



Technology, informal workers and cities: insights from Ahmedabad (India), Durban (South Africa) and Lima (Peru)

MARTHA A CHEN

Martha A Chen is the International Coordinator of WIEGO, a Lecturer in Public Policy at Harvard Kennedy School, and an Affiliated Professor at the Harvard Graduate School of Design. An experienced development practitioner and scholar, her areas of specialization are employment, gender, and poverty with a focus on the working poor in the informal economy. Before joining Harvard in 1987, she had two decades of resident experience in Bangladesh working with BRAC and in India, where she served as field representative of Oxfam America for India and Bangladesh. She is the author and editor of numerous books including most recently *Bridging Perspectives: Labour, Informality, and Poverty*, SEWA Academy, Ahmedabad.

Address: John F. Kennedy School of Government, Mailbox 32, 79 JFK Street, Cambridge, MA 02138, USA; e-mail: Martha_Chen@hks.harvard.edu

1. Kanbur, Ravi (2014), "Mindsets, Trends and the Informal Economy", Working Paper 2014-06, Charles H. Dyson School of Applied Economics and Management, Ithaca, NY, available at <http://ageconsearch.umn.edu/>

ABSTRACT Technology is a key driver of change, not least in the world of work. Yet little is known about what technologies are used by – or impact on – the working poor in the informal economy, and in what ways. This paper presents findings from a 2015 study by the WIEGO network and local partners in three cities: Ahmedabad, India; Durban, South Africa; and Lima, Peru. The findings reveal that informal workers in the study cities are using diverse tools, from manual devices to electrical equipment and internet platforms, to strengthen their livelihoods. Overall, the tools used tend to be basic. Often they are being adapted in ingenious ways in order to adapt to resource and other constraints. Take-up of improved tools is limited by low incomes and concerns about theft and confiscation. It is also affected by city-level, context-specific systems of energy, transport and waste. This paper summarizes which types of technologies are most useful to different sectors of informal workers. It argues that the policy and regulatory environment, and city-wide technological systems, should be more responsive to the technological and other needs of the urban informal workforce.

KEYWORDS informal economy / informal workers / information and communication technologies (ICTs) / technological systems / technology

I. INTRODUCTION

Technology is a key driver of change, not least in the world of work. In today's global economy, trends in technology and trade have led to changes in the system of global production and exchange and to reductions in the employment intensity of growth – and, thereby, to changes in the nature of work and the structure of labour markets. All of these have contributed to an increase in informal employment.⁽¹⁾ Yet little is known about what technologies are used by – or impact on – the working poor in the informal economy, and in what ways.

As used in the study and this paper, "technology" is conceptualized broadly to include physical tools and equipment; the skills, knowledge and processes required to use them; and the ownership or institutional arrangements around their use. While low-tech tools are widely used by informal workers, there is also a growing literature on the use of information and communication technologies (ICTs) by informal workers, largely focused on the use of mobile phone applications to facilitate financial or payment services. A study in Villa el Salvador, Peru found that

carpenters and cabinet-makers were using an app to contact customers.⁽²⁾ Some informal workers are using digital platforms or mapping software in their work: e.g. waste pickers in Bangalore, India are using a web-based platform and database to connect with households and scrap dealers;⁽³⁾ and informal transport operators in Nairobi, Kenya are using a digital mapping of the informal *matatu* (minibus) transport network to identify improved routes and reach hotspot areas.⁽⁴⁾

There is also growing interest in innovation within the informal economy, but most of the studies focus on the behaviour or resources of the individual informal worker (i.e., whether s/he is willing to take entrepreneurial risks and/or has cash to invest); the role of informal institutions (family, community, networks); and linkages with formal firms.⁽⁵⁾ Few of the studies focus on the impact of the formal policy and regulatory environment on the behaviour and activities of informal workers, especially as they relate to technology. This paper, and the study it reports on, seek to help fill the gap in the literature and in understanding.

This paper presents findings from a 2015 study⁽⁶⁾ by the WIEGO network⁽⁷⁾ and local partners in three cities: in Ahmedabad, India with the Indian Academy of Self-Employed Women; in Durban, South Africa with the NGO Asiye eTafuleni; and in Lima, Peru with a local research team and the NGO Programa Laboral de Desarrollo (PLADES).⁽⁸⁾ Part II details the research design, methods and sample. Parts III–V present the research findings on work technologies, information and communication technologies, and city-level technological systems, respectively. The concluding section summarizes the key findings and reflects on technology at the bottom of the economic pyramid.

II. RESEARCH DESIGN

The research was designed to investigate existing and emerging technologies in a range of informal occupations; the use of information and communication technologies (ICTs) by informal workers in their work and in their organizing efforts; and the impact of three city-level technological systems – energy, transport and waste – on the livelihoods of the informal workers.

The WIEGO network and its partners in the three study cities developed and used the following five methods.⁽⁹⁾

- Seven tools specially developed by WIEGO were used with **focus groups** to understand the use of technologies by different groups of informal workers.
- A **participatory method of photo documentation** called “4 Turns & Technological Asset” (4T & TA) was used to photograph the workplace of informal workers and the technological assets that they identify as being most valuable to them. The 4T & TA method was developed by urban architect–planner Richard Dobson of Asiye eTafuleni in Durban, South Africa.
- A **phone survey** with questions developed by WIEGO was conducted with 18 organizations of informal workers around the developing world.
- **Micro-narratives** were elicited, using in-depth interviews with a dozen informal workers (four from each city) chosen from the focus group sample.

bitstream/180155/2/Cornell-Dyson-wp1406.pdf.

2. Cáceres, Roxana Barrantes, Aileen Agüero, Martín Cavero and César Huaroto (2012), “The Impacts of the Use of Mobile Telephone Technology on the Productivity of Micro- and Small Enterprises: An Exploratory Study into the Carpentry and Cabinet-Making Sector in Villa El Salvador”, *Information Technologies & International Development Journal* Vol 8, No 4, pages 77–94.

3. Carr, Carlin (2015), “Mapping Bangalore’s Waste”, URB.im, 10 March, available at <http://urb.im/ca1503bge>.

4. Klopp, Jacqueline M (2014), “Cities in motion: how we mapped the matatus of Nairobi”, *The Guardian*, 19 February, available at <http://www.theguardian.com/cities/2014/feb/19/cities-motion-how-we-mapped-matatus-nairobi>.

5. Daniels, Steve (2010), *Making Do: Innovation in Kenya’s Informal Economy*, Creative Commons; also Harris, John C (2014), “The confounding influence of urban informality on innovation and production specialisation in production clusters: evidence from Nairobi”, *African Journal of Science, Technology, Innovation and Development* Vol 6, No 6, pages 529–539.

6. WIEGO (n.d.1), *Technology & the Future of Work – An Exploratory Research Project*, available at <http://wiego.org/technology>.

7. Women in Informal Employment: Globalizing and Organizing (WIEGO) is a global action–research–policy network that seeks to improve the status of the working poor, especially women, in the informal economy through building stronger organizations and networks of informal workers, improving statistics and research on the informal economy, and promoting policy dialogues with organizations of informal workers to improve the regulatory and policy environment in which they work. See <http://www.wiego.org>. All authors of this paper are members of the WIEGO network.

8. With funding from the Rockefeller Foundation under its Inclusive Economies goal, Practical Action, a UK NGO, and the WIEGO network partnered on a research project on technology and the future of informal work. This paper presents the findings from the WIEGO network research under this collaborative project.

9. For details of these five methods, see Chen, Martha A (2015), *Technology at the Bottom of the Pyramid: Insights from Ahmedabad (India), Durban (South Africa), and Lima (Peru)*, WIEGO team report to the Rockefeller Foundation, available at <http://wiego.org/sites/wiego.org/files/publications/files/WIEGO-Technology-bottom-pyramid-2016.pdf>.

10. In each city, for each sector, four focus groups with five workers each were conducted: the sample in each city was 80 workers, with a total sample across the three cities of 240 workers (both women and men). The photo documentation was done with the same sample.

11. WIEGO (n.d.2), *Informal Economy Monitoring Study*, available at <http://wiego.org/wiego/informal-economy-monitoring-study-iems>.

- **Key informant interviews** were conducted with local organizers, academics, policymakers and other stakeholders in each study city.

What technologies are used – and how – in the work process vary considerably by the type of work being done. Therefore, the WIEGO research team structured its sampling strategy around a few key occupational groups, or “sectors”, that are common in each local economy (Table 1).⁽¹⁰⁾

This report also draws on the findings from a 2012 study in 10 cities, including Ahmedabad, Durban and Lima, by WIEGO and local partners. That study, known as the Informal Economy Monitoring Study (IEMS), was designed to interrogate what is driving change in the urban informal economy and how urban informal workers respond to change; and sampled three sectors of workers: home-based workers, street vendors and waste pickers.⁽¹¹⁾

III. EXISTING AND EMERGING TECHNOLOGIES

In this study, work technologies are defined as the tools or equipment that workers, specifically informal workers, use in their work, and related know-how and skills. The study examined existing and emerging technologies, as well as technologies that are fading or being displaced.

a. Existing technologies

The common tools used by informal workers in their work are quite basic across the three study cities. But no matter how basic, each tool of the trade has an inherent value to its users. In Ahmedabad, a widowed waste picker stated that her sack is her “life” and a home-based incense stick roller stated that her wooden rolling board is her “god”.

The common tools include: a polypropylene or jute gunny sack to collect and transport waste (waste pickers – Photo 1A); a shallow *metal basin* for carrying bricks and cement, as well as a shovel (construction workers – Photo 1B); a *wooden board* for hand-rolling incense sticks (incense stick rollers – Photo 1C); a hand-pushed *barrow* or *trolley* (market porters and waste pickers – Photo 1D); a *cooking vessel, stove* and *fuel* (street food vendors – Photo 1E); a *scale* (street vendors and market traders – Photo 1F); and an *electric sewing machine* (garment makers – Photo 1G). In Lima, some informal workers are using slightly more sophisticated technologies; for example, some of the market porters have manual forklifts or stackers, and some market traders have been able to invest in refrigerated display cases. See the online supplement for Photo Collages 1–3 of existing and emerging tools in each study sector/city.

TABLE 1
Occupational sectors sampled by city

Ahmedabad	Durban	Lima
construction workers	transport workers	market porters
garment makers	garment makers	market traders
incense stick rollers	street vendors	street vendors
waste pickers	waste pickers	waste pickers



PHOTOS 1A–1G

Existing technologies used by waste pickers (A), construction workers (B), incense stick rollers (C), market porters/waste pickers (D), street food vendors (E), street vendors/market traders (F), and garment makers (G)

PHOTOS 1A AND 1F

© Themis Castellanos

PHOTOS 1B, 1C AND 1G

© The Gujarat Women's Video SEWA Information and Communication Cooperative Society Ltd

PHOTO 1D

© Asiye eTafuleni

PHOTO 1E

© Gerald Botha by permission of Asiye eTafuleni

Explaining basic technology: value chain dynamics

There are some differences in the basic tools used across the study cities, reflecting differences in the city contexts. In Durban, South Africa, waste pickers sell their recyclables to mobile waste dealers who drive around the market area looking for recyclable waste to buy, either from the itinerant waste pickers or directly from shopkeepers. The Durban waste pickers use trolleys to haul their waste around the market area.

In Ahmedabad, the waste dealers are not mobile and the waste pickers have to transport their recyclables to the dealers' shops, which are often at some distance from their collection routes. Most Ahmedabad waste pickers, therefore, have to hire rickshaws – bicycle rickshaws or (if they can afford them) motorized rickshaws – to transport their recyclables to the point of sale. In Lima, waste pickers also use sacks for collection. In

inner-city districts of Lima it is only recyclers higher in the value chain who have motorized transport (such as trucks) to collect recyclables. But in the outlying districts, waste pickers need vehicles to transport their recyclables to the nearest buyer, including moto-taxis or three-wheelers that can be pedalled or pushed, or are motorized.

Explaining basic technology: security

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. This is also true for waste pickers who need a place to store recyclables they have collected, if they cannot sell them right away. The need for storage is particularly acute in Durban-eThekweni as most informal workers live in townships at some distance from the market area.

Consider the case of Nhlanhla (Photo 2), a water porter in Warwick Junction, who supplies water to cooked food vendors and other street vendors in the market. Earlier, Nhlanhla transported water containers on a shopping cart that he bought from other water porters. But the police would harass him and often confiscate the cart. Since 2010, Nhlanhla has used a trolley that he has modified by adding two bread crates, salvaged from the side of the road.

The idea for the modified trolley came from a fellow water porter who had earlier adapted his trolley in this way. Now all four of the water porters operating in the market use this particular model. The adapted trolley can carry more water containers per trip than the shopping cart, and the bread crates help to stabilize the water drums on the bumpy journey from storage facility to tap, to customer. The adapted trolley is also tough and does not break easily, but the wheels do require regular oiling and have to be changed about once every two months due to wear and tear.

An added advantage of these modified trolleys is that they do not draw the attention of the police in the same way the shopping carts do. Unfortunately, this does not apply to the thieves in the neighbourhood. 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, three to four times per year. When this happens he is saddled with the cost of purchasing and modifying a new trolley. This takes about a week to obtain and forces him to return to the use of a shopping cart in the meantime (Durban micro-narrative).

Another dimension of insecurity for those who work in public space is the risk of being chased away, arrested or fined by authorities. In Lima, both waste pickers and market porters value their uniforms – either a vest or a pullover with a logo – because they signal that the municipality has authorized them as workers (Photo 3). The recyclers' vests also provide physical protection, as they have a reflective strip that helps make the waste pickers visible at night, when many are out collecting waste from households.

In sum, the research found that the risk of harassment and confiscation discourages asset building and investment in improved tools or technology.

b. Emerging technologies

Each occupational group identified new or emerging tools in their sector, used by others doing the same tasks as themselves or doing different tasks further



PHOTO 2
The modified trolley of Nhlanhla, a water porter in Warwick Junction, Durban

© Annie Devenish by permission of Asiye eTafuleni



PHOTO 3
A pullover indicating membership of the National Federation of Recyclers of Peru

© Sally Roever

up the value chain. Many participants considered a tool “new” if it was recently acquired by them, even if it had existed in their sector for a long time.

Consider the construction workers, home-based workers, and waste pickers in Ahmedabad. Some of the construction workers in Ahmedabad are manual labourers sifting sand, mixing cement, and carrying cement and

bricks; others are skilled masons or carpenters using tradesperson's tools as well as machines owned by their contractors or the construction company. One focus group (FG) of male construction workers in Ahmedabad noted: *"We were using a heavy duty hammer to break the stones, which is an old tool but now a tile cutting machine is available"* (Ahmedabad, Male Construction Worker FG 1). Some male waste pickers in Ahmedabad aspire to acquiring a bicycle rickshaw in order not only to transport their recyclables but also to supplement what they earn from recycling by hiring themselves out as rickshaw drivers.

Some incense stick rollers in Ahmedabad no longer hand-roll sticks in their homes but are hired to operate rolling machines in small workshops. The garment makers in Ahmedabad discussed newer models of electric sewing machines; gadgets for stitching buttonholes, hemming, and interlocking; and embroidery machines and cutting machines. These are needed to enter the ready-made, especially modern, garment sector and to better compete in the traditional garment sector. Referring to the industrial-grade electric sewing machine brand popular in both Ahmedabad and Durban, one garment maker in Ahmedabad stated, *"The Juki machine is very expensive. It is useful for those who stitch ready-made clothes"* (Ahmedabad, Garment Maker FG 4). See the online supplement for Photo Collage 1 of existing and emerging tools in Ahmedabad.

In Lima, both street vendors and market traders mentioned new technologies that are being used by higher-income traders, such as digital scales, electric meat slicers and refrigerated display cases. The focus groups pointed out that different display units are used depending on the type of product sold and the place of work. Itinerant vendors of small prepared food items like cakes need a tray; vendors who sell from the ground need a strong tarp; and vendors with a fixed spot on the street may use a trolley, table, display stand, basket, or mobile cart or stove – with the most sophisticated ones being outfitted with a refrigerated chamber and/or a heated chamber for food. In Lima, a recent municipal ordinance mandates that street vendors use stainless steel rather than wooden carts if they want to get their licences renewed.

Among market porters in Lima, the technology used depends on how different products are packaged and transported from the delivery trucks to the wholesale market stalls. Goods may arrive at the wholesale market in plastic or wooden crates or in bags or sacks of different sizes and weights. Only certain products, including tomatoes and green beans, arrive in wooden crates, so only porters who transport those products still use hammers or crowbars.

In the waste sector in Lima, the most significant emerging technologies relate to the transport of recyclable materials. Moto-taxis have been around for a long time, but recently some users have begun to modify them to carry materials instead of passengers. These have begun to replace motorized three-wheelers, which have been banned as too dangerous, as the cargo is placed at the front, which can obstruct the driver's vision and otherwise cause accidents. However, only a few waste pickers, mainly men, can afford a modified moto-taxi. In general, though, the informal workers in Lima are using old technologies far more widely than new technologies. See the online supplement for Photo Collage 2 of existing and emerging tools in Lima.

In some cases, technological change is driven by market forces, often in combination with local ingenuity. Consider the case of Juliet Mchunu (Photo 4), who makes and sells grass mats in Warwick Junction in Durban.

ENVIRONMENT & URBANIZATION

Around 2011, Juliet bought a weaving frame for 200 rand (approx. US\$ 30 as of July 2011) from a man who came around the market selling them. This was the first time she had seen such a device, but it quickly caught on, and today most of the traders at her market who make mats have one too. Whereas a hand-woven mat takes two full days to make, a mat made on the weaving frame can be produced in one and a half days, or even a single day, halving the time required.

The frame works manually and is fairly simple to operate. It consists of a wooden frame, almost like a picture frame to which wooden bobbins are attached. These bobbins hold the various pieces of string or cotton that are used to join together the strands of dried grass. Juliet added the wooden bobbles herself, but otherwise the device did not require any modifications, and she has been satisfied with its functioning. In addition to the weaving frame, Juliet Mchunu's business has benefitted from the use of other technologies. Like seamstress Sizakele Ncube in the Berea Station market, Juliet uses a mobile phone to confirm orders and make appointments with her customers (Durban micro-narrative).

The energy crisis in South Africa today has prompted those at the bottom of the economic pyramid to diversify their energy sources. Those who sell cooked food using electrical stoves have resorted to using salvaged wood, charcoal and petroleum gas. Those who operate other electrical appliances – for example, music vendors, street barbers and cobblers – have resorted to using rechargeable batteries and inverters. This has given rise to secondary businesses, including recharging services utilizing high-tech equipment, and the transport of heavy deep-cycle batteries.

The need for appropriate and cost-effective transport has spawned technologies such as the market barrow (modelled on those used in the Covent Garden market in the UK); the ingenious addition of wheels to a chassis made from salvaged items to form a conveyance; and the appropriation of commercially available equipment (notably supermarket carts). Operating or owning a conveyance is a risky activity as it is routinely confiscated by authorities or stolen. Thus the ingenuity evident in the salvaging and adapting of technology, which makes it less likely to be taken, has significant economic logic.

Explaining improved technologies: cost-benefit analysis

Many of the focus groups of informal workers were quite clear about the costs and benefits of new or emerging technologies in their sector. Consider the cost-benefit analysis of modern electric sewing machines by the garment makers in Ahmedabad (Table 2).

Chandaben Dipakbhai Chetwani, a garment maker in Ahmedabad, bought a Juki-brand industrial-grade electric sewing machine, in 2011. Using the Juki machine has increased her productivity and decreased her maintenance costs. Work that would have taken one whole day with an ordinary machine can be done in five to six hours on the Juki machine. Also, using the Juki, Chandaben can stitch different types of fabrics (silk, thick plastic) using different types of stitches. Chandaben is proud that she can replicate new designs or patterns on her own and is keen to learn new techniques. An additional benefit of the Juki machine, noted by Chandaben, is that it is fairly low maintenance: it requires regular oiling but servicing only once a year (for about 200 rupees [approx. US\$ 3.15 as



PHOTO 4
The weaving frame used by Juliet Mchunu to make grass mats in Warwick Junction, Durban

© Annie Devenish by permission of Asiye eTafuleni

TABLE 2
Cost–benefit analysis of electric sewing machines: garment makers in Ahmedabad (focus groups)

Benefits	
Productivity	<i>"A fully electric machine is useful because we can work fast and do more work with it."</i> (FG 3)
Earnings	<i>"I can do more work and earn more money."</i> (FG 2)
Competitiveness	<i>"The Juki machine... is useful for those who stitch ready-made clothes."</i> (FG 4)
Costs	
Capital investment	<i>"Juki machines cost between 35 to 40 thousand rupees."</i> (FG 4)
Skills acquisition	<i>"If one does not have the skills to operate the machine it can go in reverse and injure your hand."</i> (FG 4)
Electricity	<i>"The electricity bill increases."</i> (FG 3)
Repairs	<i>"The machine cannot be repaired by us, even if the needle breaks we have to carry it to the repair shop."</i> (FG 3)

SOURCE: Technology and the Future of Work WIEGO focus groups (2015).

ENVIRONMENT & URBANIZATION

of July 2015) and otherwise is problem free. She and her husband have invested in an industrial-grade steam ironing machine to iron garments at home (Ahmedabad micro-narrative).

One of the garment makers in Berea Station in Durban, Sizakele Ncube, bought a second-hand Juki that came with a table and foot pedal, for 2,600 rand (approx. US\$ 212 as of July 2015). It proved to be a worthwhile investment, sewing faster, straighter and neater than her old Singer machine, thereby enhancing her productivity. As Sizakele explained: *"You can't work properly on a smaller machine."* With the Juki model she can make up to six garments per day and earn 3,000–4,000 rand (approx. US\$ 245–326) per month, whereas with her Singer machine she was only able to produce two garments daily and to earn around 1,000 rand (approx. US\$ 82) per month. Sizakele cleans her machine on a regular basis with a brush, because dust can cause problems if it gets into the working parts of the machine. Each night, Sizakele stores her machine and its accessories, plus her cloth and finished garments, in a storage unit within the train station that she rents for 10 rand per month (approx. US\$.80) (Durban micro-narrative).

c. Fading technologies

Some existing technologies are disappearing or being displaced. Consider the technological changes reported in Ahmedabad. Perhaps most notably, incense stick rolling is being mechanized. This mechanization has the advantage of increasing production (the machines can produce 120–140 sticks per minute) and decreasing pollution and occupational hazards. However, as one hand-roller commented: *"One machine can replace five to six women"* (Ahmedabad, Incense Stick Roller FG 3). Furthermore, there is competition in the sector from a longer variety of incense sticks imported from China and Vietnam. In sum, the future for women who hand-roll incense sticks is uncertain.

Across India, including in Ahmedabad, the construction sector is being mechanized. Manual construction work – especially tasks like digging and lifting – is being replaced by diggers, loaders, and other machines. And in the garment sector, few garment makers use manual pedal- or hand-operated sewing machines anymore, 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.

In the waste sector in Ahmedabad, as elsewhere in India, the primary collection and transportation of waste is increasingly being done by garbage workers and garbage trucks. But the modern garbage collection system does not sort out or reclaim recyclables. The informal waste pickers continue to do this important task using the same basic tools – but their task is made more difficult because they have to compete for waste with the private garbage collection companies that are paid by the tonne for hauling waste to landfills or incinerators, and with the garbage workers who syphon off some recyclables for themselves. Also, the waste that is available is no longer in open spaces, but in large bins, depots or landfills, making access more difficult. Whilst co-operatives of informal waste pickers in India may theoretically apply for local government waste management tenders, in Ahmedabad they are required to first deposit a large sum of money. This effectively excludes such organizations from the tender process (interview with Mahadevia, an urban scholar).

IV. ICTS, WORK AND ORGANIZING

The focus group discussions found that informal workers are using mobile phones in their work and in their organizing efforts, to contact members and convene meetings, more than any other ICT (Table 3). In terms of intensity of use of ICTs in *work*, on a scale of 1–10, mobile phones ranked 5.5 (Ahmedabad), 8.5 (Durban) and 7.8 (Lima). And, in terms of intensity of use in *organizing*, mobile phones ranked 6.2 (Ahmedabad), 3.9 (Durban) and 6.7 (Lima).

Some informal workers – notably waste pickers and barrow operators – do not possess or are not even aware of ICTs other than simple mobile phones, radios and television. A male waste picker in Ahmedabad, when asked whether he used the internet, replied: *“I do not know what the internet is or how to use it”* (Ahmedabad, waste picker FG). In Durban, a street vendor thought that only people who work in offices use internet, and a barrow operator thought that only young people use internet. Among the handful in the study sample who do use internet, the usage is mainly restricted to the instant messaging app WhatsApp, which allows them to communicate with customers. Some groups of informal workers do not own even simple mobile phones because they share the phones of other family members or they fear their phone will be stolen. As a waste picker in Durban reported: *“While we rest or are sleeping, people who are passing by come and steal our cell phones”* (Durban, Waste Picker FG 15). In Ahmedabad, a group of women construction workers noted that their husbands would not allow them to own a phone as they did not want their wives to communicate directly with the male recruiters and contractors.

Despite these constraints, many informal workers reported that they used mobile phones and other basic ICTs in their work. First and foremost, informal workers use mobile phones to get market information: whether suppliers have stock available, whether contractors have work available, and what the prevailing price or wage rate is. 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 over the phone.”* And a street vendor in Durban reported: *“[A mobile phone] enables us to contact customers about their orders. It allows me to convey information in a speedy manner”* (Durban, Street Vendor FG 1).

South Africa has high mobile phone and internet costs. Although internet-based mobile messaging applications are becoming popular, the most pervasive communication technology used by informal workers is still the basic model mobile phone. What is intriguing are the ways in which informal workers maximize the capability of their phones for phone calls and text messaging, not least of which is to buy SIM cards from various networks. By using these various SIM cards interchangeably, informal workers are able to access the preferred or discounted rates competitively offered by the networks.

Consider the case of Sizakele Ncube, a garment maker at the Berea Station in Durban, South Africa. Sizakele uses her mobile phone to take orders from clients and to make appointments without meeting them face to face. And when orders come in from further afield, like Cape Town, she asks her clients to SMS their measurements so that she can make their garments to order, an arrangement that has enabled her to expand her client base beyond her immediate geographical reach (Durban micro-narrative).

In Lima, some street vendors and market traders use phones to contact their suppliers and place orders for supplies so that they can save

TABLE 3
Intensity of use of ICTs (focus groups)

ICTs	Ahmedabad	Durban	Lima
Mobile: use in work	5.5	8.5	7.8
Mobile: use in organizing	6.2	3.9	6.7
Internet: use in work	1.3	3.6	2.6
Internet: use in organizing	1.0	1.1	5.7

NOTE: Respondents were asked to rate the importance of mobile and Internet technology on a scale of 1–10, where 1 is not at all important and 10 is very important.

SOURCE: Technology and the Future of Work WIEGO focus groups (2015).

time and money on transportation (Lima, Street Vendor FGs 12 and 16). Mobile phones are used to provide better services. Consider Mario Quispe, who sells vegetables. Mario realized that his regular customers are always in a hurry and have very little time to shop for groceries. So he decided to give his mobile phone number to his regular customers so that they could call him and place an order for groceries. He takes the orders, calculates the cost, and packs the groceries for his clients who drop by to pick up and pay for and their orders (Lima micro-narrative).

Some informal workers use mobile phones to advertise their products or their selling hours. Waste pickers in Lima use mobile phones to generate extra work opportunities: for example, to arrange contracts to use their three-wheelers to transport furniture or materials. A group of waste pickers in Ahmedabad said they listen to the radio and watch television to get information on how to store and recycle waste.

In Lima, there is a pilot project being implemented by the Municipality of Santiago de Surco and a local waste pickers organization. The objective is to enable the waste pickers, who work at night in certain parts of the district, to alert the municipal security force of any incident or suspicious activity that they encounter on their routes. The municipality has created two direct phone lines to its public safety call centre for the waste pickers to use, but only one is free for the caller (Lima micro-narrative).

Ninety per cent of the organizations reported that their organizers use some type of ICTs to help organize members. Two-thirds of the organizations use mobile phones and social media in their organizing work; and half also use smart phones, e-mail/internet and websites as organizing tools. While the majority of membership-based organization leaders surveyed said they found ICTs useful, many indicated that traditional forms of organizing are still important, particularly to reach people in remote rural areas where there is limited mobile phone or internet access or older members who do not use ICTs.

Some organizations of street vendors use mobile phones to warn or inform their members about police raids. A home-based worker in Thailand, a member of HomeNet Thailand, was able to use an app called Line as a source of evidence in court against a subcontractor who refused to pay her for an order. She had received an order from a subcontractor who subsequently refused to pay her for the work done, indicating he

had never placed an order with her. She had received legal training from HomeNet Thailand, so knew what evidence was required to prove the subcontractor had made the order. She could not find any written documents but found text in her Line messages with the contractor that showed that he had in fact placed the order. She was able to use this as evidence in her claim against the contractor.

V. CITY-LEVEL TECHNOLOGICAL SYSTEMS

In developing large infrastructure systems, cities make technological choices that often have major impacts on the livelihoods of informal workers – as does the decision by some cities to privatize these systems. How a city perceives and approaches the informal economy and what a city does in terms of infrastructure services are critical determinants of whether the working poor are able to take advantage of technology. As Richard Dobson of Asiye eTafuleni put it in a key informant interview: *“Provision of infrastructure is a defining pathway for the uptake and use of higher-order technology.”*

In the focus groups, each occupational group was asked to discuss three city-wide technological systems – energy, transport and waste. They were also asked to rank which system had the biggest, medium and least impact on their livelihoods, and whether the impact was positive, negative or mixed.

In terms of *degree of significance*, the city-wide systems were ranked quite similarly across all three study cities. The energy system was ranked as most significant by garment makers in both Ahmedabad and Durban, as most of them use electric sewing machines, and by incense stick rollers in Ahmedabad, who need electricity to be able to work at night. The transport sector was ranked as most significant by street vendors, market traders, market porters and transport workers. The waste sector was very significant to the waste pickers and of limited significance to the other sectors.

But in terms of *whether the impacts were positive, negative or mixed*, the rankings varied a good deal across the study cities, depending largely on the status of the sector in each city, as follows:

a. Energy

There is a national energy crisis in South Africa today, with frequent unpredictable load shedding (deliberate electricity shutdowns) and power outages. This had significant negative impacts on all sectors in the Durban sample. In the focus groups, Durban garment makers reported, *“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, Garment Maker FG 6), and *“Customers blame us for incomplete work when the electricity goes off”* (Durban, Garment Maker FG 8). One focus group of waste pickers reported, *“When there is load shedding, the shops from where we collect recyclable materials close and we do not have access”* (Durban, Waste Picker FG 10). Another focus group of female waste pickers noted, *“In winter, if the street lights are not on, we hesitate to arrive before the DSW [Durban Solid Waste] workers due to the risk [of operating in the dark]”* (Durban, Female Waste Picker FG 11). And a focus group of street vendors observed, *“Electricity is used in the production of petrol. If there is no electricity there will be no petrol; and there will be no transport”* (Durban, Garment Maker FG 6).

Since electrical supply was privatized over 15 years ago, Ahmedabad City has been known for regular electrical supply but high unit rates.

Despite the cost, the regular supply of electricity is a great boon to the home-based garment makers, most of whom operate electric sewing machines, and to the incense stick traders and workers who operate rolling machines powered by electricity. While the supply of electricity is steady and widespread across Ahmedabad City, the presence of street lighting is spotty. One waste picker noted that street lighting along her route helped her sort and collect recyclables during the early morning, while some street vendors compensate for the lack of street lighting at night by running solar-powered lanterns for hours at night. However, alternative energy sources generally require a large upfront investment that is often unaffordable to the poor (interview with McKenzie, Founder of Urban Earth; interview with Solanki, Manager of Torrent Power office).

In Lima, Peru, electrical supply covers more than 95 per cent of households. While the price of electricity rose during the course of the study, market traders and street vendors were more concerned about the rise in gas prices. As a focus group of street vendors observed: *“Almost all the market needs electricity, but as we have it and the prices remain the same, there is no major impact on our work, there are no changes. If we didn’t have it, sure, there would be concerns because without electricity we wouldn’t have water”* (Lima, Street Vendor FG 12).

b. Transport

The lack of affordable and accessible public transport is a key concern to virtually all informal workers in the study cities, as in most cities around the world.⁽¹²⁾ Public transport between their place of residence and place of work tends to be costly, infrequent and unreliable. Moreover, transporting goods on public transport is usually banned. Most informal workers have to resort to private transport of different kinds, or commute and transport goods on foot. The 2012 study by the WIEGO network found that on average, home-based workers in three Asian cities (Ahmedabad, Bangkok and Lahore) spent 30 per cent of their earnings on transport. And of those who spent on transport, one-quarter operated at a loss.⁽¹³⁾

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. But public transport in South Africa is inadequate, unreliable and very costly, forcing the informal workers to use private vans and taxis. For street vendors, *“transport is the most important system”* (Durban, Street Vendor FG 3); *“We cannot go anywhere without transport: it is the main key system”* (Durban, Street Vendor FG 3). As one mielie (corn on the cob) cook observed: *“Where we collect mielies is too far; we need a car to collect them”* (Durban, Mielie Cook FG 15). Those who transport goods for other people, use public transport to get to work. As one transport worker in Durban put it: *“If we don’t have transport to come here, we won’t be able to provide for our families”* (Durban, Transport Worker FG 13).

In Lima, public transportation was privatized in the 1990s. Since then, small and medium private companies have provided transport services. The road infrastructure is insufficient, resulting in increasing congestion and chaos. Recently, the government built two subway lines and a metropolitan bus line. However, these investments have proved to be insufficient to meet demand; so a third subway line is being built. Another problem is that the schedule of the trains and buses does not

12. An urban expert in Bangkok refers to the BTS SkyTrain and subway systems as “class-transit”, not “mass-transit”, as the poor cannot afford to ride them. In fact, the poor cannot afford the more informal modes of transport in Bangkok: the two-wheel and three-wheel motorized taxis. The poor tend to walk and take public buses or, if they can save enough money, buy their own motorcycle or car (Apiwat Ratanawaraha. Chulalongkorn University, personal communication, January 2014).

13. Chen, Martha A (2014), *Informal Economy Monitoring Study Sector Report: Home-Based Workers*, WIEGO, Cambridge, MA, available at <http://wiego.org/sites/wiego.org/files/publications/files/IEMS-Home-Based-Workers-Full-Report.pdf>.

meet the needs of informal workers. One waste picker, for example, said, “[The transport system] does not help us. Sometimes the buses do not want to pick us up.” Another said, “Sometimes I might wait until very late [in the night] and they [buses] do not pick us up” (Lima, Waste Picker FG 6).

In all three cities, no consideration has been given to the need of informal workers to transport goods. “Buses are not designed for that sort of carting”, stated a Durban transport planner (Estevez interview). The result is that all informal workers – but especially street vendors, market traders, and waste pickers – have to use taxis, private cars or other private vehicles to transport their goods.¹⁴

Furthermore, urban infrastructure projects, including transport projects, have major impacts on the livelihoods of informal workers. In Ahmedabad, for example, several urban development and infrastructure projects, including a Bus Rapid Transit system (BRTS) (2006), a model roads scheme (2011), a riverfront development scheme (2004), and road widening, have recently been implemented. In the design of these projects, natural (open air) markets of street vendors and the vendors themselves were not considered – with the result that many natural markets have been destroyed or evicted by the Ahmedabad Municipal Corporation. In many cases, the alternate space provided to vendors is not suitable as it does not attract customers.

The implementation of a Bus Rapid Transit (BRT) system is currently in its early stages in Durban. The municipality is aware that the system will realign urban space and potentially disrupt natural markets throughout the city (Estevez interview). With the collaboration of Asiye eTafuleni, a model transport node that incorporates informal traders has been proposed, but whether this will be implemented is questionable (Estevez interview, Dobson interview). Asiye eTafuleni continues to be critical of the BRT system, arguing that it is based on a model that values “frictionless” public transport, which minimizes interactions with public spaces, as the ideal, rather than promoting friction as way to increase economic opportunities (Dobson interview).

c. Waste

Waste management was privatized in Ahmedabad around 2010. Today, the private waste collection covers about 70 per cent of the city (estimate of the Indian Academy of Self-Employed Women). In some parts of the city, the waste pickers can reclaim waste from municipal waste bins. But not all areas have municipal bins, and in some areas that do, the municipal street cleaners or the private garbage workers reclaim waste for themselves.

In Durban, solid waste management is still a public sector function: through the Department of Durban Solid Waste (DSW). One group of waste pickers reported: “The DSW often comes early and takes all the waste including cardboard, so it is important for us that we arrive before the DSW” (Durban, Waste Picker FG 11).

In Lima, solid waste management is a public sector function but the quality of service differs from one municipality to another. A few district municipalities work well with the waste picker associations and include them as part of the waste management system, or provide them with sorting and recycling centres. In other districts, the conditions of the waste pickers are more difficult: the waste pickers have to reclaim recyclables before the municipal garbage trucks collect waste, often having to work at night.

14. In an interview, Gustavo Guerra-García, former Vice Minister of Transport and former adviser to the Management of Urban Transport of the Municipality of Lima, pointed out that the public transport system does not allow transport of goods of any type or amount. Responding to the information found in the study, he noted that specific services would be required to transport goods in the municipality.

Finally and importantly, the focus group discussions during this research, as well as the earlier IEMS research in the same cities, revealed that the unpredictable, often hostile, policy and regulatory environment serves to inhibit the livelihood strategies of informal workers, including their choice and use of technologies. The lack of legal recognition and protection means that informal workers often face demands for bribes, confiscation of goods and equipment, evictions, and other forms of harassment. These inhibit their ability or willingness to invest in improved technologies or enhanced stock. For instance, street vendors without secure vending sites are inhibited from investing in expensive or heavy equipment as they have to be able to pick up and move their equipment and stock when they see the police coming.

Most critically, 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.

Consider the situation of Benedict Matlalo and other metal scrap recyclers 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 a saw. However, possession of these tools – which are essential for their livelihoods – makes them vulnerable to police harassment and confiscation. As Benedict explained, the tools recyclers use in reclaiming and recycling scrap metal are the same ones that thieves use to break into houses. The police therefore assume that they possess and use these tools because they *are* criminals and are plotting to use them to carry out burglaries. This is further aggravated by the fact that their job requires them to walk around local neighbourhoods looking for scrap metal and cardboard, in an environment where there are already heightened fears of crime. The police response is to confiscate their tools or to surround them at the park where they work, forcing them to run off and hide. On occasion, they have even been shot at with rubber bullets: one of Benedict's colleagues lost his eye, but being a migrant he chose not to report the incident as he was afraid of being deported. On other occasions the police have loaded them up "*like sardines*" into police vans, and taken them somewhere to be "*hosed down*", or driven them far away to a dump site, from where it has been difficult to get back to their work site (Durban micro-narrative).

VI. CONCLUSIONS

The research findings presented above shed much-needed light on the reality of work and technology at the bottom of the economic pyramid.

The findings suggest that both existing and emerging work technologies, in all the sectors across the three cities, are quite basic. The study also found that the costs and risks of new technologies are well understood, including direct costs (capital investment, energy requirements, maintenance and repairs, and replacement if broken, lost, stolen or confiscated); lack of necessary know-how or skills to use and maintain technologies; and lack of basic infrastructure services. Other factors are portability (especially for street vendors who have to move on when police arrive) and storage availability (especially for street vendors and waste pickers). Perhaps most importantly, the study found that fear of theft and of confiscation by local authorities are major deterrents to investing in improved technology.

The findings also suggest that informal workers and their organizations are beginning to use ICTs in their work and organizing, but that individual informal workers use mainly simple mobile phones while organizations of informal workers are beginning to use internet and online platforms. But there are limits to using ICTs as many members do not own smartphones, many organizations do not own smartphones or computers, many members are not literate, and many members live in remote areas without internet access. Also, the findings make it clear that ICTs alone cannot address the wider systemic constraints faced by informal workers.

Perhaps most importantly, the findings suggest that city-level systems and city-level policies and practices have a significant impact on informal workers, their livelihoods and their ability to adapt to technological change. An unpredictable, often hostile, policy and regulatory environment serves to inhibit the livelihood strategies of informal workers, including their choice and use of technologies. This reality is summed up succinctly by a street vendor in Lima: *"I sell from a small bag. If I sell more, the municipal police come and seize my things"* (Lima, Street Vendor FG 12).

The available evidence suggests that individual informal workers adapt or invest in technologies to increase productivity and incomes, to address occupational health and safety concerns, and to compensate for wider structural constraints. However, the adaptations or investments are quite modest, as follows:

To increase productivity and income, informal workers use simple mobile phones to contact suppliers, buyers and contractors. As for sector-specific technologies, construction workers seek training in specialized skills and invest in tradesperson's tools; garment workers prefer improved electric sewing machines and specialized gadgets; street vendors benefit from investing in improved displays and digital scales to attract customers; and both street vendors and waste pickers use improved barrows, trolleys and carts.

To address occupational safety and health risks, construction workers weave topknots out of string or plastic to cushion the weight of headloads; market porters use tools to deal with heavy loads, treating boards as ramps to cushion weight when loading/offloading heavy bags or boxes; and street vendors and waste pickers put reflective strips on their trolleys, barrows or carts.

To compensate for lack of basic infrastructure services, street vendors extend selling hours through the use of solar lamps.

Finally, *to compensate for lack of accessible/affordable public transport*, all workers in the studied occupations hire private transport, sometimes jointly.

The evidence also indicates that organizations of informal workers can and do help their members to make technological choices, to jointly acquire expensive technology, and to negotiate the wider environment. Organizations of informal workers help their members negotiate access to raw materials (including waste); workplaces and storage spaces; basic infrastructure services at their homes and workplaces; affordable transport services; permits or licences to work; and contracts to provide public goods and services – all of which make it more likely that informal workers can invest in improved technologies.

To sum up, little is known about the technologies used by the working poor in the informal economy and little attention has been paid to developing technologies for them. Meanwhile, informal workers have been adapting their existing work technologies to match new work opportunities and adapting their existing work to meet new technological

ENVIRONMENT & URBANIZATION

challenges, but largely on their own in a negative policy and regulatory environment. As one street vendor in Lima observed, informal workers belong to “a different world”: a world that is either invisible to or stigmatized by government, the private sector and the general public. To make technology development more inclusive and just for informal workers, governments and other key stakeholders need to recognize and value informal workers and their livelihoods, and to take them into account – to listen to their needs – when designing not only technology but also city-level regulations, policies and systems.

ACKNOWLEDGEMENT

Laura Alferts, Namrata Bali, Themis Castellanos and Richard Dobson oversaw the field research and the analysis of findings. Mike Bird, Kendra Hughes, Sally Roever and Mike Rogan also contributed to the analysis and this paper. Laura Alferts, Deputy Director, WIEGO Social Protection Programme, South Africa; address: e-mail: l.alferts@ru.ac.za. Namrata Bali, Director, Indian Academy of Self-Employed Women, Self-Employed Women’s Association, India; address: e-mail: mahilasewatrust@vsnl.net. Mike Bird, Operations Director, WIEGO, UK; address: e-mail: mike.bird@wiego.org. Themis Castellanos, Independent Consultant, Peru; address: e-mail: themiscastellanos@gmail.com. Richard Dobson, Co-founder, Asiye eTafuleni, South Africa; address: e-mail: richard@aet.org.za. Kendra Hughes, Programme Support Officer, WIEGO, Canada; address: e-mail: kendra.hughes@wiego.org. Sally Roever, Director, WIEGO Urban Policies Programme, USA; address: e-mail: sally.roever@wiego.org. Mike Rogan, Senior Researcher, Neil Aggett Labour Studies Unit, ISER Rhodes University, South Africa; address: e-mail: m.rogan@ru.ac.za.

REFERENCES

- Cáceres, Roxana Barrantes, Aileen Agüero, Martín Cavero and César Huaroto (2012), “The Impacts of the Use of Mobile Telephone Technology on the Productivity of Micro- and Small Enterprises: An Exploratory Study into the Carpentry and Cabinet-Making Sector in Villa El Salvador”, *Information Technologies & International Development Journal* Vol 8, No 4, pages 77–94.
- Carr, Carlin (2015), “Mapping Bangalore’s Waste”, URB.im, 10 March, available at <http://urb.im/ca1503bge>.
- Chen, Martha A (2014), *Informal Economy Monitoring Study Sector Report: Home-Based Workers*, WIEGO, Cambridge, MA, available at <http://wiego.org/sites/wiego.org/files/publications/files/IEMS-Home-Based-Workers-Full-Report.pdf>.
- Chen, Martha A (2015), *Technology at the Bottom of the Pyramid: Insights from Ahmedabad (India), Durban (South Africa), and Lima (Peru)*, WIEGO team report to the Rockefeller Foundation, available at <http://wiego.org/sites/wiego.org/files/publications/files/WIEGO-Technology-bottom-pyramid-2016.pdf>
- Daniels, Steve (2010), *Making Do: Innovation in Kenya’s Informal Economy*, Creative Commons.
- Harris, John C (2014), “The confounding influence of urban informality on innovation and production specialisation in production clusters: evidence from Nairobi”, *African Journal of Science, Technology, Innovation and Development* Vol 6, No 6, pages 529–539.
- Kanbur, Ravi (2014), “Mindsets, Trends and the Informal Economy”, Working Paper 2014–06, Charles H. Dyson School of Applied Economics and Management, Ithaca, NY, available at <http://ageconsearch.umn.edu/bitstream/180155/2/Cornell-Dyson-wp1406.pdf>.
- Klopp, Jacqueline M (2014), “Cities in motion: how we mapped the matatus of Nairobi”, *The Guardian*, 19 February, available at <http://www.theguardian.com/cities/2014/feb/19/cities-motion-how-we-mapped-matatus-nairobi>.
- WIEGO (n.d.1), *Technology & the Future of Work – An Exploratory Research Project*, available at <http://wiego.org/technology>.
- WIEGO (n.d.2), *Informal Economy Monitoring Study*, available at <http://wiego.org/wiego/informal-economy-monitoring-study-iems>.