



Final Report

Technology and the Future of Work

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Practical Action

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Executive Summary

The potential of new, innovative technologies to positively or negatively impact the wellbeing of informal workers places the system of rules and incentives that guide technological innovation at the centre of the development challenge. Technologies are pervasive in all work sectors and in all aspects of work, including informal work, and technology upgrading is often considered a crucial means to improve the decency of work, productivity and scale. Yet the role and importance of technology in informal work opportunities and livelihoods is little understood or explored. The rapid growth of cities globally, particularly in developing countries, is placing huge pressures on governments to respond to the growing demand for decent, stable and profitable urban work opportunities. Yet there exist in every city huge networks of informal workers, covering almost every work sector, which sustain the city economies and provide livelihood opportunities for poor urban dwellers; though these livelihoods are often characterised by marginalisation, vulnerability, fragility and instability.

Through a year-long project, Practical Action and WIEGO have explored the technologies, cities, work and systems that influence the disruptive impact of technologies on informal workers. The Technology & Future of Work project explored how the working poor are able to mitigate the negative livelihood impacts of technology disruption, or harness technologies to create new work opportunities in five cities (Ahmedabad, India; Dhaka, Bangladesh; Durban, South Africa; Lima, Peru; and Nairobi, Kenya). By creating and adapting innovative research techniques and methodologies, to put the perspectives and lived experiences of poor urban workers at the heart of the research, Practical Action and WIEGO aimed to understand how technologies are accessed, innovated, and utilised by informal workers; the determinants of technology choices among informal worker groups; and the changes being experienced in the technology-work nexus.

The work is underpinned by three interdependent normative frameworks: Technology Justice, Inclusive Economies, and Informal Worker Empowerment. Each provided a lens with which to analyse the findings of the work from unique perspectives, and which each seek to achieve inclusive, sustainable and empowering outcomes for informal workers. The key findings of the research are summarized in the paragraphs that follow.

Technology has a role in decency of work, but not in new work opportunities

Technologies were not found in and of themselves to be generating work opportunities. Rather, several sectors are seeing the introduction of technologies which - while making productivity gains and decreasing manual labour in particular work processes - have the potential to displace informal workers. Only those who are able to gain relevant skills to operate mechanised technologies, invest in technologies themselves, or are able to harness the positive transformative power of such technology developments will be able to benefit. The workers likely to bear the biggest cost of the introduction of new technologies in these sectors are those that are the most vulnerable: informal workers, in particular women.

However, developments in certain technologies, including improved energy access, improved telecommunications, and more relevant transport systems, can all help to expand and improve existing work opportunities, and make them both more decent and more stable. It is not the availability of work opportunities *per se* which drives worker's choices in what they do, the technologies they use, and where they work; but rather the stability of that work - workers are actively selecting technologies which are more "low-tech" in response to challenging environments to attain more secure and stable work.

Thus, creating stable environments in which workers can invest in new technologies, is crucial to enabling more inclusive economies and supporting new work opportunities. Characteristics of such enabling environments include, *inter alia*, secure land tenure and/or secure places of work in public areas (including for safe storage of technologies), equitable access to basic services, regulations which recognise and support informal workers, targeted skills training opportunities, and innovative financial access initiatives which target informal urban workers.

The critical role of organising

The research has shown that organizing is a key pathway to facilitating informal workers' being able to access technologies, to capture the full benefits of technological change, or to mitigate the negative impacts of particular technologies. Organising not only supports workers to act together to advocate for regulatory change in their favour to create greater work stability and inclusion in more formal work systems, but also to share technical knowledge, jointly adapt and innovate technologies, and collectively invest in more modern or "high" technologies and/or storage space for them, to progress beyond basic tools and precarious livelihoods.

There is a stark comparison between informal worker groups who have organised, and those that remain disparate groups of individual workers. Organising and collaborating with other relevant groups and organisations significantly improves organised worker's capacities to upgrade their technology options, to gain from technology advancements in their sector and keep up with the pace of change, and to soften the blows from negative impacts of technology change in their sector. It can also provide recognition and status in urban communities of their work and value to the city, which is an important means by which groups can start to advocate for rights and policies which are more responsive to their needs and improving their livelihood opportunities.

Basic technologies prevail, yet innovation abounds

Despite notions of emerging technologies and disruptive innovations dominating contemporary discourses, informal workers are largely disconnected from such technological advances. At a firm level, informal firms are unable to seize competitive advantages from new technologies. In many cases, this is largely due to the relatively prohibitive cost of such technologies, and the faster pace of investment in higher technologies by formal firms. Thus their investments in 'new' technologies are often steps up 'technology ladders' (for example improved stoves, improved carts, or improved sewing machines), but still lag far behind investments by formal firms and workers into high technologies, which require greater capital investment, a more secure future, and sufficient space and security to store and operate the technology. This is compounded by the exclusion of many informal workers in urban areas from accessing appropriate finance products.

Nonetheless, the research uncovered hotbeds of frugal innovation in each of the cities, as workers made the most of the resources at their disposal to improve both the efficiency and decency of their work. This included specially adapted water pumping and filtration systems in Nairobi, made from scraps of other technologies; custom-built motorised tricycles in Lima used to expertly navigate difficult city roads to carry municipal waste, and handmade rolling boards in Ahmedabad used to improve the physical nature of the work of incense stick rollers. The groups who were most able to capture the benefits of technologies and innovate were those that were able to organise and collectively bargain for greater technology access, or collectively invest in new technologies. They were also those most able to connect with vitally important 'meso level' institutions, which act as conduits between technology developers and the workers.

Many of the disruptive technologies observed in the research can be categorised into mechanisation of existing labour tasks (incense stick rolling, construction, waste processing, and market porter

operations), technologies which are entirely changing the systems of service delivery (such as water 'ATMs' in Nairobi, and solar power systems for street vendors), and technologies which are changing the nature of work (such as mobile phones in Nairobi, and new sewing machines in Ahmedabad).

The research indicates technologies which have greatest positive impact on the work and livelihoods of informal workers are those where workers have the greatest involvement in innovating, are particularly adapted to local needs, and can be readily owned and utilised by informal workers. This indicates that to truly achieve Technology Justice, to create empowered and decent livelihoods, and to craft inclusive, growing economies, measures should be taken to be inclusive of the needs, realities, and innovative, entrepreneurial potential of informal workers; rather than focusing on technology transfer of already created and non-modifiable technologies from elsewhere. This can to a great degree be achieved by improving and supporting worker knowledge systems and peer-to-peer learning platforms.

Gendered differences

Women face differentiated and greater challenges in realising the benefits of technologies, and mitigating the negative impacts on their work opportunities of some technological disruptions. Women also faced further difficulties in that they are socially excluded from certain types of work, for example in value-added waste processing activities in Bangladesh, greatly limiting their ability to seek new and better work opportunities, and access and invest in new technologies. The confluence of cultural norms, religion, and economic disempowerment, compounded to consign women to the more hazardous work in harder to reach areas, with more limited access to technologies and limited support to respond to shifts in labour skills demands within and across work sectors.

In some cases though, technology has empowered women informal workers. Mobile phones in Nairobi have enabled female soap makers to connect with customers far beyond their traditional customer base, to order supplies in a timely fashion and arrange to have goods delivered and collected. This has reduced their commuting costs and time and significantly increasing both their efficiency and income, as well as improving their safety. The reason mobile phones have become more accessible and empowering for women vis a vis other technologies is that there is are much lower entry barriers – they require minimal skills to operate, and these skills can be readily acquired, they are widely available and at an affordable cost, and their operating costs remain affordable for low usage, and there are established markets for repair and maintenance. Like energy access, they are a platform technology which can unlock positive impacts through enabling access to other technologies and circumventing existing gendered inequalities, for example in market transactions.

The need for equitable access to basic rights

The presence or absence of equitable access to public goods, space, and services inhibits work opportunities, livelihoods and informal workers' ability to use or adapt technology. Examples include how street vendors' access to public space impacts the technologies they use and choose in their work. Where they have access to public space (such as the market vendors and *emolienteros* in Lima), they are more likely to invest in more "high" and expensive technologies and tools, versus those that lack access (unorganised street vendors in Lima). Similarly, equitable access to public or basic services such as affordable and reliable electricity is essential to informal livelihoods and directly affects how, when and whether certain informal workers such as garment workers choose to use particular technologies in their work.

The inclusion of informal workers in the delivery of public goods and services, such as water and waste management, is also critical to enabling workers to sustain livelihoods, while also providing

services to populations unserved or underserved by public means. Informal workers often represent the majority of the urban workforce in developing cities but are frequently excluded from public policies and laws. This underlines that the “rules of the game” are not always participatory or inclusive of informal workers. Their exclusion from public policy means that often their full participation in the economy is hindered because their work is not recognized. Therefore, they face myriad problems including confiscations, harassment, arrest - creating a vicious cycle where they face instability and insecurity in their income and livelihoods, and are unable to accumulate any form of capital or savings to be able to invest in technology or other items with the potential of improving their livelihoods.

Access is driven by responsiveness of interlocking city system determinants

The research indicates that in most cases, justice in access to the technologies workers need to live decent and improving lives and to enable them to undertake decent and secure work, is not being achieved. Informal workers are limited in accessing technologies by a range of compounding and interlocking determinants: a focus on transfer of high-technologies to large firms, a lack of stable market systems for inputs necessary for some technologies (such as LPG, or electricity), a lack of opportunities to attain the necessary skills and knowledge to operate new technologies, a lack of adequate resources (safe storage, means of transport, know-how) to utilise technologies, and often above all else the cost of new or improved technologies in relation to the workers’ incomes and ‘room’ to take risks and investments, which is compounded by the exclusion of informal workers from many financial systems.

Workers’ potential for creating sustainable economies and utilising technology sustainably is curtailed by their systematic exclusion from central policies and regulations. For example, street vendors are being denied the opportunity to utilise more sustainable technologies, such as clean cookstoves, as they are kept constantly mobile by their lack of secure public spaces to operate, and denied their full profits because they are forced to bribe officials to maintain their operations for as long as possible. This thus denies them the opportunity to build up sufficient capital to invest into new, more sustainable technologies.

Empowered workers can be not only vital providers of key city services, but also dynamic drivers of change for inclusivity and economic growth, operating at the crux of multiple value chains. As the informal economy grows in each city, particularly with new urban migrants seeking better livelihoods and better incomes, a focus on empowering workers to harness the potential of technologies could be important to ensure those city economies develop and grow in inclusive and equitable ways.

Conclusions for the future of work

The debates and discourse on the future of work must be taken forward differently when one considers the future of work of informal workers in the rapidly expanding cities of the global south. In particular, the mass influx of new workers into the urban labour markets poses significant challenges to creating inclusive economies.

The future of work debates in the growing cities of the global south, and the roles technologies may play in shaping and changing those futures, must give strong credence to issues of urban migration, rights of informal workers, the transient nature of workers between informal professions, and the understanding that the focus on technologies must be on how technologies can be used by workers in an enabling and empowered environment, rather than specific technologies themselves necessitating change.

Part 1 - Introduction

In cities across the globe, technologies are driving disruptions of informal and formal economies and shaping the lives and livelihoods of the urban working poor. The disruptive impact of technologies is complex: it can be at once positive and negative, and may differ depending on a whole range of contextual factors. Technology access is recognised as crucial to the realisation of the Sustainable Development Goals (SDGs), the Paris Agreement on Climate Change, and its importance is highlighted in other development discourses and debates. The rapid growth of cities globally, particularly in developing countries, is placing huge pressures on governments to respond to the growing demand for decent, stable and profitable urban work opportunities. Yet there exist in every city huge networks of informal workers, covering almost every work sector, which sustain the city economies and provide livelihood opportunities for poor urban dwellers, albeit livelihoods which are often characterised by marginalisation, vulnerability, fragility and instability.

The potential of new, innovative technologies to positively or negatively impact the wellbeing of informal workers places the system of rules and incentives that guide technological innovation at the centre of the development challenge. This necessitates a broad view of technology, which includes a range of devices, processes and practices. Innovation is a diverse system comprised of goals, technologies needed to reach those goals, people and organizations who act within the system, and regulations, norms, and incentives that shape the processes.

Technologies are pervasive in all work sectors and in all aspects of work, including informal work, and technology upgrading is often considered a crucial means to improve the decency of work, productivity and scale. Economies often face a trade-off between labour-saving technologies and labour-linking technologies to boost productivity while maintaining employment levels. While it is acknowledged that technology is less likely to change work opportunities as dramatically in developing economies in the coming years - as labour costs remain lower than technology capital, running and maintenance costs - there are nonetheless many predictions of the transformational potential of emerging technologies to eradicate poverty. Yet the role and importance of technology in informal work opportunities and livelihoods is little understood or explored.

Through a year-long project, Practical Action and WIEGO have explored the technologies, cities, work and systems that influence the disruptive impact of technologies on informal workers. The Technology & Future of Work project explored how the working poor are able to mitigate the negative livelihood impacts of technology disruption, or harness technologies to create new work opportunities in five cities (Ahmedabad, India; Dhaka, Bangladesh; Durban, South Africa; Lima, Peru; and Nairobi, Kenya). It also explored scenarios of plausible futures and how to ensure better outcomes for the working poor, towards a more inclusive city economy.

The project contributes to the debates on the role of technology in the future of work, bringing these debates out of high income developed economy discourses, into the real life situations of poor informal workers in developing countries. It is apparent that the future of work - and the role of technology in those futures - will look very different between developed and developing countries, and in particular between formal and informal livelihoods.

The project aims to put the perspectives and lived experiences of poor urban workers across a variety of work sectors, and cities at different stages of development, at the heart of the research, providing a platform to have their voices and issues integrated into such global debates. It aims to understand how technologies are accessed, innovated, and utilised by informal workers; the determinants of technology choices among informal worker groups; and the changes being

experienced in the technology-work nexus. By gaining a deeper and wider understanding of the factors determining technology adoption in informal work activities, it is intended that the research can be used to better inform informal workers of the risks and opportunities presented by technology changes in their sectors, and provide development actors and policymakers with a new perspective on how to craft inclusive economies - and the roles technology may play in doing so.

This report will take the following structure: first the research design and methodology will be detailed, including the key conceptual and normative frameworks used. Next the research findings will be presented by worker group and sector. This will be followed by an analysis of the findings against the analytical framework, drawing out key lessons to inform the normative frameworks and key debates which the work seeks to inform. The final section will outline plausible future scenarios for each work sector, including the changes governments, businesses and other actors can make to enable more positive and inclusive futures for informal workers.

Part 2 - Research Design and Methods

A. Conceptual framework & key research questions

The key questions which guided the research included:

1. How are informal workers choosing, using and adapting technologies to
 - (a) create and improve incomes,
 - (b) enhance productivity,
 - (c) facilitate organizing, and
 - (d) respond to change?
2. What is influencing the presence, absence, quality and cost of technologies as they impact on work opportunities, at the individual, sector, city and global levels?
3. What are the positive and negative impacts of technology on work opportunities, and how do they differ between men and women?

The partners adopted shared definitions for “technology” and “work opportunities” to guide the research which helped inform the conceptual framework (depicted in Figure 1 below):

- “Technology” was conceptualized broadly and consistently with literature that conceives of it along three dimensions: first, physical tools and equipment; second, the skills, knowledge and processes required to use them; and third, the ownership or institutional arrangements around their use.
- While for formal workers, the term “work opportunities” connotes the creation of jobs or paid employment opportunities, for informal workers, "work opportunities" requires a broader connotation of opportunities to earn an income or livelihood, through self-employment or paid employment. And opportunities for self-employment need to include the opportunity or right to use and access public spaces and resources in order to earn a living.

Figure 1: Conceptual Framework for the Technology & Future of Work Project



The above definitions, research questions and elements of the normative frameworks (discussed in part B below) helped form the conceptual framework. Examining the figure from the bottom up, central to the framework are the elements which can lead to improved informal worker livelihoods or “decent work” (namely improved income, work security, welfare and social needs). Relevant literature indicates that several factors can shape the type and level of impact that technology

(tools, innovation and adaptation, skills and know-how) has on work opportunities and livelihoods. These include:

- city context and institutions (i.e. political/legal situation, presence/absence of supportive policies and laws for informal workers, type of waste, transport, or energy system and whether it is responsive to needs of the urban poor, etc);
- organizations and processes (i.e. presence/absence of supportive organizations to advocate for informal worker member rights or to provide training so workers can use technology);
- a worker's place in the value chain or status in employment (denoted in the diagram as "typology of work") (i.e. a self-employed worker must acquire their own tools and depending on context, may have less access to training than a subcontracted worker whose tools and training may be provided by the contractor, facilitating technology access and use); and
- global technology and trends in technology (i.e. informal workers may experience downstream impacts such as obsolescence, increased competition, etc)

B. Normative frameworks: Inclusive Economies, Technology Justice and Informal Worker Empowerment

The research was informed by three normative frameworks: the Rockefeller Foundation's Inclusive Economies framework, Practical Action's Technology Justice framework and WIEGO's Informal Worker Empowerment framework. This section provides a brief definition and explanation of each framework, how they were used to inform the conceptual framework and how they will be used to frame, analyze or organize the findings.

The Inclusive Economies approach at the Rockefeller Foundation is guided by the goal to expand opportunities for more broadly shared prosperity, especially for those facing the greatest barriers to advancing their well-being. Per the goal, the main characteristics of economies that are inclusive are understood to be ones which are equitable, participatory, growing, sustainable and stable. Informal workers by definition often lack social and legal rights and protections, and are some of the most vulnerable workers in economies. The discussion section of the report will examine how and under what circumstances technology can help create more inclusive economies for such workers.

Technology Justice is a concept and analytical framework developed by Practical Action to explore and understand the ways in which technology is used by societies, the systems of control over technology choices, and the consequences of the use of technologies. It is defined as "The right to choose and utilise technologies necessary to lead the lives people value, without preventing others, both now and in the future, from doing the same."¹ Technology Justice comprises three key aspects: Access, Sustainable Use, and Inclusive Innovation. The research will be used to inform thinking on how Technology Justice for informal workers can be understood from their perspective, and what is needed to achieve it. A summary of the findings and how they speak to this concept will be presented in the discussion section of the report.

Finally, the research is informed by WIEGO's informal worker empowerment framework. The framework builds on the concept of "decent work" popularized by the ILO and the philosophy of the Self-Employed Women's Association (SEWA). Asset-building, organizing and capacity building all

¹ Meikle, A., and Sugden, J., (2015) *Introducing Technology Justice: A new paradigm for the sustainable development goals*, Rugby, UK: Practical Action Publishing, <http://dx.doi.org/10.3362/9781780446240>

contribute to the empowerment of informal workers, who, through their organizations can fight for more secure livelihoods. Each of these elements of empowerment are included in the conceptual framework and will therefore be discussed in the findings section.

These normative frameworks will be drawn upon throughout the findings, analysis and discussion sections to both organise and to analyse the research findings, and what they indicate for the future of work for informal workers across cities of the global south.

C. Methods

A variety of research methods were used to explore the impact of technology on informal worker livelihoods, organizing and work opportunities. First, a literature review² was conducted to identify gaps in research and to inform the development of the research questions and conceptual framework. Methods were designed by each partner to:

- 1) understand the grounded experiences of informal workers with technology; and
- 2) probe global trends related to technology and work which may have a downstream impact on informal worker livelihoods.

The local level fieldwork took place in all five cities. Methods used included Four Turns & Technological Asset (4T&TA) photo documentation, storytelling micro-narratives, participatory focus groups, key informant interviews and worker profiles. Fieldwork done at the global level included a survey of informal worker organizations, key informant interviews and development of the *Udadisi* tech trend aggregator. These methods are summarized in the paragraphs below.

Local level research methods

Four Turns & Technological Asset (4T&TA) Photo Method

The 4T&TA is a photographic documentation method. It was deployed in 3 cities (Ahmedabad, Durban and Lima) with a total of 80 workers across 4 sectors in each city. Designed as a participatory method, informal workers were approached at their place of work and asked to identify the most valuable technological asset or tool (TA) in their work.

To build an understanding of the context in which their TA was deployed, each field researcher then took four photos of the four cardinal points (4T) at their place of work. The five photos for each worker were recorded on field sheets (see Appendix 1 for an example) and accompanied by a short write-up to assist with analysis of the field sheets. A framework was then designed to understand how technology is used and acquired by the different informal worker groups based on the following questions:

- How was the workers' technological asset acquired?
- How was the workers' technological asset deployed?
- What was the key external consideration determining the use of the technological asset?
- What livelihood strategy is embodied in the technological asset?

² <http://policy.practicalaction.org/resources/publications/item/literature-review-technology-and-the-future-of-work>

To complement this information, interviews were carried out with 12 participants to gain an in-depth understanding of the dynamics of technological change and adaptation and how those affect the lives and livelihoods of individual informal workers.

Sensemaker Micro-Narratives

In three cities (Dhaka, Nairobi and Lima), a total of 974 informal workers from two sectors per city were asked to tell a story or “micro-narrative” of how a technology enabled, hindered or changed a work opportunity. Their stories were recorded in text, video or picture format in a software called Sensemaker, developed by Cognitive Edge. Workers were then asked to indicate how the stories should be interpreted by answering a series of questions, marking their responses on a set of triads and dyads. These narratives were then aggregated for comparison purposes across different regions and sectors to interrogate the impact of different technologies, trends and emerging patterns on worker livelihoods and opportunities.

See Appendix 2 for details of the questions, triads and dyads.

Participatory Focus Groups

Participatory focus groups were undertaken in all five cities with a sub-set of workers. The focus groups asked workers to reflect on:

- the changes in technology taking place in their work sector (i.e. introduction of new technologies, changes in or disappearance of old technologies);
- the positive and negative impacts of technology on their lives and livelihoods;
- how city-wide transport, waste management and energy systems impact their livelihoods; and
- how and whether workers use ICTs for their work and organizing efforts.

Key Informant Interviews

Key informant interviews were undertaken in all five cities with a selection of city officials, contractors higher up the value chain, local organizers, NGOs, and academics. These interviews focused on the technology changes, disruptions and plans at a city level and across value chains, highlighting some of the key decisions and changes taking place which may impact upon the work opportunities for informal workers.

Global level research methods

Phone Survey with Informal Worker Organizations

To gain a wider comparative understanding of technological change and adaptation in the informal economy, a phone survey was conducted with 18 organizations of informal workers from the developing world. Leaders from each organization (who are members of the WIEGO network) were asked to speak to emerging energy, waste management and/or transport technologies which could affect informal worker livelihoods, the citywide technology systems important for their members, whether and how they use ICTs for organizing and whether and how their members use ICTs in their work.

Technology Trend Aggregator

To gain a deeper understanding of technology changes at a global level, an online technology trend aggregator tool was developed with Edinburgh University’s Infomatics Lab and *Tirami*, a software

development collective, which draws upon key sources of information on technology innovation from 3 cities (Lima, Dhaka, Nairobi) and internationally.

The *Udadisi* tool (www.udadisi.com) is designed to enable the rapid exploration of key trends in the nexus between technology and international development. It scours the web from an initial curated list of sources, covering social media, academic publications and respected blogs.

This is a tool intended to be used beyond the scope of the research project, by other actors involved in international development. As a fully open-source tool, it can be adapted for all manner of additional means, with simple tweaks. A fully accessible guidance document accompanies the open code for easy modifications.

Udadisi is intended to be used as a ‘horizon scanning’ tool, to be used by civil society organisations and others involved in technology and work issues within the three focal cities, to explore the range of emerging technologies, innovations and trends which may soon be shaping and impacting work opportunities in those cities. It may be used as either an “early warning system” of potential implications for workers and industries, or as a scoping mechanism for civil society organisations to better stay abreast of key technology developments in the focal cities and globally.

Both approaches would enable users to better respond to future opportunities and challenges and improve their technology knowledge. The intention is that such organisations would act as intermediaries between workers and other market actors to disseminate this knowledge. Other possible uses include those by journalists and funding organisations to stay at the cutting edge of technology developments and trends, or as a research tool for academics exploring the nature of innovation and ‘hype cycles’.

D. Study cities and sample

The research was undertaken in 5 cities: Ahmedabad, Dhaka, Durban, Lima, and Nairobi. To carry out the research, WIEGO worked with local partners (SEWA Academy in Ahmedabad; Asiye eTafuleni in Durban; and a local research team in Lima) and Practical Action worked with research teams coordinated by its regional offices in Dhaka, Nairobi and Lima. In total, 1214 workers (both men and women) participated in the research across the five cities. Work sectors were selected in each city based on existing contacts with worker groups. One common sector (waste pickers) was examined across the five cities for comparability:

Table 1: Cities and sectors studied

AHMEDABAD	DURBAN	LIMA	DHAKA	NAIROBI
Construction workers Garment makers Incense stick rollers Waste pickers	Barrow operators Garment makers Street vendors Waste pickers	Market workers Street vendors Waste pickers	Street food vendors Waste pickers	Street vendors Waste pickers

Part 3 - Research Findings (by work sector)

Barrow operators/non-motorized transport operators (Durban)

There is strong evidence to suggest that close to 100 tonnes of goods a day are moved by non-motorized barrow operators around the inner city of Durban (Dobson Interview). In Warwick Junction market in the city centre, they transport water, food and other goods for traders and the public using trolleys, barrows and other conveyances. The most common technologies being used by workers in the sector are very basic: different types of trolleys, barrows, rope and wheels (see Table 2 for examples of the conveyances used by barrow operators). In South African society, this form of manual labour is seen almost exclusively as a male work opportunity, with very few female barrow workers in Durban.

Tools and technologies

In discussing the *inqola* one barrow operator said, “It carries a heavy load, which allows for better profits” (FG 13, Durban) while another indicated the *isigadla* helps them to, “get money and be able to support our families” (FG 14, Durban). While income and productivity are considerations in their technology choice, the cost of repairs is also a factor which is a major influence. Barrow operators respond to the costs of repairs to old barrows by always trying to buy new barrows where possible, despite the expense (R1200). They use informal savings groups (*stokvels*) to fund the outlay.

Table 2: Examples of conveyances used in Durban



Although the work of barrow operators is essential to many economic activities in Warwick Junction, their work and ability to adopt and adapt technologies to further enhance their work is hindered by the exclusion, harassment, disrespect and criminalization they face. Though Durban recently developed a non-motorized transport policy, it caters only for recreational cyclists and pays no attention to the needs of the barrow operators who transport tons of goods around the city on a daily basis. Focus group participants pointed out that there are often no pathways for them to use, so they are forced to operate alongside cars or simply cannot work in areas without pavements, decreasing their ability to work in particular areas and putting their personal safety at risk.



Theft, police harassment and confiscations also have an important impact on the ability of barrow operators to invest in particular technologies to enhance their income and livelihoods. The case of Nhlanhla, a water porter in Warwick Junction, who supplies water to cooked food vendors and other street vendors in the market demonstrates this. Police would harass him and often

confiscate his cart. Since 2010, Nhlanhla has used a trolley which he has modified by adding two bread crates, salvaged from the side of the road. It does not draw the attention of the police in the same way the shopping cart trolleys do. Unfortunately, one of the biggest obstacles Nhlanhla faces in his business is the regular theft of his modified trolley. Since 2010 he estimates that his trolley has been stolen more than 20 times. One of the reasons Nhlanhla's trolley continues to be stolen is that he does not have access to a proper storage facility in the market where he works - a reminder that "...it's not just about having the right tools and equipment to do your job effectively, it's equally about ensuring that one has the adequate infrastructure - including access to secure storage - to ensure that your tools and technology are kept safe on the job".

In addition to the contextual factors which impact technology choice and use, barrow operators also discussed the positive and negative impacts of particular tools and systems on their livelihoods and work opportunities. For example, one water porter noted how the efficiency of the *inqola* may impact workers: "...it [*inqola*] makes our work easy and faster but it also drains our body and reduces jobs opportunities because you can take a big load of water containers" (FG 13, Durban). Other barrow operators noted how the physical effort required to operate different trolleys and barrows affects their work: "If you use *isigadla* you suffer from back pain" (FG 14, Durban) and, "*Inqola* is not heavy without a load but when the water container is loaded it is very heavy to pull and it drains your body...You are the engine of *inqola*...sometimes we even fail to come to work or only work five days and consequently that reduce profit" (FG 14, Durban).

The above demonstrates how for this work sector, though the work tools provide productive benefits, using them does present occupational health risks. This raises questions as to whether barrow operators would adopt or invest in more ergonomic barrow designs better suited to their work if they were offered a better level of security for their tools (i.e. through storage facilities) or if they were able to operate under improved work conditions (free of harassment, confiscations).

Transport

Barrow operators also discussed how the transport system impacted their livelihoods and work opportunities. Given the spatial legacy of apartheid in South Africa, whereby the poorer black population still lives in townships at some distance from cities and business centres, transport is a key system for the informal workers in Durban. In keeping with this, barrow operators identified transport as the most important system affecting their work. While they acknowledged that it was essential in linking them to their work - and therefore positive ("If we don't have transport to come here, we won't be able to provide for our families" (FG 13, Durban)) - they also discussed how it negatively impacts on their livelihoods and work.

Some noted that buses and taxis in some areas are inconvenient because they operate only during specific hours. They remarked that often they need to get to the city centre to start work very early in the morning (arriving at 1am) and public transport does not operate at that time. Others discussed how fare increases negatively affect their work: "If the prices go up, where we work is not easy to increase our prices because our customers will complain that we never informed them. For the past six years we were selling water for R2 (\$0.14), so in order for us to meet the transport fare, we were forced to increase water pricing" (FG 13, Durban).

Overall, barrow operators face several challenges to choosing, using and adapting technology in their work. They lack secure storage space which means their work tools are vulnerable to theft. This would likely dissuade them from making significant investments in technology due to the constant need to replace their high-value tools. The fact that the non-motorized transport policy does not recognize or include them also contributes to lack of recognition of their work. They face harassment, police confiscations and occupational hazards as they are often forced to pull their

loads alongside cars on roads not designed to accommodate both manual and non-manual transport. The reality is that for some informal workers, possessing technology is a risky liability, rather than an asset.

For female workers to enter into this profession in Durban, there would likely need to be both adaptations and innovations of the key technologies utilised by barrow operators, as well as a need to overcome many of the social barriers which limit their participation in the sector.

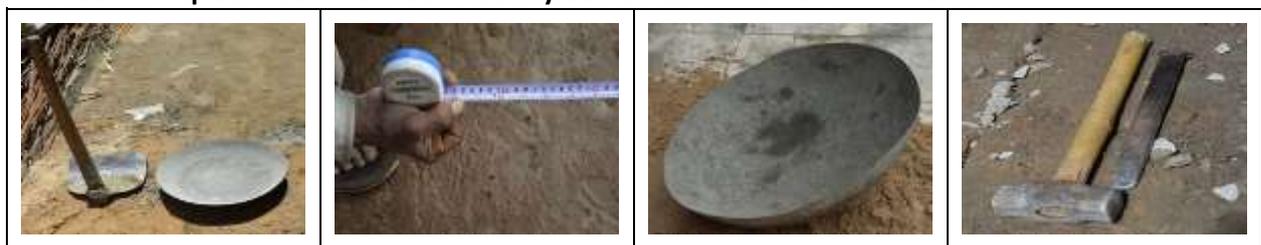
Construction workers (Ahmedabad)

In India, construction workers, home-based producers (including incense stick rollers and garment makers) and waste pickers represent around 30 percent of the urban informal workforce (Chen and Raveendran 2014). Many construction workers in Ahmedabad are manual labourers sifting sand, mixing cement, and carrying cement and bricks; while others are skilled masons or carpenters using tradesmen’s tools as well as machines. Both skilled and unskilled construction workers participated in the research.

Tools and technologies

The common tools used by these workers included: a shallow metal basin for carrying bricks and cement, a hoe, and a sieve for sifting sand (for the manual construction workers) and a trowel and plumb line (for the masons/tradesmen). Because they are often wage labourers, the construction workers’ tools are provided by the contractor: “We do not have our own tools. Contractor provides the tools to us. We come with the lunch box only; rest all the tools or technologies are provided by the contractor” (FG 2, Ahmedabad, Construction).

Table 3: Examples of common tools used by Construction Workers in Ahmedabad



Technologies such as a metal basin, hoe, chisel & hammer were the tools cited as most important for their work. Workers said they had mostly positive impacts on work opportunities as “both skilled and unskilled workers can use it [the hoe]” (FG1, Ahmedabad); it helps them work faster and more effectively (in reference to the metal basin) and they are able to get employment by using it (in the case of the hammer and chisel). However, because these tools are often associated with manual unskilled labour, construction workers frequently spoke of leg and back pain, the potential for injury while using some of the tools and breathing problems from inhaling dust during their work, all of which could have a long-term detrimental impact on their health and ability to work.

Increasingly, the construction sector in Ahmedabad is experiencing mechanization. The most commonly cited emerging work tools for construction workers in Ahmedabad were machines for skilled trades such as mixers, grinders, cutters: “With these technologies the work is faster and reduces the manual labour work. These machines are operated by skilled workers only” (FG1, Ahmedabad, Construction). And, manual construction work – especially tasks like digging and lifting – is being replaced by diggers, bobcats, and other machines, as they become more readily available. So, there is less demand for manual laborers who use hoes to dig and basins to lift and carry, and, increasingly, a smaller number of more skilled workers will be needed on construction sites.

To respond to this change, construction workers need skills training as masons, tile layers, carpenters, and electricians to be able to graduate from manual to skilled labour. Although the Self-Employed Women's Association (SEWA) is training women in these trades, there are few such training opportunities for most women manual construction labourers in India. Moreover, even women trained by SEWA in the skills of the trade face financial and cultural constraints in acquiring the tools of the trade. In Ahmedabad, there are strict norms of female modesty, seclusion, and veiling among the Muslim community.

As one group of women construction workers reported: "Although there are many other technologies in this sector none of them are in the hands of women workers." (FG 2, Ahmedabad, Construction Workers). Focus groups with women construction workers also revealed that while they were somewhat dependent on mobile phones for communicating with their contractor or passing along work-related information, their husbands would not allow them to own a phone as they did not want them to communicate directly with the male recruiters or contractors.

Transport

In evaluating the positive and negative impacts of particular technologies on their work, all focus groups in Ahmedabad noted that the transport system was the most important system affecting their work: "*If we cannot reach at labour area on time then we have to lose the wages for a day. Therefore to get the work; the first need is for a good transportation service*" (FG 3, Ahmedabad, Construction).

Construction workers are often not required to bring their own tools to the work site. In most cases, workers use public transport such as rickshaws and buses to reach the worksite. Often, the contractor is responsible for ensuring the work tools or raw materials are at the work site (they use private transport for these purposes). In addition, in contrast to other work sectors, if the work site is far from the workers' homes, the contractor may provide money to cover transportation expense or arrange private transport. These private transport arrangements explain the construction workers' more positive perception of the transport system compared to other Ahmedabad workers. However, relying on this form of work alone holds workers back from progressing to more lucrative and specialised work opportunities in the sector, and relies on the continuation of this arrangement.

Therefore, there are several challenges that workers in this sector are facing: financial and cultural constraints to acquiring and using the tools needed to access better opportunities, a shortage of training opportunities to become more skilled workers coupled with the entrance of machines which are replacing many manual tasks in the trade. Some of these dynamics may have a more heavy impact on women construction workers in Ahmedabad than men. For example, it is women that face cultural barriers to using and acquiring tools. And, based on the sample of workers who participated in the focus groups, women are doing mostly unskilled work whereas there were a greater number of men engaged in skilled work in the study sample. Therefore, a preliminary conclusion would be that the increasing mechanization will have a heavier impact on women informal construction workers than men in Ahmedabad.

Garment workers (Durban, Ahmedabad)

"The garment industry is one of the oldest and largest export industries... Informal garment and textile workers often experience isolation, invisibility and lack of power, especially those who produce from their homes".³ The garment workers from Durban and Ahmedabad work in slightly different conditions. In Durban, most of the garment workers surveyed are self-employed and work in public spaces near Berea train station in the city centre. By contrast, garment workers surveyed in

³ WIEGO, 2016, Garment Workers, <http://wiego.org/informal-economy/occupational-groups/garment-workers>

Ahmedabad were both sub-contracted and self-employed home-based workers. Despite this difference, workers in both cities identified very similar emerging technologies (such as cutting machines or embroidery machines).

Tools and technologies

The most important tools were also similar: electric sewing machines, scissors and needle and thread. Table 4 presents their analysis of the cost and benefits of using the electric sewing machines - the most important technology in their work:

Table 4: Cost-Benefit Analysis of Modern Sewing Machines: Garment Makers in Ahmedabad and Durban (Focus Groups)

Benefits	
Productivity	<p>“A fully electric machine is useful because we can work fast and do more work with it.” (FG3, Ahmedabad)</p> <p>“Machine produces more” (FG1, Durban)</p>
Earnings	<p>“I can do more work and earn more money,” (FG 2, Ahmedabad)</p> <p>“...we make a lot of money. Sometimes I wish to own more than one machine...” (FG1, Durban)</p>
Competitiveness	<p>“The Zuki machine... is useful for those who stitch ready-made clothes.” (FG 4, Ahmedabad)</p>
Costs	
Capital Investment	<p>“Zuki machines cost between 35 to 40 thousand rupees.” (FG 4, Ahmedabad)</p> <p>“Flat sewing machine is expensive [...]A brand new sewing machine cost about R5000” (FG 4, Durban).</p>
Skills Acquisition	<p>“If one does not have the skills to operate the machine it can go in reverse and injure your hand.” (FG 4, Durban)</p>
Electricity	<p>“The electricity bill increases.” (FG 3, Ahmedabad)</p> <p>“Electricity is expensive, so we pay more to access it [...] we make business budget, we put money for electricity aside” (FG1, Durban)</p>
Repairs	<p>“The machine cannot be repaired by us, even if the needle breaks we have to carry it to the repair shop.” (FG 3, Ahmedabad)</p>

Work in the garment sector in Durban and Ahmedabad is becoming increasingly mechanized. However, unlike the mechanization taking place in construction and incense stick production, the technology emerging in the garment sector (i.e. electric sewing machines) is owned and operated by individual workers and is perceived to enhance productivity but not displace workers. The need to respond to industry trends is largely driving this shift: garment workers need modern sewing machines to enter the ready-made, especially modern, garment sectors (in the case of Ahmedabad) and to better compete in the traditional garment sector (in the case of both cities).

In line with this, focus groups in Ahmedabad noted that few garment makers still use manual pedal- or hand-operated sewing machines; although some have held onto their manual machines for when there are power outages or when another member of the family can use the manual machine to help meet work orders. There is thus a heavy reliance on the quality and stability of the power network for grid-connected workers, to ensure they can meet order demands.

Similarly, in Durban, a few older workers continue to use hand and foot powered machines, but younger workers have switched to the more expensive electric machines. The similar nature of the machines, along with affordable pricing, means that they are a readily-accessible technology in the sector. But their use is limited, and many more complex garments now require more specialised machinery. Workers in Ahmedabad explained that they rarely invest in such machinery as individuals, as their uses are so highly specialised, and fashion trends so swift, that there is rarely opportunities for home-based workers to realise sufficient returns on investments. Thus it is the larger factories and SMEs that are then able to use their economies of scale to invest in and generate profits from investments in such technologies.

Figure 1: Common tools for garment workers in Ahmedabad and Durban



ICTs

While traditional tools of the trade are indispensable to their work, garment workers in both cities also discussed the importance of ICTs such as cell phones, the internet and cameras. Cell phones were the most important and most widespread ICT used by the workers. They are mostly used to receive orders and communicate with customers, contractors and suppliers. A garment maker in Ahmedabad reported: "The covers that I stitch have the mobile number of the person who collects the stitched covers. I get orders for stitching covers through phone." (FG1, Ahmedabad).

This was echoed by a garment worker in Durban: "Everything is done through a cell phone, we communicate with customers and suppliers" (FG1, Durban). Some garment workers in Durban also use the Internet and mobile applications like WhatsApp to communicate with customers, but this is not yet a common or widespread practice. For those few garment workers, using WhatsApp and text messaging has allowed them to communicate with customers more cheaply and enabled them to make garments to order for customers outside the city. In Ahmedabad, some garment workers were using cameras to document their designs or previous work.

It is clear that as people's confidence in mobile technologies grows, they are increasingly utilising the power of ICTs and the internet to improve their work opportunities. So while ICTs are not changing the nature of the work, they are helping to significantly scale the size of entrepreneurs' work, and increase the efficiency and reach of market transactions. With India and South Africa two of the leading countries in digital economies, there is great scope for these practices to become ever-more widespread among garment workers and other work sectors in India.

Though workers in both cities are beginning to use ICTs such as cell phones, radio or the Internet for organizing, this is not yet a widespread practice. Many garment workers in Durban reported not knowing how to use the Internet, and, in general they are less organized. Despite this, cell phones are relatively widespread so where organizing activities take place, it is the primary ICT used.

In Ahmedabad, it seems that in comparison to other sectors, garment workers use mobile phones more readily in their work which could explain it beginning to be used as an organizing tool by SEWA members (where it is used by members to notify friends about meetings). However, traditional

forms of organizing, such as door to door organizing will likely remain important as a means of reaching out to home-based workers for the foreseeable future given their isolation.

Energy

In examining the impact of city-wide systems, garment workers in Durban and Ahmedabad both indicated that the energy system was the most significant (as most garment workers use electric sewing machines). There is currently a national energy crisis in South Africa with frequent unpredictable load shedding/power outages. At Berea Station in Durban (the workplace of many garment workers), electricity supply regularly overloads and cuts out, on average twice a week (Durban Micro-Narrative). This has significant negative impacts on garment worker livelihoods: "Electricity is a problem due to the existence of load shedding: while we are in the middle of our work electricity just shuts down." (Durban GM, FG 6); "Customers blame us for incomplete work when the electricity goes off" (Durban GM, FG 8). In some cases, if a garment is not ready at the agreed upon date and time, the customer will cancel the order and demand a refund, leading to a loss of business and income.

In marked contrast, Ahmedabad City is known for regular electrical supply and high unit rates since electrical supply was privatized over 15 years ago. Despite the cost, the regular supply of electricity is a great boon to the home-based garment makers, most of whom operate electrical sewing machines. Therefore, while several acknowledged the high rate cost, on the whole, most garment workers who participated in the focus groups indicated the stability of the energy system had a positive impact on their work.

In summary, the garment workers in Durban and Ahmedabad represent an interesting case. Though their work is becoming increasingly mechanized, workers appear to be able to make the investments in new technology to remain competitive and respond to changes in the industry. In each context, workers have access to a reasonably protected and secure work space - an essential factor which can enable a worker to confidently invest in a high cost technology/tool without fear of theft, confiscation, or damage to the technology.

In Ahmedabad, the participating garment workers are all members of a strong and effective membership-based organization (MBO), known for worker training and savings and banking (among other services). These activities have resulted in loan finance that enables both supportive infrastructure (workers' homes) and capital for acquiring particular technologies. Therefore, the presence and performance of tools is facilitated by organizing, responsive support structures and access to skill upgradation (4TTA Analysis, Ahmedabad). In Durban, garment workers are in a public environment with access to reasonably protected and secure work spaces. Though they are not supported by an MBO, Durban has a fragile formal garment industry that, as a consequence, regularly upgrades or disposes of machines which indirectly enables informal worker to acquire machines at lower cost (4TTA Analysis, Durban). These factors, coupled with relatively predictable income/work (given that technology is acquired by garment workers to attract and undertake specific types of work) have facilitated how they choose and use particular technologies and the level of impact that mechanization has on their livelihoods and work, despite the ongoing instability and poor quality of energy supply.

Incense Stick Rollers (Ahmedabad)

Home-based workers - including incense stick rollers - make up an important share of the urban workforce in India. In Ahmedabad, all incense stick rollers who participated in the study are sub-contracted workers. While many of the women workers hand-roll incense sticks in their homes,

some are now employed in small workshops operating rolling and mixing machines to make incense sticks.

Tools and technologies

For the women hand-rolling incense sticks, the most important assets are basic tools including wooden boards (where they roll the incense sticks), a basin/pan (to carry the dough, sticks and their finished product to the contractor), and a knife (for cutting the dough and cleaning the board and hands). For the women who work on machines, their most important tools include rolling machines, spanners/wrenches (to repair the machine in case of a breakdown) and a bucket (for putting dough in the machine).

Like the construction and garment sectors, incense stick rolling is being mechanized. This mechanization has the advantage of increasing production and decreasing pollution and occupational hazards. However, the owner of an incense stick factory estimated that this mechanization has resulted in 8 out of 10 workers losing their jobs (Chandak Interview). This represents a practice that is under threat of mechanization eg. hand made production of approximately 4,000 sticks/day compared to machine manufacture of approximately 1,000/hour. Also, there is competition in the sector from a different, longer variety of incense sticks imported from China and Vietnam. So the future for women who hand-roll incense sticks is uncertain. As one hand-roller summarized: “One machine can replace five to six women” (FG3, Incense stick rollers, Ahmedabad).

Table 5: Common existing and emerging tools used by incense stick rollers in Ahmedabad



Decisions to mechanize the work process are often made by the incense stick traders and contractors who can afford to buy and house the new rolling machines, not the workers: “We cannot afford a machine because it is costs (One Lakh rupees, \$1,500)”(FG 1, Ahmedabad). As one incense

stick roller noted, “Our trader does not have huge capital to purchase the machine, so we are doing the work manually” (FG1, Ahmedabad). Though decisions on mechanization are being made higher up the value chain, workers are well aware of the costs and benefits of the machines, challenges they face in using them and positive and negative impacts on their work:

“Machine is advantageous for the employer as he has to keep just a few machines and a few people. The machine works all the time, no leaves, no social functions, no excuses, in short there is no labour shortage or any labour related issue in case of machine work. So work is fast and easy” (FG2, Ahmedabad).

ICTs

When asked whether any ICTs were important as tools in their work or organizing activities, they said ICTs were not used for work. Incense stick rollers contained in the sample were either working as wage labourers in small units in their neighbourhoods or as subcontracted home-based workers. Those in the small factories are not allowed to use phones or other ICTs during working hours. The subcontracted incense stick rollers operating at home are home-based but not homebound: it can be inferred they have relatively regular face to face interaction with their traders and suppliers given that they pick up raw materials from suppliers and deliver finished incense sticks to traders. These two factors may explain why ICTs were not listed as important in their work.

Energy

In discussing how particular city-wide technology systems affect their work, both hand rollers and machine users cited the energy system as the most important. Those that hand-roll incense sticks at home need electricity to be able to work at night and those that use the machines need electricity to operate them: “Electricity is important for preparation of dough. If electricity is not there then the dough cannot be prepared. The machine also needs electricity and three phase electricity connection is important for them” (FG3, Ahmedabad). All focus group rated the energy system as having a positive impact on their work. This is because while Ahmedabad City electricity has a high unit rate, it is known for having a regular electrical supply. Transport and waste systems were rated as less important for their work, given they are home-based.

While the women seem to acknowledge the uncertainty of their work as hand rollers, other factors may affect women’s responses to the influx of technology. Some women are not willing to work as employees in workshops owned by the traders due to gender norms which restrict women’s mobility and interactions outside the home and put competing demands on their time; or because they prefer to work from their own homes and set their own work schedules. In either case, ownership of the machines by individual workers remains mostly out of reach due to the high transaction cost of purchasing a machine, high operating costs (due to expensive electricity) and lack of skills of some of the women to operate the machines.

Market workers (Lima)

In Peru, informal traders account for 28 percent of total informal employment.⁴ In Lima, market traders from three markets participated in the research - the “Las Mercedes” and “Rosa de las Américas” markets in San Martín de Porres and the “San José” market in Jesús María district. The market traders are self-employed and most operate from fixed stalls inside the markets where there is shelter from the elements, security and other supportive infrastructure like water and electricity.

⁴ Herrera *et al*, 2012, Informal Sector and Informal Employment: Overview of Data for 11 Cities in 10 Developing Countries, WIEGO Working Paper No. 9

Tools and technologies

Since many of the market traders who participated in the research sell fresh or prepared food, they identified their most important tools to be scales, display cases, and cutting implements. New technologies being used by higher-income traders include digital scales, electric meat slicers and refrigerated display cases. The traders classified these technologies as ‘new’ in the sense that workers like them were just beginning to use them, even if the technology itself had been around for a long time. These newer tools were largely seen by workers as enhancing productivity while not displacing other workers in their sector (contrary to the pattern seen in the construction and incense stick sectors). For example, they viewed digital scales as largely positive because the tool provides a more precise weight and cost and makes adding costs faster and easier - it therefore enhances their productivity and helps them better serve customers.

Table 6: Common tools used by Market Vendors in Lima



On the other hand, they reasoned that cheap digital scales break easily and few technicians exist to fix them while the more expensive ones get stolen. The traders noted that years ago, scales were more expensive, higher quality and lasted several years. Now, although there is a wider variety of scales, it is hard to find good technicians for the high quality scales so they instead buy the cheapest Chinese brands of digital scales: “They are disposable, but for that price it is affordable.” (Lima, FG11). Some market traders also noted that health regulations require them to use stainless steel equipment, which implies a change in tools.

The types of tools identified by the sector as “most important” for their work - scales, refrigerated display cases, knives/axes - have a relatively higher capital cost than some of the other sectors. The ability and willingness to invest in enhanced technologies here can likely be attributed to the fact that compared to some of the other sectors, market traders have a fixed and secure place of work (the market), with supportive infrastructure (water, electricity) and relative security to be able to do their work. This appears to be a clear enabler for them to be able to invest in productivity and income enhancing technology.

ICTs

In addition to their work tools, most focus group participants also commented how they use cell phones for their work. Most noted that they use it almost all the time and that it is necessary for their work - to contact their suppliers about prices, to confirm deliveries or take orders from customers and to place orders for supplies so that they can save time and money related to transportation (Lima, FG12 and 16). Some focus groups participants also use cell phones for organizing purposes: to communicate with other members and to find out about announcements and meetings. However, they use their phone less for organizing than for work.

Transport

For market traders who transport their goods from different parts of the city to their place of work, the transport system is very important. However, all focus groups indicated that while it was critical to their livelihoods, it negatively impacts their productivity and work:

“If I work eight hours, I spend five more in a bus.”(FG1, Market Vendors, Lima)

“It is not likely they (taxis) will pick me up with products and packages, and especially at the time I want to go” (FG1, Market Vendors, Lima)

“They (taxi drivers) do not want to tell us how much they can charge us because we will accept any charge; [the issue is] simply that they do not want to take us with our packages.”(FG1, Market Vendors, Lima)

The above demonstrates that the lack of inclusion of the needs of the informal traders acts against the creation of inclusive economies, as such supporting infrastructures fail to account for their needs and their movements around the cities.

Energy

Almost all of the focus groups acknowledged that the energy system was important for their work. One potential reason behind this is that it allows them to invest in productivity-enhancing technologies and tools for their work. They commented that the price of electricity has gone up but that now that it has stabilized, it has not impacted them much. However, they agreed the transport system impacts them more.

Market porters (Lima)

In the Lima Metropolitan Wholesale Market in Santa Anita, many men work as market porters, unloading the trucks that bring agricultural products to the market and transporting the produce to merchants within the market.

Tools and technologies

The tools and technology used by market porters are slightly different depending on the type of produce they transport because some products are transported in plastic or cardboard boxes while others come in bags or wooden crates. However, the common tools used by most porters include wooden pallets, manual forklifts (used together with the wooden pallets to move goods from the trucks to the merchants) and hammers (to repair wooden crates prior to stacking them on the pallets).

Table 7: Common tools used by Market Porters in Lima



There is some variation, for example, in the way onion porters work because onions come in heavy bags which cannot be stacked on the pallet and forklift. Onion porters continue to carry the sacks manually, on their backs and shoulders. Their most important tools are belts which they wear to protect their kidneys and body from the strain of carrying the heavy sacks and wooden pallets. An onion porter commented that because of the belt: “one can continue working” (FG3, Lima). Prior to

2013, the majority of market porters interviewed worked this way, carrying heavy boxes and bags of produce on their shoulders and backs. The impetus for the shift to the wooden pallets and manual forklifts came when the major wholesale market - *La Parada* - was relocated from the city centre to a new market in a district outside the city centre.

Initially, the Empresa Municipal de Mercados S.A (EMMSA) refused to let the market porters work at the new market location. Market porters were already organized and the Federación de Estibadores Terrestres y Transportistas Manuales del Perú (FETTRAMAP) was able to negotiate an agreement with EMMSA. It was agreed that they could continue working in the market, a work regulation was issued and as part of the agreement, they were required to gradually transition to a mechanized model of transporting goods.

ICTs

Market porters also highlighted how they use ICTs including cell phones, two-way radios, the internet and computers for their work and organizing. There is some variation in terms of the extent and amount of use of ICTs among porters because of differences in how work is organized for porters of different produce. However, in general, cell phones seem to be the most important means of communication for this sector, both for work and organizing. As a tomato porter explained, “We are always calling each other on the cell phone to advise that a shift is starting, to let each other know the trucks are arriving or about any change” (FG1). Green bean porters are using two-way radios to communicate in the market about the arrival of trucks and about shifts. One radio is left in the organization’s office and the other stays with the *tablero* responsible for the schedule.

Some porters also indicated that they use the internet and computers for organizing purposes but that they are mainly used by leaders to write reports or for communication purposes. This constant communication between the different porters about shifts and work scheduled may have partly arose as a result of negotiations with EMMSA during the move to the new market:

“The leaders of the association had to find ways to get in touch with their members and share the decisions and agreements [reached with EMMSA]. They also had to organize shifts and work schedules to show that they could handle the products better than other porters and that they could cover the demand” (Lima Micro-Narrative, Market Porters).

In sum, the technology use and choice by the market porters was the pre-requisite to their having a work opportunity: to be able to work in the market, the owner required the market porters to adopt the technology (wooden pallets and forklifts), which required readily learned skills. However, this agreement between owner and porters would not have been possible had the market porters not been organized. This enabled them to negotiate with the owner and reach an agreement whereby they obtained the right to work in the new market, something which had not originally been contemplated. Finally, the importance of appropriate infrastructure - in the form of secure storage - cannot be overemphasized as it allows workers to maintain valuable and work-appropriate tools.

Street vendors (Durban, Lima, Dhaka, Nairobi)

Across the four cities, street vendors faced uncertain, unstable, and unsafe working environments. Their work opportunities were among the most fragile across all the sectors. And despite informal traders accounting for a significant proportion of city economies and delivering vital, valuable services, their needs and safeguards are rarely addressed in economic or urban planning policies.

This is despite informal traders accounting for 92 percent of all market trade in countries such as Bangladesh.

Tools and technologies

The technology choices of most street vendors are inherently shaped by the precarious nature of much of their work. Technologies were often chosen not because of the productivity or efficiency characteristics, but rather due to the mobility of the technologies, and the lower values of the technologies. Workers needed technologies which are easy to transport, so that they can rapidly move their trading stalls from location to location, as they are regularly instructed, and often harassed, by local authorities.

Table 8: Examples of Common Tools used by Street Vendors in Lima and Durban



Equally, evidence shows that workers are deliberately selecting lower value technologies, in the knowledge that these have a high risk of being confiscated by local authorities, thus in the face of such issues, they need to be able to afford to readily replace these technologies on a frequent basis. Unpredictable, often hostile, policy and regulatory environment serves to inhibit the livelihood strategies of this group of informal workers, including their choice and use of technologies.

It can be said there is a hierarchy of workplaces for street vendors. For instance, among street vendors, some vend from baskets or mats on the ground, others from pushcarts of various types and sizes, still others from wooden carts with display units, and yet others from kiosks or other semi-permanent structures. Such a hierarchy impacts on the technology choices available to informal workers, and also on the ability to utilise new technologies productively. Findings from WIEGO's informal economy monitoring study (IEMS) also indicate the lack of a secure workplace and a secure storage space, high costs for permits and rents, and high costs of transport inhibit investments in both technology and stock.

Though street vendors in Durban have some protection through a local government permit system and are therefore able to invest in certain technologies, this is off-set by concerns for security, risk and location. This suggests that appropriate infrastructure e.g. shelter and storage are another defining pathway to the investment in and deployment of enabling technology. The lack of a secure space to store goods and equipment at night inhibits investment in tools and equipment as well as stock. This is particularly true for street vendors who need to store equipment – scales, display units – as well as stock overnight, every night.

The lack of legal recognition and protection means that informal workers often face bribes, confiscation of goods and equipment, evictions and other forms of harassment: which inhibit their ability or willingness to invest in improved technologies or stock. As one trader in Lima conveyed,

“If you don't pay what they [guards hired by the municipality] ask for, sometimes they will even beat you, throw your merchandise on the street, kick you, take your stuff away and the Municipality will not do anything. They are on their side.” (Lima, SV FG5)

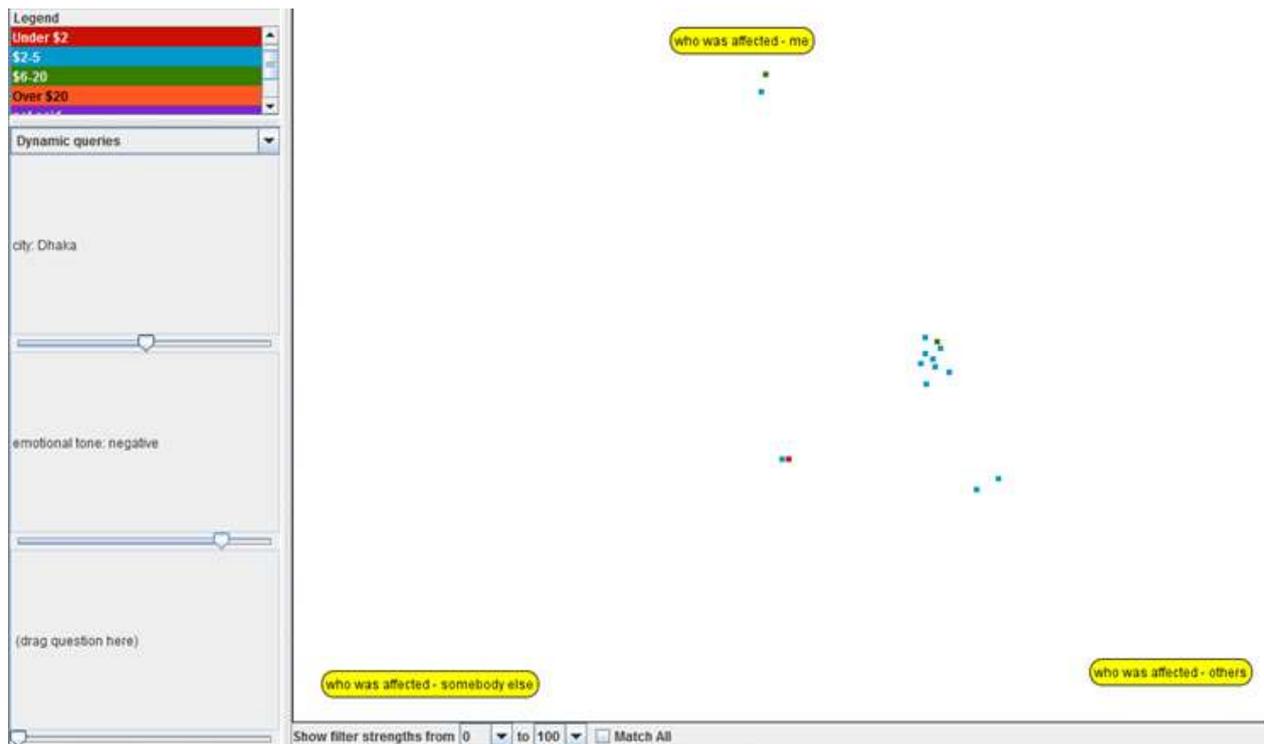
While most street vendors were found not to be using adapted technologies, largely because their existing basic tools met their needs, or off-the-shelf technologies worked without needing adaptation (although many respondents highlighted the need to frequently repair or replace cheap electronic goods), water vendors in Nairobi were frequently found to be experimenting with new innovations and adapting existing technologies. Most of this innovation happened in response to the need to pump water more efficiently, and in many cases vendors were found to have engaged with local entrepreneurs, NGOs and even universities to help innovate more appropriate pumping and bottling technologies, such as the ‘money-maker’ pump, which requires minimal power to operate.

But street vendors in Nairobi also faced constraints in investing in new technologies, in particular in relation to spatial constraints and insecurity. Water vendors and soap makers complained of both a lack of space to store and use new technologies, as well as insecurities over land tenure and theft. As informal settlements are frequently torn down, and many residents in slums and informal settlements have no land titles for their properties, they shied away from investing in new technologies which could easily be removed or destroyed as they are forced from place to place. Equally, the lack of adequate housing and secure storage options posed a threat to those wanting to invest in new technologies over fears they could be easily stolen.

Thus while Nairobi provides a snapshot of a city bustling with innovation and entrepreneurship, the structural difficulties faced by informal street vendors (and others alike) highlight that without supportive institutions and contexts, opportunities to craft inclusive economies will be stifled.

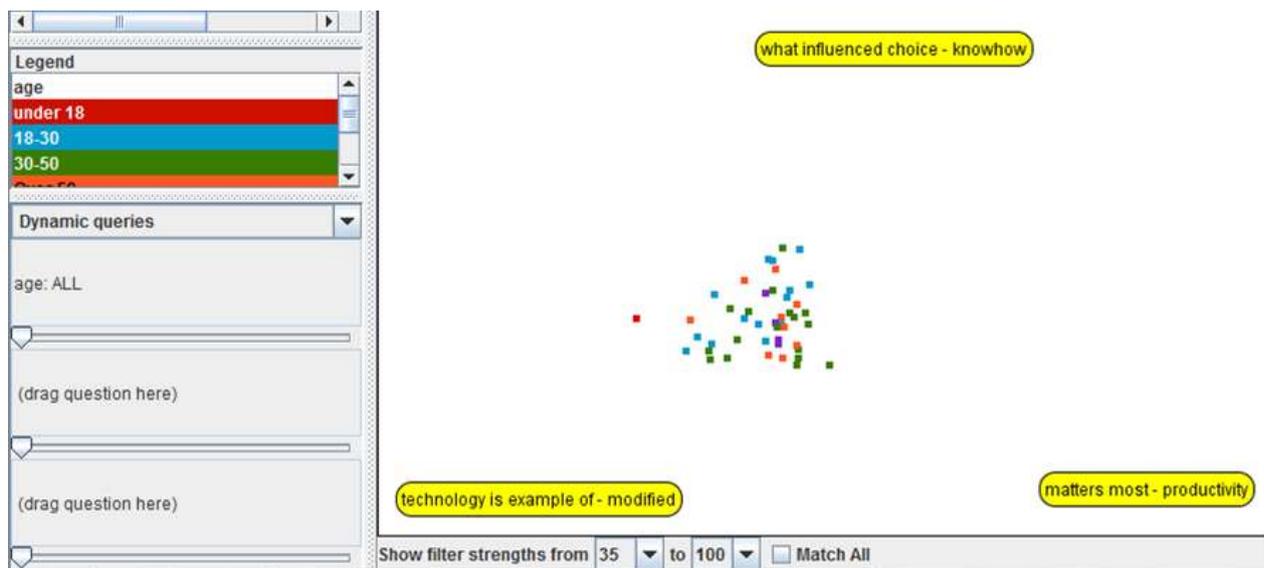
The issue of urban migration intersecting with poverty and work opportunities was particularly prevalent among street vendors in Dhaka. All of the stories signified as ‘negative’ came from recent migrants to the city, and workers signified that their stories had negative impacts on themselves and “others like them” (see Graph 1). This highlights that special considerations need to be taken to provide specific support to new urban migrants, who face challenges in integrating into their new environments and have comparatively fewer resources than their incumbent city counterparts. Initiatives which build their social capital could be critical to ensuring that these new workers are included in decent work opportunities in their new cities.

Graph 1 - “Who was affected in your story” - Dhaka, ‘negative’ responses.



Graph 2 demonstrates how in Lima, Nairobi and Dhaka, there is a strong correlation between stories in which knowhow, modified technologies, and the importance of productivity are strongly signified. 76% of those featured in this graph are young males, and all but three from Lima and Nairobi, suggesting that young males have both the ability (both technically and socially) and the means to take risks, to innovate, and to focus on productivity over security. Equally, all but one story (from Dhaka) are signified as positive or very positive, highlighting that an ability to innovate is associated with more positive work and livelihood outcomes for informal workers.

Graph 2 - sensemaker 3rd level analysis



Energy

For most food vendors, basic equipment including scales and hand-pulled carts are the technologies upon which their livelihoods depend. For those serving prepared foods and drinks, heating stoves

are also a critical technology. The research indicates that despite global efforts to increase uptake of improved cookstoves - those which are more efficient and cleaner-burning - most street vendors across the study cities continue to use the cheaper kerosene stoves. This is partly due to prohibitive costs, but also due to a lack of awareness of other technology options, or failures in the fuel value chains, where non-kerosene fuels are often unavailable.

“Per day it takes more than 100 taka to pay for the kerosene. If I could use the cylinder gas instead that could be more beneficial for me, but I cannot afford it.” Food vendor, Dhaka

“I don’t know any technologies other than this [kerosene] stove in this business” Emolientero, Lima

Equally, the research demonstrated that informal workers are often forced to work seasonally, and to work multiple jobs in order to maintain a basic livelihood. The transient, and mixed, scheme of work also has significant impacts on both access to, and choice of technologies. For example, an *emolientero* in Lima, who was not part of an organised worker group, noted that,

“In my hometown I had a big tea stall. As I don't have skill to do another job, after coming to Lima, I commenced this temporary tea stall for last three years. I use kerosene stove to make the tea. As it is a temporary shop, so that it is not possible to use the gas stove. Beside this, wooden oven is cheaper but it is not very comfortable. I run my business from morning to evening. If I stay for dark, I must stand under the street light post.”

While a *Jalipa* food vendor in Dhaka also noted,

“When I finish my work I can carry my [kerosene] stove easily as it is light in weight. But gas cylinder is heavy so it's tough to carry and dangerous. So to me stove is more appropriate for my profession.”

This also highlights that while new, more productive, more efficient and more environmentally friendly technologies are being developed and are available to informal workers, the lack of appropriate transport, the lack of secure storage, and the lack of reliable power, all have critical bearings on the technology choices they make to ensure their work opportunities are both as stable, secure and easy to operate as possible, within the contexts in which they operate.

The power of light is another crucial energy technology for street vendors. Without sufficient access to reliable and stable light, their hours of operation are curtailed, and their safety put at great risk as the days darken. Street vendors across the cities had varying access to power for light. *Emolienteros* in Lima, some of whom were part of an organised worker group, were able to secure permanent spaces for their trading vans and were able to access the grid energy system to use to power both lighting technologies as well as power for other technologies, such as refrigerators. Thus, security of place not only has an impact on the security of the work opportunities, but also on the technology choices available to the workers.

While most workers talked of kerosene lamps used for lighting, several did mention the emergence of pico-solar lanterns too, although only a few of those interviewed owned or used solar lighting products, all in Lima. An increasingly pervasive technology for vendors was rechargeable batteries used to power their lights, particularly in Dhaka. These battery units were seen as convenient as they were cheap and could be charged overnight, although they were heavy.

How energy access is regulated, provided (or not), and enforced, varied significantly in each city. In Dhaka, street vendors were largely excluded from accessing grid energy supplies, with a handful of vendors with established (although not secure) vending spots tapping illegally into power lines, but facing poor quality connections. An iced coffee vendor in Lima highlights the issues with accessing the grid system as an informal street vendor: “The most important technology for my work is generator. In this place if I want I can easily get electric connection. But the problem is that in this street all the vendors use one line. In my business the blender needs a lot of electricity. So if I use the common line, it causes problems for other street food vendors. My generator is a local one, so it easily gets damaged and needs frequent repairs, but without this generator I cannot do business.”

Durban faces electrical energy constraints in general but a conservative policy regarding its reticulation in public spaces for the use of street vendors is a further limitation to the more pervasive use of higher order street technology. This has however, given rise to a substantial business opportunity in battery charging and DC current technology e.g. music vendors and street barbers. But it is clear that enabling equitable access to energy services, regardless of the type of work, has clear benefits for work opportunities for informal workers. This is highlighted by an informal water vendor and toilet operator in Nairobi: “I operate toilets and sell water. The toilets were installed with electricity for lighting inside, so my customers don't have to be in darkness. Before, the toilets were in darkness, which was difficult for customers and a little scary. Now I have more customers. Because I have a legal connection for electricity, I pay a monthly bill for power for around 500 shillings (\$4.94).”

“My name is Anis. I sell halim (a soup made with dal and meat). I came to the city and started this business for last 20 days. I sell the halim with a four wheeler cart. Still I can not make a fixed place for my business. I sit beside a market and any time police can get me out this place. So I have no work security at all. In my work the most effective technology is the stove. Because halim has to be warm all the time otherwise people won't like it. But I have to be able to move my cart and stove if police get me. I also need electricity as I sit afternoon to night. I don't have any power source so I work with the light that came from the shop of the market. Per day I get 500 to 700 taka (\$6.39-\$8.94) as profit. If I could manage the power supply I can add some more item in my business.” Anis, street food vendor, Dhaka City, Bangladesh

ICTs

The role of ICTs in street vending varies across the cities. Few vendors in Durban noted the use of ICTs in their work, and none of those interviewed in Bangladesh spoke of using ICTs for work or for organising. However, the high use of ICTs in both Nairobi and Lima among street vendors could be attributed to the more organised nature of the work. In both Durban and especially Dhaka, street vendors largely operate as individuals. The mass rural-urban migration to Dhaka appears to be a key factor in the lack of organisation, as the new urban residents lack the social capital to form strong, organised worker groups.

In Lima, street vendors (as with waste pickers) described how they used mobile phones to communicate with their fellow workers, to warn of any risks, and to communicate with suppliers, “It allows me to convey information in a speedy manner.” (street vendor, Lima).

In Nairobi, ICTs were the central tools of the soap and water vendors. Mobile phones were used not only for organising and communicating with supplier, and indeed customers, but crucially the role of mobile money payments through the M-Pesa system has made mobile technologies a vital tool for improving work opportunities in Nairobi. As one female soap maker explained:

“I have been making soap for three months, and have been using my mobile phone for my business for one month. Before, I didn't have any customers who would use a mobile phone to contact me. Now my customers use the mobile phone to call me when they are ready for me to go to them and they can also pay me money they owe me for the soap. I also call my customers to let them know I have soap to sell, or to remind them to pay me, as most buy on credit. Having a mobile phone makes my work easier in terms of connecting with my customers.”

Mobile payments are only just beginning to emerge as a commonly-used technology in other cities, and no respondents outside of Nairobi cited their use. But given the impacts this has had on multiple work sectors in Nairobi, in terms of increased work opportunities, increased security (by not having to handle cash), and more reliable informal credit options, one can identify this as a key potential trend in positively changing work opportunities in other areas.

But ICTs in Nairobi have played other key roles for informal street vendors. In the struggle to deliver adequate water supplies to the growing slums of the city, informal water vendors have provided a critical service to the city's poor, disconnected populations. But unlike other vendors, such as the *emolienteros* in Lima, their work is almost entirely dependent upon the proprietary technology of the water and sanitation services provided by the City government and others, by legally and 'illegally' tapping the mains resources with a variety of adapted pumping and bottling technologies. Thus, governance of water systems can become incredibly fraught as conflicts over the scarce water resources arise. As a male water vendor explained:

“I used to use NCWSC water meters, and only the staff could explain how they worked. Now, we can pay bills through the phone, and see how many units of water we have used. The technology has made it very easy to access the meter. Also, Maji Voice (mobile phone app) allows me to voice a complaint, connect with customer care (at the NCWSC), your meter can be fixed, the installation of the meter can be made easier, and your complaints can be recorded for reference. The reference gives us legal safety, in case you have to raise an issue in court. There was a time that they (the city) were making a sewage line near where we had our pipes. The city tractor broke the pipes. We used Maji Voice, and they came in five days to fix the problem.”

This signals that, as the use of mobiles becomes increasingly prevalent among informal workers in other cities, ICT-based governance systems could be a useful way to enable more inclusive economies and respond to the needs of the poor. However, the Maji Voice system, in its current state, is not responding to the needs of informal water vendors and working against inclusive economies in the water service sector - only 'registered' water vendors can be included in the system, despite 60% of citizens in Nairobi being served by informal, unregistered vendors. Including informal vendors into this system could not only improve water service delivery across the city and informal settlements, but also create enhanced economic opportunities for informal water vendors, and increase their work security.⁵

Transport

For street vendors, who are not only mobile in their daily business activities, but also must move vast quantities of goods across the city, and travel daily from their homes to their areas of work, transport systems are a significant variable in their ability to seek viable work opportunities. In

⁵ Douglas, 2015, Tapping into Informality: the suitability of MajiVoice as a tool to improve water service delivery and governance in Nairobi's informal settlements, Edinburgh University

Nairobi, the woefully poor roads and paths which extend into the slum areas and informal settlements make transporting goods extremely difficult, and can make transport throughout the city both slow and dangerous. In particular, during the rainy season, the roads become muddy and impassable, especially for vehicles and heavily loaded barrels, significantly impacting on the work opportunities of the informal water vendors, as well as having a dire impact on other economic and work activities, as well as access to basic services, such as clean water. In Lima, many informal settlements are at risk of landslides, which in addition to the tragic human cost also destroy roads.

And in other cities, the lack of suitable, affordable and reliable public transport systems forces street vendors to take expensive, difficult, and time consuming routes. They also face problems with arranging private transport (especially taxis) when laden with goods and technologies. As one trader in Durban argues, “Sometimes they [taxi and bus drivers] don’t want to pick you up, they say they don’t go where you want to go”, while a street vendor in Lima points out that “The metro works until 10 pm. So when I am done there is no metro.”

Workers in Durban and Lima also noted the impact of increasing private transport fares (mostly from taxis) has on their ability to work and their income-earning potential. These costs either have to be absorbed into the already very marginal profits of informal street vendors, or passed onto the customers, potentially having a negative impact on the vendor’s competitiveness. As a street vendor in Durban noted, “When the fares go up, we end up working to cover transport costs, not to earn a profit” (FG4, Durban).

This highlights the need for public transport systems to respond to the needs of all communities within a city, and not just the wealthy living close to the city. Improving public transport systems which reach the areas street vendors use, live and work, could not only improve the viability of many street vending work opportunities, but also improve the safety of the workers, and provide opportunities for workers to invest in improved technologies for enhanced productivity, to create growing, inclusive economies.

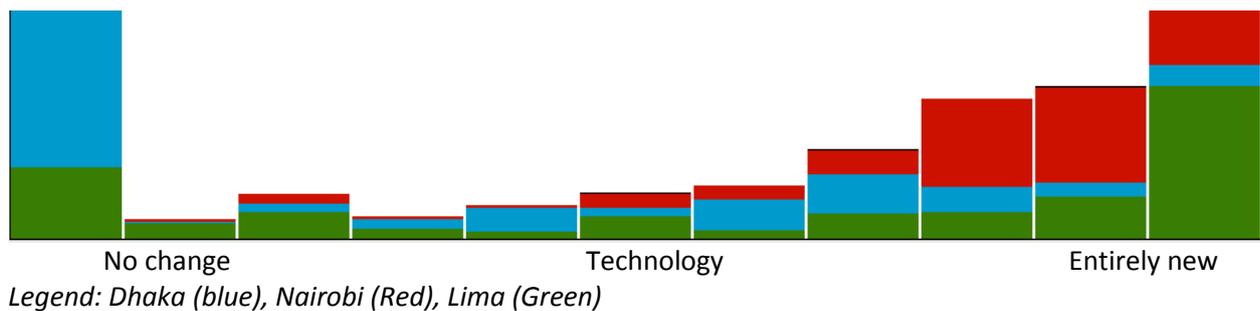
Waste pickers (All cities)

Informal waste pickers provide vital services in each city, filling the vacuum left by public or formal private waste clearance services, in particular in hard to reach areas. Their work is also crucial to maintaining circular economies of recyclable materials, reclaiming vast quantities of reusable and recyclable materials from public waste. However, their work is often poorly remunerated, unrecognised, extremely unsafe, and utilising only the most basic technologies.

Tools and technologies

There were marked differences between informal waste workers across the cities, however. Those in Dhaka responded that the technologies in their sector had rarely changed. They also signified that in most cases they did not own the technologies they used in their work. This is in stark contrast to waste workers in Lima and Nairobi, who largely signified that the nature of technology in their sector has changed significantly in recent years; and in Lima that they were using modified technologies which they owned.

Graph 2 – Technology Change



Socio-cultural factors also played a key role in technology adoption and use, particularly in Dhaka. Workers there spoke of eschewing personal protective equipment, such as rubber gloves, boots, and picking implements. Workers spoke of being seen as “not a friend of the waste” and “not one of us” if a worker were to utilise personal protective equipment; while yet others spoke of the need to use bare hands for more intricate work and separating waste, with gloves “uncomfortable”, “sweaty” and “unhelpful” in such tasks. This may in part be due to the lack of social capital among informal waste workers in Dhaka, many of which were recent migrants to the city; thus conforming with existing social norms within the sector would be important to assimilate into the new community and secure their ongoing work opportunity.

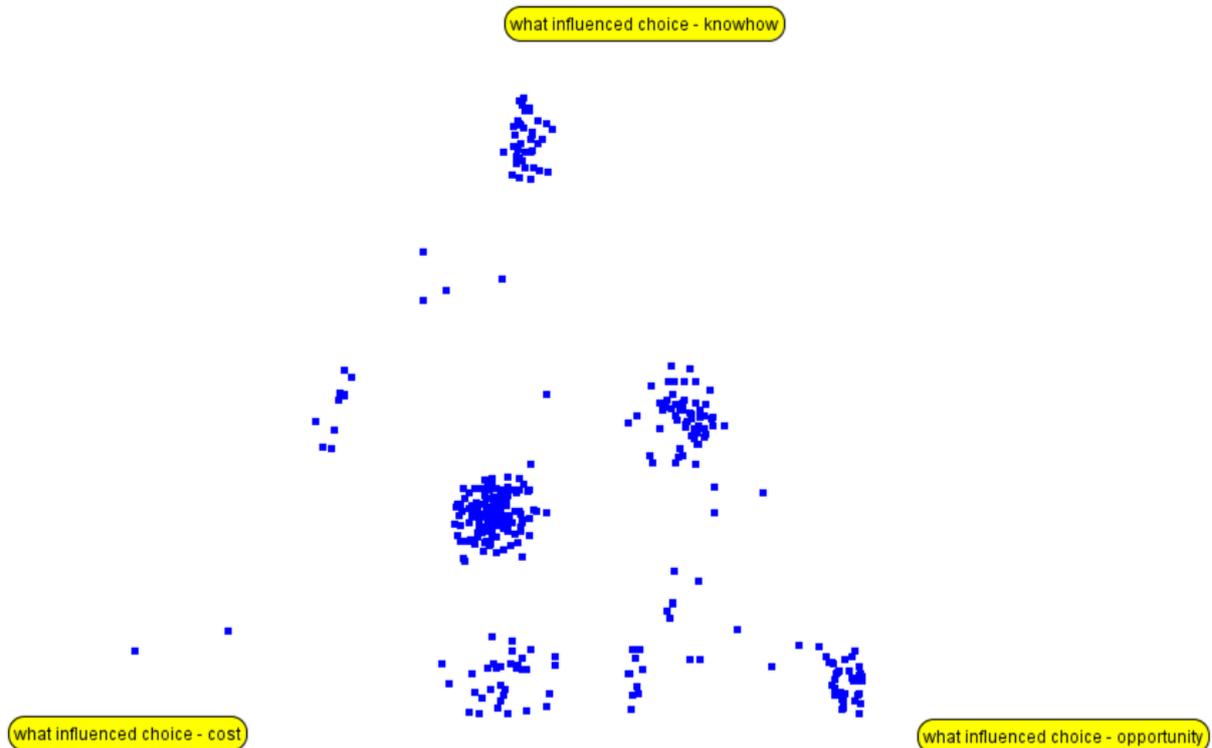
Informal waste workers in both Lima and Nairobi were central parts of hotbeds of frugal innovations. These included modified tricycles and custom-built motorcycle carts in Lima, used for transporting waste and recyclables across the city where workers teamed up with local craftsmen to design and develop their carts; and waste processing units in Nairobi, used for shredding, compacting and packaging card and plastics into uniform blocks which sold at a premium price, developed from scraps of discarded technologies in partnership with local civil society organisations. These findings highlight that when waste workers are given respect, recognition and stability in their work, they are able to create great opportunity from innovative technologies, with greater capital investments, often through collective pooling of resources through worker groups .

Nonetheless, for many waste workers (such as workers in Ahmedabad and Durban), the tools and equipment remain basic - sacks, jute bags, gloves, barrows and trolleys. These remain critically important to informal waste workers, who struggle to access many areas with larger mechanised collection vehicles due to poor road conditions, particularly during rainy seasons. Steep, narrow, unkempt and often muddy roads can make vans and even many barrows, impossible to use.

Moreover, though there are examples of technological investment in higher end technologies in the waste sector in Lima, only a few waste pickers in Lima can afford a modified moto-taxi to transport their recyclable materials, and they are mostly men. If women can afford a moto-taxi, skills may still be an obstacle to their making full use of it. One woman waste picker indicated while she owns one, “I still haven’t learned how to drive it” (Lima, micro-narrative).

As indicated in Graph 5 below, 84% of respondents across Lima, Dhaka and Nairobi signified more strongly with “secure work opportunity” compared to “know-how” and “cost”. Interestingly, in Graph 5, those that signified more strongly with “know-how” were mostly (70%) negative stories, indicating it was a *lack* of know-how about other technologies that limited their choice to existing basic technologies.

Graph 5 - “What influenced the choice of technology in your story?”



For waste pickers in Durban, the essential tools of their trade, used to break down appliances and other sources of metal, are a hammer, a chisel, a screwdriver or spanner, and an axle saw. However, possession of these tools - which are essential for their livelihoods - also make them vulnerable to police harassment and confiscation. This is because, as workers explained, the tools they use in their scrap metal recycling business are the same ones that criminals use to break into houses. The police therefore assume that they are in possession of these tools because they *are* criminals and are plotting to use them to carry out burglaries. This sector's technological ambitions are artificially constrained and thwarted because of the workers' vulnerability and harassment by prejudiced public and enforcement agencies. Punitive enforcement denies the acquisition of appropriate technologies. As one worker claimed,

"Police come at night and confiscate our goods. They throw them away and sometimes beat us. They say your trolley is not permitted on the roads and then they confiscate it." (Micro-narrative, Durban)

As such, city policies affect types of technology adopted by workers - at times leading them to downgrade because of punitive policies. In Durban, the waste pickers no longer carry knives or blades for fear of being arrested under the "Nuisances and Behaviour in Public Space" law adopted by the Durban eThekweni municipal council in June 2015. This restriction is particularly hard on the cardboard recyclers who need knives to break down cardboard boxes and cut rope to tie the cardboard pieces to their trolleys. Inappropriate tools for hazardous work results in occupational health and safety risks e.g. cardboard recyclers are reluctant to carry knives for fear of being accused of criminal behavior resulting in them using razor blades with exposed edges instead of box cutters, designed for the purpose. Wider policy issues can also impede technology options and work opportunities for informal waste workers. In Lima, companies refuse to sell insurance to owners of motorized three-wheel vehicles, a common technology used by waste pickers.

Yet city policies can also be positive and empowering for informal waste workers, also affecting the types of technologies they use. In Lima, where district municipalities like Los Olivos have included waste picker associations as part of the waste management system, waste pickers work more safely. They have better conditions than other parts of the city: for example, they receive recycled materials from neighbors, work during the daytime, and wear uniforms and safety gadgets. This creates more decent work opportunities, and greater work security.

Like street vendors, the lack of appropriate infrastructure (such as storage spaces) impedes technological investment. A lack of a secure space to store goods and equipment at night inhibits investment in tools and equipment as well as stock. Waste pickers often need a place to store recyclables they have collected, if they cannot sell them right away.

Organisation

Waste workers in Dhaka were also largely unorganised. While more than half of those who participated in the research were self employed, one third worked on behalf of the city corporation (although not paid to do so, they receive access to waste collection vans and guaranteed routes). Yet none of the workers were part of worker cooperatives or other worker groups. This may in part be due to the transient nature of informal work within the waste sector in Dhaka - many respondents spoke of having moved in and out of waste work in recent years and months, and equally many street vendors spoke of having transitioned from waste work to street vending. Therefore those not working on behalf of the city corporation may not associate strongly enough in the sector to engage in worker groups, while those registered with the city corporation may fear losing their work opportunities if they were to challenge existing conditions (focus group findings).

In contrast, waste workers in other cities leveraged the power of collective action and organisation to improve their working conditions and work opportunities. This was also enabled through the fact that workers in most other cities owned their technologies and tools, unlike those in Dhaka. By gaining legal recognition and safeguards, as well as being provided with appropriate personal protective equipment, and respect and recognition through wearing uniforms, waste workers in Lima achieved greater security and recognition of their work in the city, so workers were more able to invest in new technologies and invest the time, effort and resources to innovate their technologies as well. Their uniforms also bring an added protective component to work, as the recyclers' vests, for example, have a reflective strip that helps make them visible at night, when many are out collecting waste from households. Through membership-based organization (MBO) and co-operative support structures, shared and / or supplied technology is available to enable, improve and dignify the waste collection activities.

Energy

For most waste workers, the energy system was not a pivotal aspect of their day to day work. The majority of their work involved manual tools, or mechanised transport. However, some workers in Dhaka and Durban noted the value of street lighting, which - where available - enabled them to work for extended and more flexible hours; "In winter, if the street lights are not on, we hesitate to arrive before the DSW workers due to the risk of operating in the dark" (Durban WP, FG 11, female). Some workers in Dhaka also noted that street lighting enabled them to collect waste before others, highlighting the competitive nature of such work, despite the marginal income available and the poor working conditions.

The poor quality of energy access faced not only by informal workers and inhabitants, but also of formal businesses, has an indirect impact on the work opportunities of informal waste workers. Their livelihoods depend upon access to waste from both households and local businesses. But

waste workers in Durban complained that, “When there is load shedding, the shops from where we collect recyclable materials close and we do not have access” (Durban WP, FG 10).

These issues highlight that interventions to create inclusive economies must look beyond direct support to informal workers, but to engage with them to understand the full range of related services and infrastructure which impact upon their work opportunities and livelihoods; and that there may be interventions - such as improving energy supplies - which can have multiple complementary benefits for those in both the formal and informal economies.

But interventions must also consider who will benefit and who will not. In Dhaka, there are highly gendered splits between different roles within the informal waste management system. Women are largely not allowed (through social norms) to be involved in the street collection opportunities, which also includes the retailing of separated recyclable materials. They are largely confined to the hazardous separation and sorting roles away from the streets. Thus men will benefit more than women from investments in energy service improvements, compared to investments in personal protective equipment, transport, or safe separation technologies - their critical role in the waste management value chain will remain out of sight and out of mind.

Transport

Public transport between workers’ place of residence and place of work is often costly and infrequent or unreliable; and, typically, transporting goods is banned. Most informal workers have to resort to private transport of different kinds; or commute and transport goods on foot. “[The transport system] does not help us. Sometimes the buses do not want to pick us up...Sometimes I might wait until very late and they (buses) do not pick us up”, argued a group of waste pickers in Lima.

The situation for informal waste workers is similar to other workers - public transport systems do not respond to the needs of informal workers, while private transport systems remain too costly for many to utilise. There also remain issues of access to these private options too, with many services failing to cater for informal waste workers in either the locations in which they live and work, and the times at which they need to commute. Changes to more affordable public transport systems in cities which meet the needs of informal waste workers could significantly enhance work opportunities and reduce the commuting costs and time associated with this already demanding and poorly remunerated sector.

The state of the road networks in each city also present huge challenges to informal waste workers, as well as fundamentally shaping the technology options available to them, and the innovations in technologies necessary to respond to those challenges. In Dhaka and Nairobi, there is a paradoxical relationship between the state of the road networks and work opportunities for informal workers. Where improved roads exist, it enables more automotive/mechanised waste collection technologies to be deployed as they are able to navigate the roads. As neither city has the capacity to deal with the full range of waste produced each day, both formal and informal actors operate, through contracts or through licensing. Those with more capital can invest in automotive collection technologies to operate in areas with improved roads.

This means that informal workers are largely pushed towards worse roads, where manual technologies are used to navigate the roads and collect the waste. These areas limit the technology options available and often required specific modifications to deal with the various conditions and types of waste collected. It may also mean that workers have to travel further to conduct their work, have less access to higher-value waste materials, and operate further from collection/selling/sorting centres (known as ‘dustbins’ in Dhaka).

Thus improving roads without changing the inherent system by which waste collection operates could marginalise informal workers to less lucrative and even more remote areas and reduce the work opportunities available.

But the regulation of “informal” waste work in Dhaka and Lima demonstrates different approaches to, and levels of recognition of, informal waste workers; and ultimately the technology options available to them. In Dhaka, workers can register with the City Corporation to collect waste from certain areas. But to register one must have a van - this presents a significant barrier to entry for many informal workers. Most vans require at least 2 people to operate it - a driver and a collector. In practice, entrepreneurs with access to sufficient capital tend to own the vehicles and lease them to informal waste workers who drive the vans for waste collection and receive a wage for doing so - but are not paid for the additional labour needed for collection.

Thus the drivers must then pay for labourers to help operate the van out of their salaries. They are also responsible for maintaining the vans and making any necessary modifications - where they are permitted to do so. Thus the confluence of both the transport system and the regulations over waste collection, which are tied to technology access, act to shape the work opportunities of informal waste workers in Dhaka.

Somewhat regardless of the transport system, privatization of waste management systems seems to have a negative impact on waste picker livelihoods. In Ahmedabad approximately 70% of the city is served by private waste collection. In parts of the city which still have municipal waste bins, waste pickers can reclaim waste but not all areas still have these waste bins and occasionally private garbage collection workers reclaim waste for themselves so access to waste is an issue. “It is difficult to find many recyclables in the dustbins as the municipal workers sort out and take the recyclables, so we have to go to nearby villages to find recyclables” (WP, FG 2, male). The often negative impact of privatization of waste management systems was also confirmed through the phone survey: the majority of organizations globally with waste picker members reported that privatization of waste management was currently impacting waste pickers in negative ways: reducing their access to waste and effectively banning them, even when they are organized into cooperatives, from bidding for solid waste management contracts.

Innovation

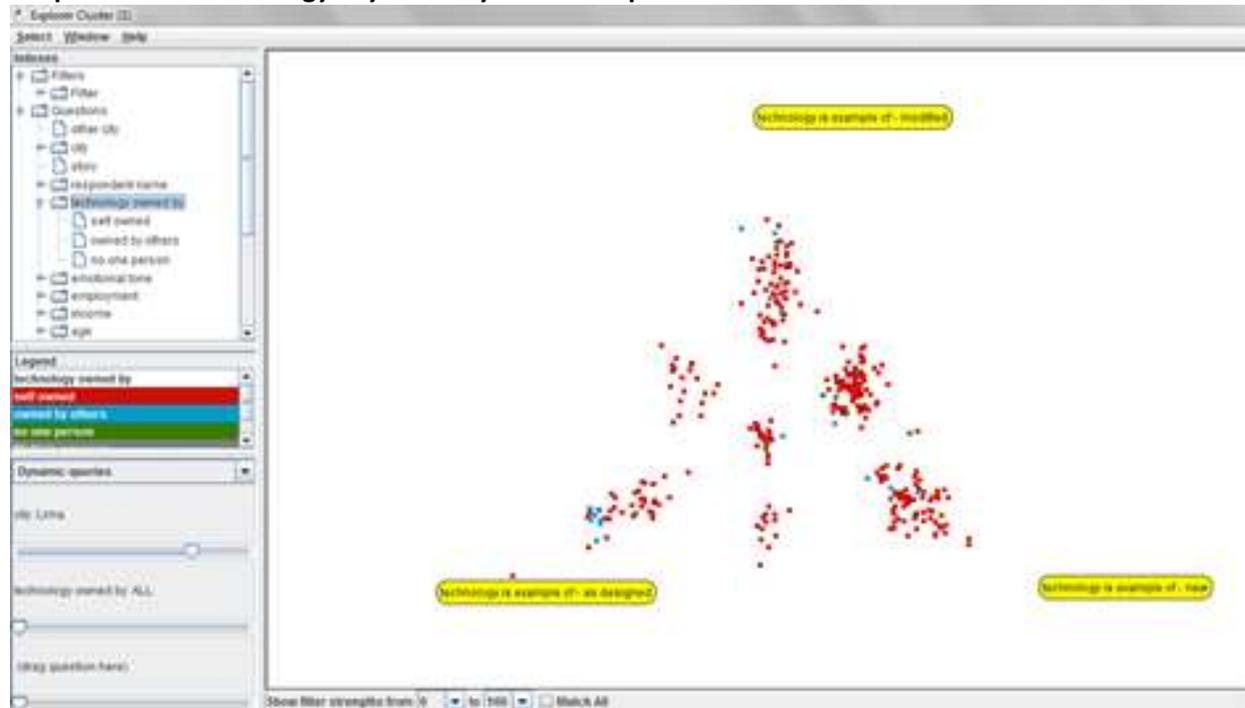


By contrast in Lima, informal waste worker cooperatives and member-based organisations have successfully lobbied to be included in and recognised by city government plans and regulations and operate city-wide. Many waste workers operating in areas with improved roads have been able to invest in automotive transport technologies, including a range of modifications (see image 2 for example of a modified waste collection vehicle).

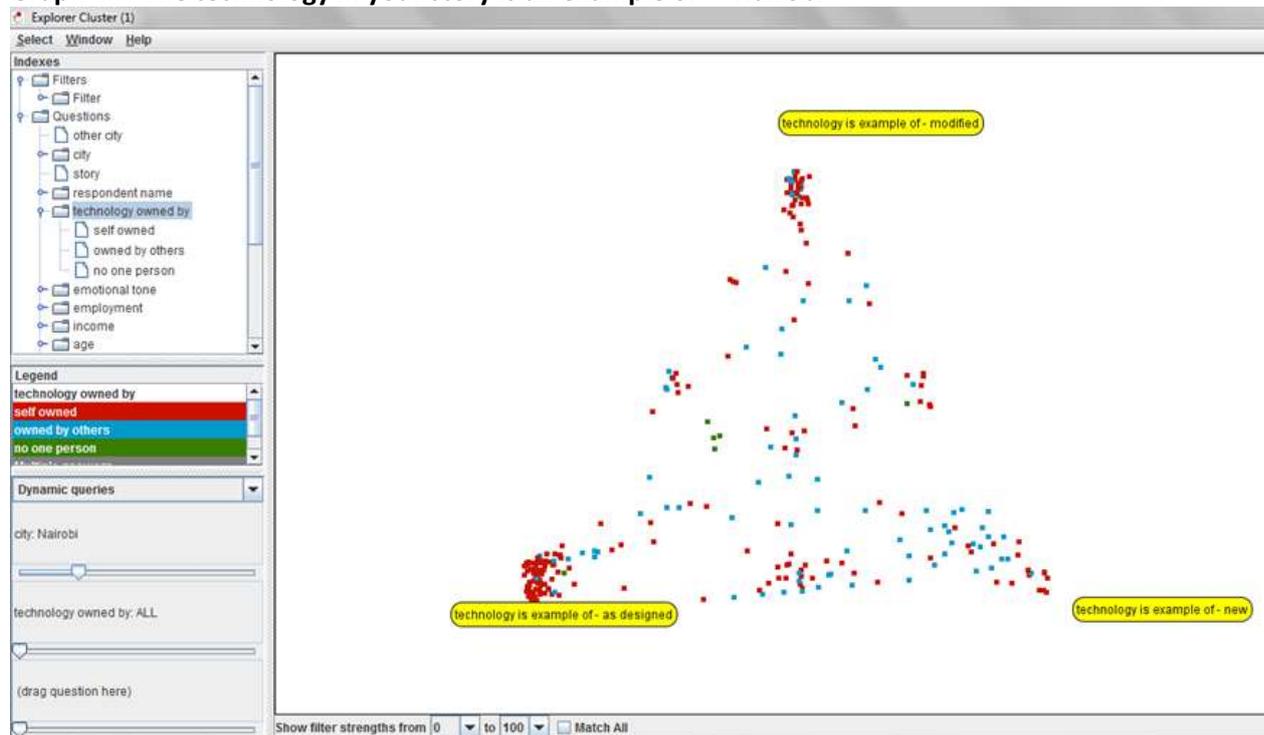
Image 2: modified automotive waste collection vehicle, Lima

But such innovations are only possible due to the ability of informal workers in Lima to own their own technologies, in comparison to those in Dhaka. Graphs 3-5 below demonstrate how, across Dhaka, Lima and Nairobi, informal waste workers' technology choices and modifications are shaped by both technology ownership and the wider systems in which they operate:

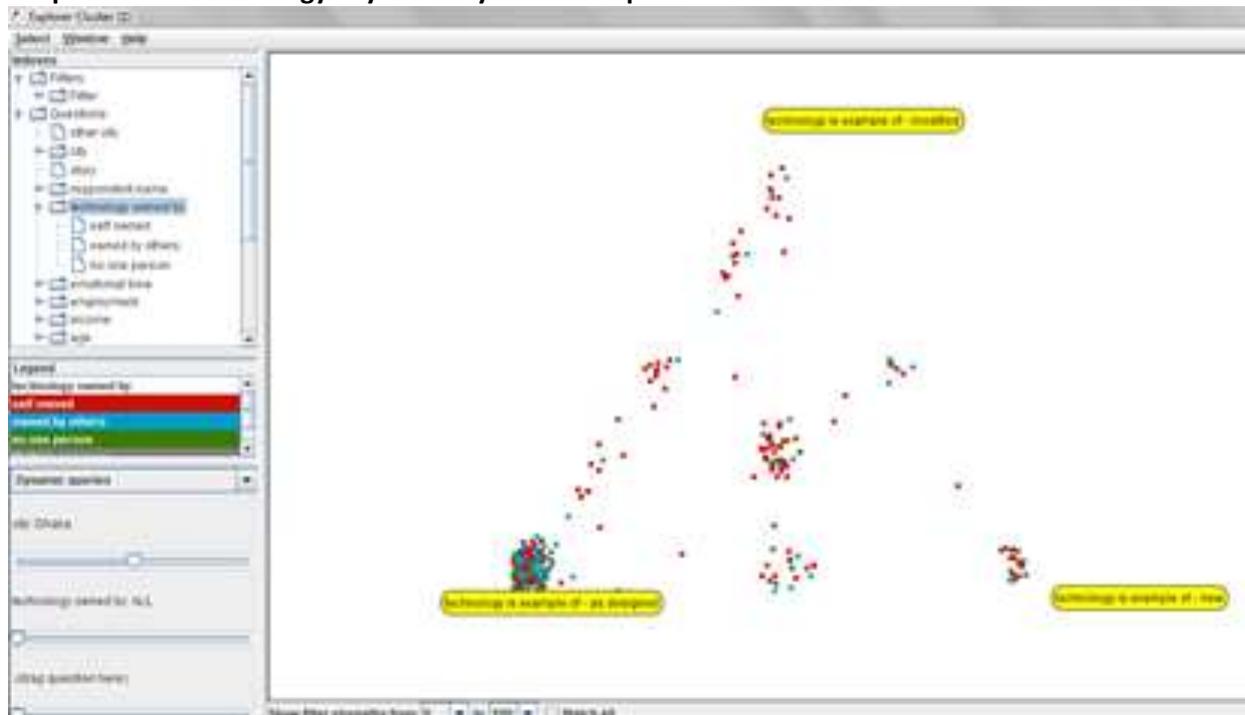
Graph 3 - "The technology in your story is an example of" - Lima



Graph 4 - "The technology in your story is an example of" - Nairobi



Graph 5 - “The technology in your story is an example of” - Dhaka



The organizations participating in the phone viewed mechanization in waste processing and treatment (such as through trash compactors) quite favourably, as it can enhance the dignity and earnings and reduces the physical labour of waste pickers, provided the mechanized technology is in the hands of waste pickers rather than in the hands of the dealers they sell to. Given the vast volumes of waste that must be dealt with in each city, the growing mechanisation of processes in this sector does not seem to have had the same negative impact upon work opportunities as in other sectors, such as construction or incense stick rolling.

Rather, the mechanisation enhances the quality of work, improves productivity, and increases both the value and the quality of the reclaimed materials, which can contribute towards maintaining material value - a key component of circular economies. This is assuming that waste pickers are included as actors in such mechanization processes. In Nairobi, informal waste workers collaborated with both civil society organisations, in particular the vibrant youth groups, which facilitated the organising of workers, as well as providing personal protective equipment, and matched the workers’ funds with their own to help collectively purchase waste processing machinery, highlighted by the story below titled, ‘Top Waste Management’:



The community used to dump their trash in the river. So we came together (Viwandani Pamoga Youth Group), and our kijiji (village) elders supported us. We started in 2008, and partnered with Jhpiego, Ministry of Health, PS Kenya and the Viwandani Comprehensive community Organization to fund our work. The shredder breaks down the waste plastics. Every community now has garbage sorters for metals,

plastics and organics. The aim of the project is to empower youth. We work with 20 youths weekly, rotating each week, and train them in the process and how to use our three shredders. The shredded plastic is then sold at the market for around 40 shillings per kg. We hope to someday get a pelletizer, because plastic pellets sell for 120 shillings per kg.

Image 3 – Waste worker, Nairobi

Energy

It should be noted that although waste-to-energy incinerators were not raised as disruptive technologies in the cities studied, they were raised as negatively disruptive for both informal workers and the environment in both the literature review and the phone survey of member-based organisations. This could simply be due to the fact that these systems are not yet being considered in the study cities. However, where such systems were being introduced, the intrinsic link between waste to energy incinerators and privatised collection and processing contracts, meant that many informal workers were 'locked out' of such systems, as they were unable to bid for contracts and their access to waste significantly decreased due to the emphasis on burning garbage rather than recycling. They have also been seen to work in opposition to 'clean city' initiatives, such as the 'Clean Dhaka, Green Dhaka' policy, as they fail to reclaim much of the reusable material, and pollute the environment.

Part 3 – Analysis and discussion

A. Technology has a role in decency of work, but not in new work opportunities

The research did not necessarily shed light on technologies which were in and of themselves generating work opportunities. Rather, several sectors are seeing the introduction of technologies which - while making productivity gains and decreasing manual labour in particular work processes - have the potential to displace workers. Only those who are able to gain relevant skills to operate mechanised technologies, invest in technologies themselves, or are able to harness the positive transformative power of such technology developments will be able to benefit. This raises questions, particularly with reference to worker groups including incense stick rollers, garment workers and construction workers, about the costs and benefits of particular technologies and their impact on work. The workers likely to bear the biggest cost of the introduction of new technologies in these sectors are those that are the most vulnerable: informal workers, in particular women.

However, developments in certain technologies, including improved energy access, improved telecommunications, and more relevant transport systems, can all help to expand and improve existing work opportunities, and make them both more decent and more stable. A key finding of the research is that it is not the availability of work opportunities *per se* which drives worker's choices in what they do, the technologies they use, and where they work, but rather the stability of that work - workers are actively selecting technologies which are more "low-tech" as this enables them to have more secure and stable work.

B. Importance of Access to Public Space and Public Goods

A key finding across several sectors was the link between the work stability and security of the informal workplace, their ability to access and use public goods and the type of technology chosen and used. For street vendors, waste pickers, market vendors, barrow operators and some garment workers, public spaces are their workplace: they sell products on street corners, collect waste in streets, deliver goods to vendors in public spaces, sell food or other goods in public markets or produce garments in open areas (as in Durban). Insecurity in their workplace – as a result of being chased away, arrested, harassed or having goods confiscated means that workers may be deterred from investing or using newer technology. Examples in the research abound: waste pickers in South Africa no longer carry knives or blades to help break down cardboard boxes for recycling for fear of being arrested under the "Nuisances and Behaviour in Public Space" law adopted by the Durban eThekweni municipal council in June 2015; some street vendors in Lima noted they sell from a small bag because selling larger quantities might attract the municipal police who would seize their possessions; while by contrast garment workers in Durban have permission to operate from a secure public space which has enabled them to invest in and use technology (sewing machines).

For street vendors, market vendors, barrow operators and other informal worker groups, having access to public infrastructure such as electricity, water and affordable and well-located storage space are also essential to their livelihoods. In cases where workers have stable and affordable access to public goods, this has helped enable technological use and investment. For example, market porters in Lima who have access to secure storage at their workplace are able to invest in and store their pallets and stockers while market vendors in Lima who have relatively reliable access to water, electricity and storage have been able to invest in slightly more sophisticated technologies (such as refrigerated display cases).

Thus, creating environments in which workers can invest in new technologies, and with a degree of stability, is crucial to enabling more inclusive economies and supporting new work opportunities. Characteristics of such enabling environments include, *inter alia*, secure land tenure and/or the right to work in public areas, access to basic infrastructure at the workers' workplace (including for safe storage of technologies), regulations which recognise and support informal workers, targeted skills training opportunities, and innovative financial access initiatives which target informal urban workers (i.e. not based on rural-style collective credit/savings schemes).

C. Critical role of organising

The research has shown that organizing is a key pathway to facilitating informal workers' being able to access technologies, to capture the full benefits of technological change, or to mitigate the negative impacts of particular technologies. Organising not only supports workers to act together to advocate for regulatory change in their favour to create greater work stability and inclusion in more formal work systems, but also to share technical knowledge, jointly adapt and innovate technologies, and collectively invest in more modern or "high" technologies and/or storage space for them, to progress beyond basic tools and precarious livelihoods.

Organising can also help workers to access opportunities otherwise only available to formal organisations. In particular, the research (literature review and phone interviews) highlighted the ability of organised waste workers in South America to mitigate the potential negative impacts of waste incineration technologies by securing waste management contracts with municipal governments or by advocating for alternatives to waste incineration technologies.

However, where work remains unsafe, irregular and badly remunerated, workers will seek to find alternative work opportunities where possible - particularly those where the skills and technology entry points are low. This is particularly the case in Dhaka, where few waste workers are organised, as few want to remain in this profession and often use it as a temporary stop-gap between other opportunities. But with waste a rapidly growing resource - and issue - to create a growing, stable and inclusive economy for current informal waste workers, proactive - and not just responsive - measures must be taken to integrate workers into policy initiatives such as 'Clean Dhaka, Green Dhaka', to reduce the technology barriers to entry in municipal waste management contracts, and to provide suitable personal protection equipment (PPE) to all waste workers.

D. The need for supportive institutions

The research highlighted that in each city, the responsiveness and supportiveness of key institutions, in particular city governments, was critical to the ability for informal workers to seize new – and better – work opportunities, to expand their entrepreneurial activities, and to harness the positive power of new technologies in their working lives.

In many situations, informal workers told of experiences of being unable to undertake their work due to, *inter alia*, being forced from their areas of work by local authorities, being ignored and excluded from local planning processes which disrupted their work activities or places of work, having their technologies confiscated - such as sharp objects fashioned by waste workers to cut materials, or durable small-scale water pumps innovated by informal water vendors, a lack of land rights which discouraged investments in new technologies.

Due to such pressures, workers were unable to realise the positive potential of new technologies, and often actively chose to invest in old, less productive technologies out of fear of losing higher value purchases. Equally, many vendors spoke of the need to invest in particularly lightweight technologies to enable them to be rapidly mobile when being moved from location to location by

local authorities. This therefore not only limited their technology choice *vis-à-vis* licenced traders, but also narrowed their technology choices to less environmentally friendly technologies, such as kerosene stoves.

The key difference between cities with more supportive institutions, such as Lima, and unsupportive institutions, such as Dhaka, was that informal workers in Lima had gained greater recognition in law as providers of vital public services - be it waste management, or the preservation of traditional cultural good (those retailed by *emolienteros*). Their legal recognition gives them a basis from which to bring about incremental improvements to their livelihoods, and above all else a degree of legitimacy and stability which makes for a more stable work opportunity. This in part enables informal workers in Lima to take the risks of investing more in new technologies to enhance their livelihoods and capture the positive benefits of new technologies, while also working collectively, and with local institutions, to mitigate the more negative impacts of new technologies in their respective sectors.

Additionally, more stable market systems also helped informal workers in Lima plan for future technology investments and begin to develop business plans around such technologies. *Emolienteros* in Lima explained how the joint nature of both having formal recognition of their work, and a steadily growing local economy of working class customers, had helped them to gradually upgrade their technologies and make plans for both expansion of business and joint investments in technologies to improve productive efficiency.

This is in contrast to Ahmedabad, which while generally being seen as a more responsive and supportive environment, the stability of local economies was a significant factor in the ability of informal workers to ride the waves of technological change in their respective sectors. Garment workers in Ahmedabad spoke of the need to invest in relatively expensive new sewing machines to produce the specific garments in trend and in demand by retailers. Yet investments in such highly specialised technologies were often difficult to rationalise in the face of a highly fluctuating market – both in terms of textile trends, but also of the price volatility of the garments.

On the other hand in Dhaka, institutions and regulations marginalise informal workers. They are not recognised in local policies, their rights to public spaces are insecure at best, and their lack of status in law leaves them to lead fragile and precarious livelihoods. This deters - and often prevents - workers from investing in new technologies and there are few if any safeguards to help them to mitigate negatively disruptive impacts of new technologies.

In Nairobi, the responsiveness of the city institutions is somewhere between those in Lima and Dhaka, but there are certainly efforts by city institutions to engage with informal workers. Equally, the supportive policy environment for entrepreneurial activities in Nairobi, makes graduating up both the technology and work 'ladders' more accessible. However, the research shows that this is often enabled mostly from responsive and well resourced civil society organisations, which to some degree fill many of the voids left by the city institutions.

E. Basic technologies prevail, yet innovation is rife

Despite notions of emerging technologies and disruptive innovations dominating media headlines around the world, informal workers are largely disconnected from such technological advances. Even at a firm level, informal firms are unable to seize competitive advantages from new technologies. In many cases, this is largely due to the relatively prohibitive cost of such technologies. But this is compounded by the exclusion of many informal workers in urban areas from accessing appropriate finance products. Even in Bangladesh, where there is a well-established and very 'poor' microfinance sector, informal workers in cities are excluded from accessing such financial

products as they tend to have no fixed abode, and do not operate in the same community structures as found in more rural areas, which micro-finance systems often necessitate.

Equally, most informal workers and informal firms are currently low down on the 'ladders' of technology - those tools and technologies which have been around for many years, are affordable and accessible, and perform specific functions well. Thus their investments in 'new' technologies are often steps up this ladder (for example improved stoves, improved carts, or improved sewing machines), but still lag far behind investments by formal firms and workers into high technologies, which require greater capital investment, a more secure future, and sufficient space and security to store and operate the technology.

Nonetheless, the research uncovered hotbeds of innovative activities in each of the cities. Frugal innovations were apparent in every sector, as workers individually and collectively made the most of the resources at their disposal to improve both the efficiency and decency of their work. This included specially adapted water pumping and filtration systems in Nairobi, made from scraps of other technologies; custom-built motorised tricycles in Lima used to expertly navigate difficult city roads to carry municipal waste, adapted trolleys and barrows to carry heavy loads of water in Durban, and handmade rolling boards in Ahmedabad used to improve the physical nature of the work of incense stick rollers.

The groups who were most able to capture the benefits of technologies and innovate were those that were able to organise and collectively bargain for greater technology access, or collectively invest in new technologies. They were also those most able to connect with vitally important 'meso level' institutions, which act as conduits between technology developers and the workers. Such institutions included CSOs, NGOs, and local universities.

This highlights the particular role of knowledge and 'knowhow' about technologies as a key determinant of enabling innovation. Access to ICTs, and their use in work activities, appears to have a positive impact on workers' propensity to innovate, often from learning of what peers in their profession are doing. However, many informal workers still lack literacy levels to be able to harness and use such technologies in their work. Networks of knowledge, underpinned by workers organising for change, are an important factor in supporting local innovations. This is negatively highlighted in Dhaka, where there is little organising among workers in the study sectors, and where workers rarely spoke of the use of ICTs in their work, which was further confirmed in focus groups, examples of technology innovations were rare, and significantly more workers signified no change in technologies in their sector compared to Nairobi and Lima.

The findings of this research support those by ODI on the characteristics of successful and appropriate 'autonomous innovation' in developing countries; those that are inductive (arising from non-experts, the workers themselves), indigenous (arising from local needs and locally available resources), inexpensive (as workers have little capital available to invest), intuitive (those that don't require specialised skills or knowledge, and are 'good enough' rather than market leaders), and iterative (workers are regularly adapting and innovating basic technologies in response to changing opportunities and contexts).

F. Gendered differences

The research revealed that women face differentiated and greater challenges in realising the benefits of technologies, and mitigating the negative impacts on their work opportunities of some technological disruptions. The cost of travel for women was one particularly prohibitive factor, with women having to travel further, longer and often on different modes of transport, spending up to 80% of their income on commuting. This is often because they had to work in more marginal areas,

earned less income from their work and hence could not afford alternative transport options, or did not own their own means of transport.

Women also faced further difficulties in that they are socially excluded from certain types of work, greatly limiting their ability to seek new and better work opportunities, and access and invest in new technologies. This is evident in the waste sector, especially in Dhaka, where there are highly gendered roles, with women not often accepted in roles which enable them to sell on valuable recyclable and reclaimed materials. The confluence here of cultural norms, religion, and economic disempowerment, compounded to consign women to the more hazardous work of separating and sorting waste. Their lack of opportunities to gain skills due to cultural norms, such as a driving licence, further prohibited their ability to access and utilise certain automotive technologies, and seek more decent and better remunerated work opportunities. Similar phenomena could be found in Ahmedabad where women construction workers, most of whom are unskilled labourers, face significant challenges in accessing training to upgrade their skills and discrimination on construction sites where even if they have skills, are offered more work in manual work. Home-based garment and incense stick rollers in Ahmedabad also worked at home due to cultural constraints limiting their mobility outside the home. Given many of these workers live and work in slums, their ability to adopt higher end more energy heavy technologies is particularly challenging.

In some cases though, technology has empowered women informal workers. Mobile phones in Nairobi have enabled female soap makers to connect with customers far beyond their traditional customer base, to order supplies in a timely fashion and arrange to have goods delivered and collected. This has reduced their commuting costs and time and significantly increasing both their efficiency and income, as well as improving their safety, as electronic payments using the M-Pesa system enables them to make transactions without carrying large sums of cash. Nevertheless, despite Nairobi being one of the most connected cities across developing countries, there is highly-gendered differences in mobile access, with just 20% of women able to access the Internet. What is different about workers interviewed in Nairobi compared to Dhaka is their different status in society, and the range of support they have received from civil society organisations to undertake entrepreneurial activities. Two female soap makers highlighted the power of technical and general knowledge gained through a civil society initiative, and their abilities to then innovate this technology to improve their businesses:

“When the cholera outbreak happened here, customers for our soap business increased. People were scared of getting sick, so they began to buy more soap. We [National Youth Association] trained the community on better hygiene by training our caregivers who teach others, and we also teach people on the soap making process. Knowing how to make soap enables people to sell it and earn some money to buy food for their family, because as you know, there are many poor people here (Kawangware). Now, cholera has gone, but our customers haven't decreased because now they are more aware of the importance of good hygiene.”

“For me, knowledge of soap making is a technology. I joined a group of friends that made and sold soap within the community (Kawangware). They taught me how to make soap, and I have been doing so for ten years. My knowledge of soap making skills have changed a little over time - for example, we use more colours and scents now. I also have learned how to make bars of hard soap for the skin. I now teach other women how to make soap.”

The gender-responsiveness of public transport planning can also have a significant impact on tackling gender inequalities for urban informal workers. Female respondents paid on average significantly more of their wages than male respondents for commuting costs, and spent many hours longer travelling for work purposes. In Pakistan, member based organisations reported that their female members spend up to 80% of their income on transport costs. Cities can thus make planning

processes and policies more gender responsive by prioritising the needs of women workers in cities, ensuring transport networks reach the areas in which they work and reside, and that funding is prioritised for such transport networks, over for example improved roads in central areas more suitable for modern cars.

G. Inclusive economies

The research reveals in particular to how economies that are stable, equitable, and participatory can help make it more likely that technology can positively impact work opportunities and livelihoods. In many cases, research highlighted how a presence or lack of stability in informal workers' operating environment influenced whether and how they invested in technology. For example, *emolienteros* in Lima are one of the groups which demonstrated the highest degree of technological investment - this is in part because they have a stable and secure work space as most possess permits to operate in public spaces. They can do this because they are exposed to less risk of confiscation of their goods by authorities as compared to other worker groups who do not operate have permission to vend in public spaces.

A contrasting example is the barrow operators in Durban - a sector which demonstrates innovation and adaptation in their work tools but which lacks a stable operating environment. Their tools are insecure as they have no space to store them and their work is unrecognized so they often face frequent confiscations of their tools. Their adoption of tools is therefore strategic as they lack a "stable" environment for their work.

Research also highlighted how the presence or absence of equitable access to public goods and services inhibits work opportunities, livelihoods and informal workers' ability to use or adapt technology. Examples include how street vendors' access to public space impacts the technologies they use and choose in their work. Where they have access to public space (such as the market vendors and *emolienteros* in Lima), they are more likely to invest in more "high" and expensive technologies and tools versus those that lack access (street vendors in Lima). Similarly, equitable access to public or basic services such as affordable and reliable electricity is essential to informal livelihoods and directly affects how, when and whether certain informal workers such as garment workers choose to use particular technologies in their work.

The inclusion of informal workers in the delivery of public goods and services, such as water and waste management, is also critical to enabling workers to sustain livelihoods, while also providing services to populations unserved or underserved by public means. In Nairobi, informal water vendors depend upon access to water sources to which they can then bottle - and in many cases also filter - to retail to inhabitants who fail to be served by other systems. Yet in most cases, water vendors are considered to be illegally accessing water, despite its status as a basic human right and their role in delivering water supplies to otherwise unserved communities. They equally face issues with access to land and property rights, with limited, insecure housing and storage space. This limits their choices of technologies and inhibits them from operating within a stable, equitable, economy.

The fact that informal workers often represent the majority of the urban workforce in developing cities but are frequently excluded from public policies and laws underlines that the "rules of the game" are not participatory or inclusive of informal workers. Their exclusion from public policy means that often their full participation in the economy is hindered because their work is not recognized. Therefore, they face myriad problems including confiscations, harassment, arrest - creating a vicious cycle where they face instability and insecurity in their income and livelihoods, and are unable to accumulate any form of capital or savings to be able to invest in technology or other items with the potential of improving their livelihoods.

Conversely, the research highlights how growing economies are not always inclusive of informal workers. Many of the “emerging” technologies appearing in the construction, garments and incense stick rolling sectors, while productivity and therefore growth enhancing, had the very real potential to displace large groups of informal workers. Thus it begs the question of “growth for whom?” when utilising these technologies.

However, technologies which are able to be owned, adapted, and gradually upgraded by workers - in environments where they are able to access and utilise them - such as mobile phones, reliable energy supplies, waste processing machines - can improve the productivity and decency of work undertaken by informal workers. 25% of respondents across Nairobi, Dhaka and Lima signified that productivity was very important to their stories, with a further 30% weighting it equally alongside income and work security. This indicates that productivity and growth is important to the livelihoods of informal workers too, and thus embracing this and supporting it with both more responsive institutions (who include informal workers in planning processes), finance, and adequate access to relevant technologies, could unlock tremendous, inclusive economic growth.

H. Technology Justice

While the concept of Technology Justice has been explored throughout the research in terms of the injustices in access to technologies, the unsustainable use of technologies, and the role of innovation in achieving decent work opportunity outcomes, this section will explore these aspects in detail with recommendations for future action to achieve Technology Justice for workers.

The research indicates that in most cases, justice in access to the technologies workers need to live decent and improving lives and to enable them to undertake decent and secure work, is not being achieved. For many informal workers across the cities, the technologies which are entering their professions – be it waste management, garment production, or water delivery – are not within their sphere of control or influence. Informal workers are limited in accessing technologies by a range of compounding and interlocking determinants: a focus on transfer of high-technologies to large firms, a lack of stable market systems for inputs necessary for some technologies (such as LPG, or electricity), a lack of opportunities to attain the necessary skills and knowledge to operate new technologies, a lack of adequate resources (safe storage, means of transport, knowhow) to utilise technologies, and often above all else the cost of new or improved technologies in relation to the workers’ incomes and ‘room’ to take risks and investments, which is compounded by the exclusion of informal workers from many financial systems.

Despite the great potential of informal waste workers to deliver significant positive environmental benefits for cities, enabling them to deal with vastly greater volumes of waste, and importantly diverting all manner of reclaimable goods from landfill to other productive uses, informal waste workers are often overlooked in waste management systems. Their potential for creating sustainable economies and utilising technology sustainably is curtailed by their systematic exclusion from the central policies and regulations. Additionally, street vendors are being denied the opportunity to utilise more sustainable technologies, such as clean cookstoves, as they are kept constantly mobile by their lack of secure public spaces to operate, and denied their full profits by the bribing of officials to maintain their operations for as long as possible, thus also denying them the opportunity to build up sufficient capital to invest into new, more sustainable technologies.

Much of the disruptive technologies observed in the research can be categorised into mechanisation of existing labour tasks (in incense stick rolling, construction, waste processing, and market porter

operations), technologies which are entirely changing the systems of service delivery (such as water 'ATMs' in Nairobi, and solar power systems for street vendors), and technologies which are changing the nature of work (such as mobile phones in Nairobi, and new sewing machines in Ahmedabad).

The research indicates technologies which have greatest positive impact on the work and livelihoods of informal workers are those which have the greatest involvement in innovating, are particularly adapted to local needs, and can be readily owned and utilised by informal workers. This indicates that to truly achieve Technology Justice, to create empowered and decent livelihoods, and to craft inclusive, growing economies, measures should be taken to be inclusive of the needs, realities, and innovative, entrepreneurial potential of informal workers, rather than focusing on technology transfer of already created and non-modifiable technologies from elsewhere. This can to a great degree be achieved by improving and supporting worker knowledge systems and peer-to-peer learning platforms. The awareness of new technologies, the far greater role of local entrepreneurs, and the great deal of technology innovation and adoption of newer technologies in Nairobi appears in large part to be due to the far greater role played by intermediary or 'meso-level' organisations - researchers, NGOs, community-based organisations, youth groups, and others, particularly compared to Dhaka and Durban. Thus a key recommendation would be that strengthening the capacities of such meso-level institutions - particularly around knowledge sharing, innovation practices, and technology assessment could be instrumental in leveraging far more positive outcomes and inclusive economies for informal workers.

I. Informal Worker Empowerment framework

The key components of the informal worker empowerment framework include asset-building, organizing and capacity building. Organizing was found to be a key pathway in facilitating informal worker access and use of particular technologies. The research provides proof that having the appropriate skills - such as the ability and know-how to use new technology is one of the pathways to enabling informal workers to use technology to enhance their livelihoods. However, skills alone do not enable workers to be able to use technology. The ability to access and invest in a particular technology plays a key role in technological use and adaptation. Factors such as the presence or absence of a stable operating environment (i.e. access to a secure workspace, freedom from harassment), supportive policy which recognizes and supports informal worker livelihoods, and access to basic services and storage facilities, where present, were all shown to have an impact on asset-building. To secure the skills and assets, often organizing is key. Therefore, the three concepts provide a virtuous circle whereby through organizing, workers have greater likelihood of being able to harness the potential of technology, use it to create more secure livelihoods or mitigate against its negative impacts.

As we have seen, empowered workers can be not only vital providers of key city services, but also dynamic drivers of change for inclusivity and economic growth, operating at the crux of multiple value chains. As the informal economy grows in each city, particularly with new urban migrants seeking better livelihoods and better incomes, a focus on empowering workers to harness the potential of technologies could be important to ensure those city economies develop and grow in inclusive and equitable ways.

The research did not however shed light on any specific technologies which are necessarily enhancing informal worker empowerment *per se*. While ICTs are being used ever more frequently for organising and knowledge sharing, this platform alone is insufficient to change the context for informal workers, especially because many informal workers lack the education and literacy levels required to use them. And in the case of the Maji Voice system in Nairobi, the exclusion of many

informal workers from the response side of the system ultimately works to create excluding economies and actively marginalises informal workers.

But there are indeed positive cases of mobile phones economically empowering workers, if not socially or politically. In Nairobi again, the use of the M-Pesa has empowered female workers in particular to expand their businesses, create more efficient working practices by reducing transaction time and travel, and improved their safety by reducing their need to carry cash around from the sale of their goods. Thus empowering technologies, coupled with empowering systems and processes which enhance informal workers participation - in particular organising - can be catalytic in supporting efforts of cities to graduate to more inclusive economies.

J. The Future of Work

Many of the debates surrounding the 'future of work' in the media centre on labour market shifts caused by technological disruption. This is most often in relation to a 'hollowing out' of the labour market, as skilled and semi-skilled professions are replaced by technologies. And more recently the debate has also progressed to the role of artificial intelligence systems threatening analytical jobs, and labour market changes impacting upon the security of work. For example, the vast shifts towards short contract employments away from long-term permanent employments.

Yet in the cities studied and the workers engaged with, such debates are far removed from their realities, and are both obscure and irrelevant to either the workers' lives or their prospective job opportunities. While robotic devices may be replacing factory workers who operated forklift trucks in warehouses, such technologies are highly unlikely to have any impact on the work opportunities of market workers in Lima and Durban, who operate in shared spaces frequented by small-scale businesses trading in low-value goods, rather than secure warehouses trading in consumer electronics.

Thus the debate must look and be taken forward differently when one considers the future of work of informal workers in the rapidly expanding cities of the global south. In particular the mass influx of new workers into the urban labour markets poses significant challenges to creating inclusive economies. In Dhaka, the population of which is expected to balloon to 60 million by 2031. Bangladesh experienced the fastest urbanization compared to other middle income countries, and the World Bank labeled it the world's fastest growing city, with an estimated 300,000 to 400,000, mainly poor, rural migrants arriving each year. The research highlighted that in Dhaka in particular, stories which respondents signified as 'negative' were exclusively from workers who were recent migrants to the city.

The future of work debates in the growing cities of the global south, and the roles technologies may play in shaping and changing those futures, must give strong credence to issues of urban migration, rights of informal workers, the transient nature of workers between informal professions, and the understanding that the focus on technologies must be on how technologies can be used by workers in an enabling and empowered environment, rather than specific technologies themselves necessitating change.

Part 4 - Scenarios

The scenarios below provide a brief summary with projections of “high-end” and “low-end” or positive and negative plausible scenarios of the future for workers from each sector studied in the research, drawing upon the research findings. Each fictional scenario is organised to address relevant elements of the conceptual framework, and to highlight critical changes that could lead to such positive or negative scenarios for each worker type.



Thembisio the Barrow Operator

A) A future with little change

Tools

The key technology for Thembisio’s work as a barrow operator in Durban, is his barrow. He and up to 1000 others transport around 100 tonnes of goods by barrow, on foot, around the city each day.

Organisation and Process

Thembisio and his fellow workers are not well organized, and as a result have little opportunity or power to influence positive change which could improve their livelihoods.

City context and institutions

Barrow operators remain excluded from the city non-motorized transport policy. This means Thembisio’s work is unrecognised and

unsupported by a legal framework – and he has little recourse to the continued harassment by public, and confiscation of tools by authorities and police.

It also means the city streets are not planned or equipped to cope with barrow work, and as a result Thembisio’s barrow is frequently damaged, eating into his profits.

Innovation and adaptation

There is no secure space for Thembisio to leave his barrow at the market, and barrows are frequently stolen by others or confiscated by police. Thembisio has had this barrow now for 4 months, but he doesn’t want to invest in adapting or upgrading the barrow, as it might be stolen, and might even make it more attractive to thieves.

B) A future with positive change

Tools

The key technology for Thembisio’s work as a barrow operator in Durban, is his barrow. He and up to 1000 others transport around 100 tonnes of goods by barrow, on foot, around the city each day.

Organisation and Process

Thembisio brought together other barrow workers, to collectively advocate for changes to the city-wide non-motorized transport policy and for secure storage at the marketplace.

City context and institutions

The non-motorized transport policy is updated to include designated lanes for barrows. With a legitimate space to work, harassment and confiscations decrease, and so does damage to barrows from poor infrastructure, meaning repair and operating costs decrease too.

Innovation and adaptation

Thanks to new secure storage, and better infrastructure, Thembiso's operating costs are significantly decreased, meaning he has both capital and security to consider investing in technological improvements in his work tools. Because Thembiso is connected with other workers and the city recognises him as a worker, he is talking to both to understand his options for upgrading and investment to increase his productivity and protect his health.



Deepa the Construction Worker

A) A future with little change

Tools

Deepa is construction worker doing mostly unskilled manual labour in Ahmedabad. She works as a wage labourer and her most important tool is her metal basin for carrying bricks and cement.

Know-how

Deepa and other construction workers are members of a workers' organization. Though Deepa's organization does provide training to women in the construction sector, she has not yet taken advantage of this. Even with the training, she does not have the capital to buy or operate the newer machines.

City context and institutions

Though Deepa's organization provides training to women to upgrade their skills from manual labour, there are significant cultural barriers to her acquiring the tools of the trade and to being hired by contractors as a skilled labourer. There is significant discrimination against women in the construction industry in India and they are often forced to accept lower wages or are not considered for more skilled work.

Emerging Technologies

The construction sector in Ahmedabad is experiencing near-constant modernization, with technology quickly replacing manual labour. Much of this technological change is taking place higher up the value chain, and it is having a negative downstream impact on informal construction workers like Deepa, at the bottom of the chain. In Ahmedabad, Deepa and the other women doing mostly manual unskilled labour may eventually be pushed out of the work process, losing their livelihood.

B) A future with positive change

Tools

The key technology for Deepa's work is her metal basin. However, she may begin to use grinding machines, cutting machines, mixing machines or digging and lifting machines as she upgrades her skills.

Know-how

Deepa took advantage of new training being offered by her organization to women construction workers. She is upgrading her skills so that she is capable of doing skilled work (i.e. as a mason, tile layer, carpenter or electrician).

Organisation and Process

Deepa brought together other women members of her organization and organized a cooperative. As a collective, Deepa and her fellow workers were able to purchase newer mechanized technologies in the construction industry. By doing this, they were able to overcome financial barriers to access.

City context and institutions

Because Deepa and her fellow construction workers are organized, they advocate for a pro-poor policy which favours the contracting of construction worker cooperatives for public works projects. To facilitate more gender equality and decrease discrimination, there are clear provisions which favour women-run cooperatives in the policy. Deepa's cooperative can therefore bid on contracts with the government as service providers.

Emerging Technologies

Thanks to the vocational training provided by her organization and the collective assets she purchased with her cooperative, Deepa is better equipped to benefit from work opportunities associated with the "newer emergent" construction technologies which required skilled labour.



Sangeeta the Garment Worker

A) A future with little change

Tools

Sangeeta is a home-based garment worker in Ahmedabad. The key technologies for her work are her electric sewing machine, needle and thread.

Organisation and Process

Sangeeta stitches garments from her home.

Because her home is her workplace, she is isolated from other workers like her. She is not part of an organization. Deepa therefore has little bargaining power to advocate for higher piece rates and basic services which could improve her productivity and allow for technological investment.

Know-how

Because Sangeeta is isolated, working on her own at home, she has difficulty accessing information on training opportunities. Given how quickly fashion trends change, she has difficulty staying current with skills and techniques.

City context and institutions

Like many other informal workers, Sangeeta lives in a slum with unreliable and unaffordable access to basic services (electricity, water, sanitation, improved housing, etc). Because she must cover her own costs of production and provide for her own utilities, this leaves her with very low earnings. Unreliable access to electricity also affects her productivity and ability to use machines requiring electricity on a regular basis. Her raw materials and finished goods are also vulnerable to damage from rains or flooding due to her living situation.

Urban transport routes do not adequately service slum areas where home-based garment workers like Sangeeta live. Rapid transit systems are unaffordable for workers like her. She spends long hours transporting finished goods and picking up raw materials using public transport, affecting her earnings and productivity.

Global Trends

The garment industry, like the construction industry is one experiencing increased mechanization of work processes with outsourcing occurring through increasingly long and complicated supply chains. Home-based garment workers like Sangeeta feel the downstream impacts of changes in design (and the resulting tools required to produce them) but often have little control over the production process. She will be pushed out of the production process if she cannot keep pace or adapt to these changes.

Emerging Technologies

Sangeeta's earnings are very low so she faces difficulty in accumulating capital needed to invest in newer model sewing machines, gadgets for stitching buttonholes, hemming, and interlocking, embroidery machines and cutting machines. These newer model machines are necessary to enter the ready-made, especially modern, garment sector and to better compete in the traditional garment sector. Workers like Sangeeta risk being left further and further behind.

B) A future with positive change

Tools

The key technologies for Sangeeta's work include newer model sewing machines, gadgets for stitching buttonholes, hemming, and interlocking, embroidery machines and cutting machines. These would help her respond to changing trends in the fashion industry.

Organisation and Process

Sangeeta organized a group of other home-based garment workers to advocate for improved slum conditions with authorities and improved piece rates with contractors. Sangeeta's group has gained more control over the production process by organizing collective production units. Her group pooled their money to invest in newer model sewing machines, cutting machines, embroidery machines and other specialized machines for the production unit. Sangeeta no longer feels isolated.

Know-how

Sangeeta and her group share information about new sewing techniques. They are better equipped to adapt and keep pace with trends in the ready-made garment industry.

City context and institutions

The slum where Sangeeta and other home-based workers live is upgraded *in situ* with improved housing and access to basic services, allowing Sangeeta and other home-based garment workers (subcontracted or own account workers) to maintain their relationships with suppliers and contractors close to their homes. Sangeeta has more freedom and ability to operate newer model sewing machines requiring stable access to electricity and a can access more stable income.

The city examines public transport linkages serving Sangeeta's slum following advocacy from Sangeeta and her group. They agree to add a bus route which improves services to her slum. Sangeeta spends less time travelling by bus and has more productive hours for work. Her earnings increase and she has more capital to invest in her work.

Global Trends

The garment industry production processes continue to be mechanized however because Sangeeta has access to a wider breadth of tools and skills through her group, she is better equipped to respond to these changes.



Manjula the Incense Stick Roller

A) A Future with Little Change

Tools

Manjula is a home-based incense stick roller in Ahmedabad. The key technology in her work is her wooden board where she hand rolls incense sticks.

Know-how

As a home-based hand roller, Manjula does not know how to use the new mixing machines or stick rolling machines.

Organisation and Process

Manjula and other incense stick rollers are well organized and have a decent relationship with their subcontractor.

City context and institutions

Electricity in Manjula's slum is costly and not always reliable. It affects her productivity as she requires light for hand rolling. Because electricity is costly and unreliable, she has less of a desire to use mechanized incense stick rolling machines.

Because Manjula is a sub-contracted worker, she has no employment contract or formal employment relationship. She is extremely vulnerable to changes in technology or production practices but has no control over changes or recourse if she is pushed out of the production chain.

Emerging Technologies

Manjula has begun to notice that increasingly, other contractors or traders are purchasing machines - such as dough mixing and stick rolling machines - and replacing the women previously hand rolling the incense with a few people operating the machines in small workshops.

B) A future with positive change

Tools

To keep pace with technological change, Manjula's organization decides to pursue collective ownership of dough mixing and stick-rolling machines.

Know-how

Through her organization, Manjula learns to use the new dough mixing and stick-rolling machines. She has upgraded her skills and is able to respond to changes in the production process.

Organisation and Process

Manjula and her organization collectively pool their assets to buy new machines for incense stick making. Her group finds a space and creates a production unit close to the women's homes where Manjula and other incense stick rollers can work collectively.

Manjula's organization advocates for improvements to the electrical service and connections in her slum. They also negotiate for a written contract with the trader/subcontractor, providing them with a level of legal recourse and work security they did not have before.

City context and institutions

Improvements are made to the electrical connections in Manjula's slum. This gives her and her group more confidence that investing in the new machines is worthwhile (given they operate on electricity).

Emerging Technologies

The process of incense stick making is increasingly mechanized but Manjula and her organization are equipped with the tools and skills to respond.

Gilberto the Market Porter

A) A Future with Little Change

Tools

Gilberto is a market porter in Lima. His work is essential to the operation of city markets, as he unloads the trucks that bring agricultural products to wholesale markets. He manually unloads goods from the trucks arriving at the market. His most important tools are baskets and crates (used to store and unload vegetables) and a hammer (used to repair the crates prior to carrying them).

Know how

The market management are planning to relocate and modernize the market where Gilberto works. He does not know how to use manual forklifts or the pallet system being contemplated in the new market.

Organisation and Process

Gilberto and fellow porters are not well organized. They are therefore unable to bring a united voice to negotiate with authorities or market management.

City context and institutions

The work of market porters is regulated by law in Peru but not well enforced. The market Gilberto works in is soon to be re-located and modernized. The market management have not contemplated including manual market porters in the running of the new markets. They plan to mechanize the warehousing process (using manual forklifts and pallets) and outsource the process. Gilberto and other market porters risk losing their livelihoods.

Emerging technology

In modern markets around the world, manual market porters like Gilberto mostly do not exist as they have been replaced by a few people who operate manual forklifts and pallet systems.

B) A future with positive change

Tools

Gilberto is a market porter in Lima. His work is essential to the operation of city markets, as he unloads the trucks that bring agricultural products to wholesale markets. He used to manually unload goods from the trucks but the market where he works was recently re-located and modernized. The market management wanted to mechanize the warehousing process. The key technologies for his work are now manual forklifts and pallets.

Know how

Gilberto and other market porters did not know how to use the manual forklifts and pallets at first. Market porters engaged in a process of “learning by doing”. The management of the market also eventually provided a training on how to use the new tools.

Organisation and Process

Gilberto and fellow porters are well organized. Because they are well organized, they were able to advocate for inclusion as operators of the new manual forklifts and pallets with the market management. As an organized group, Gilberto’s organization was also capable of demonstrating that they could manage the distribution of orders and goods within the market.

City context and institutions

The work of market porters is regulated by law. Through advocacy, Gilberto and other market porters reached an agreement with the market management to gradually transition to a mechanized work process. To facilitate the transition, the market management provided the new tools to the market porters (pallets, manual forklifts). Gilberto’s association has since collectively invested in buying their own machines which they regularly maintain and repair.

Emerging Technologies

Main emerging tools include the manual forklifts and pallets. Market management initially provided these costly tools to market porters and Gilberto’s association collectively pooled their assets to buy more pallets and forklifts to increase their productivity. Because they have storage space at their place of work, they have the confidence that their valuable tools are safe from theft.



Maria Elena the Market Vendor *Tools*

Maria Elena is a market vendor in Lima who sells fresh fruits and vegetables and prepared food. The key technology for her work is her electronic scale.

Organisation and Process

Maria Elena and her fellow market vendors are organized into an association in the market she works in. Though the organization exists, it is not very active.

City context and institutions

Maria Elena is one of few lucky vendors able to secure a permit and fixed space in the market where she sells food. There are a relatively small number of well-located markets compared to number of vendors wanting to do this work. Most of the time, she can access basic services at her place of work including electricity, water and sanitation services though there are frequent cuts to electricity and it is difficult to run multiple appliances at once. Maria Elena is able to store her inventory and tools overnight at the market. Though the permit for the market stall she uses is expensive, compared to vendors who operate on the street, her workplace offers a level of stability and security which has allowed her to upgrade from a manual to an electronic scale.

Maria Elena uses the city public transport system to bring many of her goods to and from the market. It is hard to use the system as bus and taxi drivers often refuse to pick her up when they see she has goods. She spends long hours and a significant portion of her income on public transport.

Emerging Technologies

In recent years, with the entrance of Chinese brands of digital scales, these “newer” technologies have become more accessible to vendors like Maria Elena. Though she would like to make other improvements to her stall - such as a new display case, the electrical grid capacity in her market means that she cannot run too many appliances at once.

B) A future with positive change

Tools

Maria Elena is a market vendor in Lima who sells fresh fruits and vegetables and prepared food. The key technology for her work is her electronic scale.

Organisation and Process

Maria Elena and her fellow market vendors are organized into an association in the market she works in. Though in previous years the organization was not active, it recently successfully advocated with the market administration to upgrade the infrastructure (including electricity) in the market.

City context and institutions

The electricity grid in Maria Elena’s market was recently upgraded - a result of advocacy by her market association. In the future, this will allow Maria Elena to safely run additional appliances should she choose to invest in these.

The city is considering building new well-located markets in the city centre - in close consultation with groups of vendors. This could provide other vendors with similar opportunities to invest in appropriate technology and offer them a level of stability in their work which could lead to more secure livelihoods.

Following advocacy by Maria Elena’s market association and other informal workers, the city is beginning to understand that the city transport system is often used for “productive” purposes as well as simple transport. They have begun to sensitize drivers to decrease discrimination against informal workers such as Maria Elena. They have also added additional bus routes which connect the market where Maria Elena works to other wholesale and retail locations.

Emerging Technologies

Because of recent upgrades to the electrical grid in the market and Maria Elena’s fixed workplace where she is able to store her tools, she has an improved ability to invest in “newer” technologies which could improve her work - such as the new display case.



Monica, a street vendor

Monica sells small fried snacks using a popular local recipe from a small cart. She has been working as a food vendor for nearly 2 years, and has built up a good reputation among customers. She operates

in a very busy part of the city, close to a transport centre and a large market, with thousands of people passing her stall each day.

But there is great competition in this area, and she has no fixed place to operate – each day she must fight her way for a prime spot, and bribe the local authorities to ensure that she is not moved from place to place. Yet still they often force all the vendors to clear the area, leaving Monica to seek new, albeit less lucrative, spots from which to vend.

A/ Future with negative change

Tools

Monica has three tools critical to her livelihood – her cart, from which she vends and carries her goods each day; her kerosene stove, used to fry her snacks; and her knife, used to prepare the ingredients used in the snacks.

As the transport hub becomes increasingly popular as new businesses develop around the area, and the market too develops, city authorities impose a ban on informal food vendors in the area, with only formal, licenced units able to operate. Monica faces a daily battle to operate close to the hub, but despite customers liking her produce, she cannot compete with the larger licenced units which produce goods faster and at a lower cost. More affluent customers are wary of buying from her cart with worries about food safety compared to the glossy licenced units close by.

City authorities penalise Monica for carrying a knife, claiming it is a weapon, and confiscate it frequently. Being away from the main transport hub and market, she can no longer utilise the public lighting in this space, and her work becomes precarious in the dark, and customers instead flock to brightly lit units with their own lighting.

Know-how

Monica is a good cook, but she does not know how, nor have the equipment, to cook some of the new, more ‘Western’ foods becoming popular with the new customers. Her traditional snacks are still enjoyed by many, but units selling multiple items including new foods capture much of the market.

Organisation and Process

Monica and other street vendors face common issues, but they often view each other as competitors and are reluctant to work together. Their previous storage unit in the market has been knocked down by city authorities to build new shops, so their traditional meeting point is no longer available. However, many still use mobile phones to warn one another of coming raids and sweeps by local authorities.

City context and institutions

The local authorities have imposed strict new hygiene regulations, which Monica struggles to meet. She must pay a relatively high cost to attain a licence, and must invest in new technologies to achieve the required safety standards. This changes the nature of how customers view such small enterprises and encourages a consumer shift towards formal vendors.

Innovation and adaptation

Monica has adapted her cart for her specific needs, with her stove and tools held in place and a clear screen attached to prevent hot oil from hitting customers. However, the cart breaks frequently as Monica pushes it to and from the now more distant storage point. Her exclusion from accessing the electricity points means she cannot utilise electronic goods.

B/ Future with positive change

Organisation and Process

Monica and other street vendors are approached by a local organisation established to help female workers. As a relatively new entrant to the city, Monica doesn't know many people here, and starts to learn a great deal from interacting with her peers. The group supports the women vendors to organise and advocate for secure access to the areas in which they operate. The women's group also establishes a group savings and lending scheme amongst the women, who after 18 months use the common savings to jointly invest in a new, secure storage space for their goods and tools.

City context and institutions

The government presses ahead with its drive for improved hygiene among street vendors, but groups like Monica's successfully lobby the government to only apply this to larger food retail units, but agree to participate in training on food safety, as they care about providing a good service to their customers.

The municipal government presses ahead with their plans to ban stalls in this increasingly busy transit area, but agree to providing a designated space for traders to operate. While no longer in a prime location, the vendors do at least have security of space, and a well-lit area.

Tools, Innovation and adaptation

With the coming of the safe space and the improved storage unit, Monica takes advantage of the savings and lending scheme and invests in a new clean cookstove. With this, she is able to produce her goods at a lower cost, and no longer faces issues of smoke inhalation from the burning kerosene. She plans to also upgrade her cart to include an improved display unit.



Halim, a waste picker

Halim works as an informal waste picker, collecting waste from various households and businesses in a rapidly growing area of the city. He uses a manually operated cart to store the waste he collects, which he has modified with chunkier wheels and a wider storage compartment to enable him to navigate the badly maintained, narrow roads, and to carry a larger volume of waste in every trip he makes along the streets. He earns money by selling reclaimed

materials from the waste he collects to buyers across the city, but prices vary day to day, and he faces competition in accessing the higher value waste materials from many other informal waste workers.

A/ Future with negative change

Tools

As the city government requires Halim to own an automotive van to register as an official waste collector, he faces increased competition in accessing waste in areas with better roads and businesses, which often have the higher value waste. He is pushed to the more residential and marginal areas of the city to collect waste where good roads are scarce. He has to make ever-more frequent repairs to his aging cart, which eats into his tiny profit margins.

Halim has to separate sort the waste by hand, and finds most of the cheap protective gear available to him to be inappropriate for such tasks. The owners of vans, who receive a wage for waste

collection, have banded together to invest in mechanical waste processing technologies, which fetch a higher premium. So Halim struggles each day now to sell his goods and earn a profit.

Know-how

Halim has worked on the streets all his life, and his social network extends mostly to other waste workers. His knowledge of new skills, technologies, his rights and other knowledge is limited to only what he and other workers share amongst themselves.

The van-operating waste workers have received training from the city government in safer methods of processing waste, in particular e-waste, so now can work with more hazardous, high value materials, with fewer health risks; while the techniques Halim uses with abrasive chemicals have been outlawed by the city government.

Organisation and Process

Halim and other workers tried to get together to change their situation, but they had no resources and no knowledge of the political systems, nor what rights they had. Many of the workers left waste picking to take up other professions, often with the help of a family member already settled in the city, so Halim's group disbanded and felt disempowered to change their situation.

City context and institutions

The city government invested in new fleets of automotive technologies, along with waste incineration plants to deal with the rapidly growing volumes of waste in the city. Their policies focused on cleaning up central metropolitan areas of the city, setting up private contractual arrangements. Halim was no longer able to operate in the central city areas, being seen as a beggar and threatened by local authorities.

Innovation and adaptation

There is no secure space for Halim to store his cart, and carts are frequently stolen or confiscated by police. Halim's cart is aging and needs frequent repairs. While he continues to make ergonomic adaptations to his cart, it is a poor substitute for the more modern automotive vehicles. As he also ages, he is less able to push around his cart. His health begins to show serious signs of degrading, and he has gradually less income and energy to invest into further innovations and adaptations of his cart.

Global Trends and Emerging Technologies

Markets for recyclable goods are growing considerably, but the demand for higher quality materials means the loosely packaged and sub-optimal materials Halim is able to gather are in relatively decreasing demand.

As the population of the city booms, there is a greater demand for electricity, and government invests in new waste-to-energy plants to meet this demand locally. But with the energy mostly serving the central grid-connected households and businesses, and more and more high-value waste collected from the city centre being diverted to incineration, Halim finds himself increasingly squeezed out of his work and livelihood.

B/ Future with positive change

Tools

Halim is able to jointly access new waste processing technologies with his fellow workers, enabling him to attain better prices for the materials he sells, and reduce the hazards involved in such work.

A new waste worker storage unit enables Halim and others to safely store both their collection technologies, as well as their unprocessed materials. As an experienced cart driver, Halim sets up a small mechanics business in the unit, helping new waste workers to fix and innovate their carts. This provides a new income stream, and allows Halim to reduce the hours he spends walking throughout the city, improving his health.

Organisation and Process

With a central meeting place at the storage unit, Halim is able to work more with a range of waste workers, including those higher up the 'technology ladder' in the sector. A community based civil society organisation spots an opportunity to support these workers, and helps them to organise for more efficient collection – reducing intra-sector competition – and establish stronger, more equitable links with buyers of materials. This enables the workers to collectively negotiate prices and adjust to demand.

City context and institutions

While government policies remain largely focused on promoting automotive collection from central areas, they recognise the need for efficient waste management services in harder to reach areas. Worker groups like Halim's successfully lobby to be included in local policies for waste management, and receive basic equipment, including uniforms, that bring them dignity, safety and recognition. However, their societal status as lower-caste workers means they remain limited in improving their livelihoods significantly, and working outside of the 'prime' waste collection areas hampers Halim's ability to generate strong, reliable profits.

Know-how

Halim gradually learns more about the market demands in the waste sector, and is able to adjust his activities accordingly. Additionally, the community organisation supporting the waste worker group help him to access new technical knowledge to improve his mechanic enterprise, and expand his work also to servicing basic automotive technologies.

Innovation and adaptation

This leads to Halim being able to experiment with new ideas, adaptations and innovations. But he remains restricted in his efforts to innovate further due to the persistent lack of available credit finance options, given he remains living in a slum with few assets.

Appendix 1 – Sample sheet of 4TTA

Notes



Notes

Also sells traditional medicine



Rockefeller Foundation
Tech. and the Future of Work



IW: Sarah Mthembu
Location: Herb Market
Activity: Traditional dance instrument
GPS : S 29° 51' 00"
E 31° 00' 00"
Fieldworker: Richard Dobson
Sheet Number: **D.SV.14**

Appendix 2 – Sensemaker questions

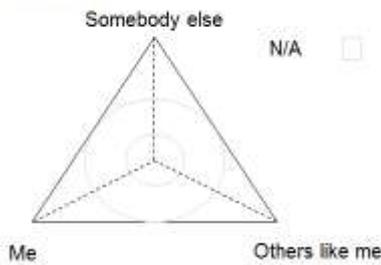
Technology and the Future of Work

- City:
- Nairobi
 - Dhaka
 - Lima
 - Other

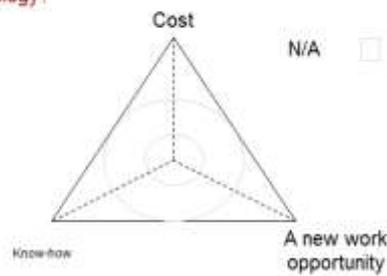
Prompt 1: Tell me about how a technology has enabled, hindered or changed a work opportunity for you or someone you know.

Your first name: _____

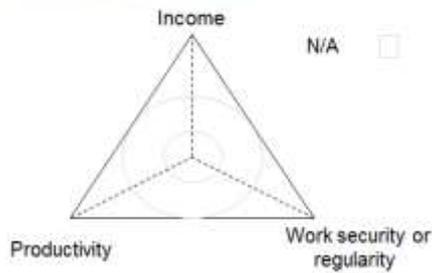
This story affected...



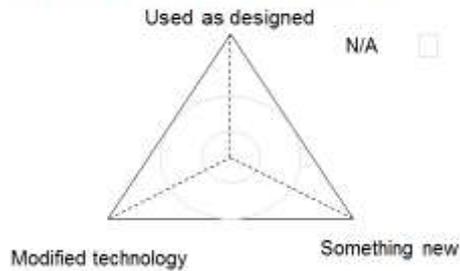
In your story, what influenced the adoption of technology?



What matters most in your story?



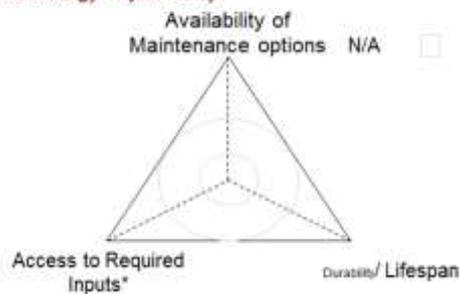
The technology in this story is an example of...



What is important about the technology in your story?



How important are these factors in the choice of technology in your story?



The technology in this story is:

- Owned by me or others like me
- Owned by someone else
- No one person*

How do these 5 factors influence the change in your story?

- Infrastructure & service
- Access to markets
- Education
- Laws and regulations
- Freedom of choice

N/A

Important Irrelevant

How have technologies changed in your work in the last 5 years?

N/A

No change, still the same



Entirely new

This is a story of something:

- Very positive
- Positive
- Neutral
- Negative
- Very negative
- N/A

I am:

- Self employed with employees (Employer)
- Self employed with no employees (own account worker)
- Sub-contracted (industrial subcontractor)
- Wage employee
- Contributing family worker
- Member of cooperative
- Casual day labourer
- Prefer not to say

I am aged:

- Under 18
- 18-30
- 30-50
- Over 50
- Prefer not to say

On average per day I earn (after costs)*:

- Under \$2
- \$2-5
- \$6-20
- Over \$20
- Prefer not to say

I am:

- Male
- Female
- Prefer not to say

