday practice of socio-material flux.

These liminal spaces reveal the tensions between the cultural ideas of *jugaad* and the normative techno-economic, business school-inspired ideas of innovation. *Jugaad*, often seen as a provisional workaround and innovation as a settled, concrete product, stand opposite to each other. *Jugaad* is normatively limited to the idea of frugality and, therefore, the emergence of business school ideas like Jugaad Innovation. Here, *jugaad* is a process that provides frugal and flexible elements to the innovation process. In this version, once the innovation has settled, the process of *jugaad* ends and the innovation is sold as a settled product. We see this in the way VL lamp designers explain their design process. Yet, this is not how *jugaad* operates in its situated cultural contexts. It is an ongoing process that consistently threatens any idea or ideal of a settled product. We see this in the modifications of SK lamps into mobile phone chargers.

In this way, Jugaad Infrastructure embodies ideas that are at odds with each other. On the one hand, it acknowledges the fact that many infrastructure designers recognise the messiness of everyday life and the ubiquity of *jugaad* practices, and some attempt to build them into the infrastructure designs. Even then, designers assume a concreteness that does not exist in practice. On the other hand, Jugaad Infrastructure alerts us that, in practice, infrastructure is embedded in the aesthetics of messy and fluid everyday life which demands versatility and unlimited *jugaad* rather than standardisation, fixity and an aesthetic of clean, neatly fitting designs.

Finally, Jugaad Infrastructure alerts us to the question, what if infrastructure designs have 'somewhat open' boundaries that engage with *jugaad* to repair, maintain and remodel infrastructure? This opens two questions for critical geographers to pursue. First, Jugaad Infrastructure emerges from the socio-cultural idea of *jugaad* in India and has parallels to many similar ideas across the Global South. Yet, such practices are not limited to the Global South. How does Jugaad Infrastructure reveal itself in part of the Global North, especially in contexts where austerity and financial crises might motivate a return to the 'make do and mend' culture and right to repair legal frameworks? Second, is Jugaad Infrastructure only limited to infrastructurally marginal spaces and small infrastructure? Do we see mega and networked infrastructure in the Global South and North playing out the logics of Jugaad Infrastructure? Additionally, although this paper has been limited to the lives of marginalised spaces and people, *jugaad* is a practice equally deployed by the elite. How might we understand Jugaad Infrastructure in elite spaces and practices? How might this help further the discussion on Jugaad Infrastructure?

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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ENDNOTES

[1] This number could be argued to be lower as it counts those connected to networked infrastructure and not people who often gain some 'access' through informal means. Alternatively, the number could also be argued to be higher as those that are counted to have gained access, primarily through centralised electricity grids, might not have consistent supply or might lose access due to breakdowns that are not accounted for in the one billion figure. In addition, the idea of 'access' itself is highly contested and its contours unclear.

[2] https://www.seforall.org/.

[3] Sun King is a market leader in solar lanterns. VL is a pseudonym.

[4] According to the designers, due to its round shape and small size of illuminating part, SK lamps have a sleeping design. VL lamps are standing with a rectangular shape and a bigger illuminating part.

[5] d.light was one of the first solar lamp companies to scale-up, selling millions of units worldwide.

[6] The VL lamp designers specifically pointed this out during the interview.

[7] See, for example, Solar What solar lamps from the University of Edinburgh.

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