





Chapter 8

The tough task of enhancing the capabilities of low-income households to benefit from the Fourth Industrial Revolution

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Abstract

The introduction of a series of advanced technologies, collectively referred to as the Fourth Industrial Revolution (4IR), has already altered traditional production and consumption patterns and is likely to continue doing so in future. South Africa faces a primary education crisis, as well as high rates of poverty and unemployment. Given the existing limitations and inequalities, it is unclear whether the 4IR will benefit all members of society equally or at all. This chapter aims to investigate the potential of the 4IR to enhance the quality of life of low-income households in South Africa. We will conduct our investigation by considering the relevance of 4IR technologies for the household, using the 25 elements of the household identified in Nova's QOLA¹ instrument. We will investigate whether there are ways in which low-income households can benefit from the transformations brought about by the 4IR or if there are specific barriers that need to be removed for low-income households to benefit. Given that the interface between low-income households and 4IR technologies is an emerging

¹ Editors' note: See Chapter 12, where quality-of-life assessment is discussed in detail.



phenomenon and that the data is sourced from case studies, this chapter will identify key questions and themes for further research rather than offer firm recommendations for action.

Keywords: elements of the household, Fourth Industrial Revolution, low-income households, social context of technology

1. Introduction

The term ‘Fourth Industrial Revolution’ (4IR) was first popularised by Klaus Schwab, founder and executive chairman of the World Economic Forum, to describe the emerging environment in which disruptive technologies and trends such as the Internet of Things (IoT), robotics, virtual reality (VR), and artificial intelligence (AI) are changing the way we live and work (Schwab, 2016).

The term ‘Fourth Industrial Revolution’ presupposes three previous industrial revolutions. The *first* one began in the late 18th century, characterised by the transition from manual production methods to machines through steam power and factory systems. The *second* revolution, starting in the late 19th century, brought about mass production and technological advances in steel production, telecommunications, and electricity distribution. The *third* revolution, from the mid-20th century onwards, was driven by the development of digital technology and automation of production.

The 4IR distinguishes itself by integrating technologies that converge the physical, digital, and biological realms. The key feature that all 4IR technologies share is that they utilise the pervasive power of digitisation and information technology (Schwab, 2016, p. 19). The 4IR introduces advanced machine learning, widespread sensor deployment, and biotechnology advancements. These technologies share common attributes such as connectivity, the use of enhanced computational power, and sophisticated data analytics capabilities. According to Schwab, there are four main physical manifestations of the technological megatrends that constitute the 4IR: autonomous

vehicles, 3D printing, advanced robotics, and new materials (Schwab, 2016, p. 19).

The 4IR is marked by a rapid synthesis of previously separate domains, allowing for real-time communication and collaboration across global networks (Schwab, 2016, pp. 14,15). The IoT is a good example of this synthesis of previously separate domains. The IoT devices are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the Internet. In short, the IoT represents a network of physical objects that can sense and communicate (Madakam et al., 2015). Recent advances in AI create yet another important layer in IoT systems. By collecting vast amounts of data through sensors, AI systems create predictive models that can command actuators based on real-time indicators. So, for example, AI systems can 'learn' the ideal soil moisture parameters to maximise the yield of a given plant and control irrigation actuators to ensure optimum conditions on an ongoing basis (Sinwar et al., 2020).

Schwab argues that the successive industrial revolutions have occurred at an increasingly faster pace and that they bring changes that are more rapid and widespread compared to previous revolutions. While the First Industrial Revolution took around 120 years for the spindle, a hallmark of that revolution, to spread outside of Europe, the Internet permeated across the globe in less than a decade (Ibid, pp. 12-13). The Second Industrial Revolution was marked by advancements in steel production, electricity, and the development of the assembly line. Schwab notes that in 1990, the three largest companies in Detroit, the heart of American auto manufacturing, had a combined market capitalisation of \$36 billion, revenues of \$250 billion, and 1.2 million employees, whereas in 2014, the three biggest companies in Silicon Valley, the hub of digital technology and software innovation, had a considerably higher market capitalisation (\$1.09 trillion), generated roughly the same revenues (\$247 billion), but with about 10 times fewer employees (Schwab, 2016, p. 14).

This comparison demonstrates one of the concerns about the 4IR: it brings changes faster but may potentially exclude large sectors of society.

South Africa has an alarmingly high unemployment rate and a dysfunctional primary education system. The official unemployment rate for the fourth quarter of 2023, based on the Quarterly Labour Force Survey by Statistics South Africa, was 32,1%. The unemployment rate, according to the expanded definition, was 41,1%. The youth unemployment rate for the same period was 43,4% (StatsSA, 2024a). The results of benchmark tests for literacy and numeracy, specifically the *Trends in International Mathematics and Science Study* (TIMSS) and the *Progress in International Reading Literacy Study* (PIRLS), show South Africa consistently in the bottom decile. However, when compared by province, the provinces with higher urbanisation, namely Gauteng and the Western Cape, do much better.

In this chapter, we will consider what needs to be done to ensure that 4IR enhances the capabilities of low-income households in Southern Africa. We emphatically do not subscribe to the view that there is a hierarchy of needs apart from the obvious fact that dead people have no needs. The ideology of a hierarchy of needs lacks an empirical basis. We view the human needs for creation, participation, understanding, identity and freedom as fundamental (see Murray & Pauw, 2022).

2. Situating South Africa within the Fourth Industrial Revolution

South Africa is a unique context because of the contrasts in wealth, skill, and technological advancement within society.

According to the recent World Bank report on inequality in Southern Africa, South Africa has the highest Gini coefficient of consumption per capita in the world, ranking 1st out of 164 countries in the World Bank's global poverty database (World Bank, 2022, p. 9).

In 2015, more than half of the population lived under the upper-bound poverty line (StatsSA, 2017). The latest (2023)

poverty lines are: food poverty: R760; lower-bound poverty: R1,058; upper-bound poverty: R1,558 (see StatsSA, 2024b). Owning autonomous vehicles or making use of advanced robotics is not, in our view, a realistic prospect for this half of households in South Africa, given the current economic trajectory. The prospect that 4IR technologies will replace some jobs is, however, real.

Despite high income inequality and a high proportion of the population living in poverty, South Africa has a relatively high proportion of Internet users, most of whom access the Internet through their mobile phones. Estimates place the number of Internet users in South Africa at the start of 2024 at about 45 million, implying an Internet penetration of approximately 75% (Kemp, 2024). This means that the basic infrastructure utilised by the 4IR is, at least in principle, accessible to the vast majority of households in South Africa.

In principle, there are two ways in which the 4IR can benefit low-income households in South Africa: It could make products and services cheaper, or it could make them better. Making products and services cheaper would be beneficial in cases where low-income households are the consumers of products produced using 4IR technologies. Making products and services better (but not more expensive) is relevant where low-income households are themselves the users of 4IR technologies. Making essential products and services cheaper is, in effect, the same as lowering the poverty line because the poverty lines are calculated from a basket of essential goods and services. This is an example of the income effect.

The other way in which 4IR technologies may benefit low-income households is if they create more new opportunities compared to the opportunities lost caused by the 4IR that are accessible to low-income households.

The question, therefore, is whether there are concrete prospects for 4IR technologies to enable low-income households to have greater freedom, more income, more knowledge, more participation, more creativity and expression and fewer health and safety risks.

Murray and Pauw (2022, p. 7) identified 25 elements or aspects of the household that facilitate the actualisation of fundamental human needs. A selection of our findings is reported below. These are sorted into six broader categories:

- **Basic necessities** water, food, waste removal, clothes
- **Localisation** terrain, air, house, climate, sound
- **Basic activities** care, work, rest
- **Relationships** self, intimate partner, household members, non-household members
- **Consciousness** faith, values, motivation, thought, learning, communication, beauty
- **Body structure** sex, development phase

Basic necessities

Every element in the households can be brought into a relationship with any one of the nine (or ten) values on the axiological axis² of Manfred Max-Neef et al.'s (1991) typology of fundamental human needs and any one of the forms of being³ on the existential axis. The household element *Food* is not only a satisfier for *Subsistence* but also for all the other needs because food is used to show love, strengthen relationships, express oneself, enjoy oneself, and even participate in communion with God.

Understandably, low-income households will tend to show low satisfaction with the elements of the *Basic necessities* group because they objectively lack them. The question is how 4IR technologies relate to households' water, food, waste removal, and clothes.

Water provision infrastructure is strongly associated with technologies from the Second Industrial Revolution since it relies on mass-produced components such as pipes, mechanical energy for construction, and electricity to drive pumps. Possible

2 Subsistence, Protection, Affection, Participation, Understanding, Creation, Idleness, Identity, Freedom, Transcendence

3 Being (personal or collective attributes), Doing (actions and practices), Having (institutions, norms and habits), Interacting (times and spaces)

improvements in water infrastructure management may be achieved by using the IoT. The effect, if any, on low-income households will likely be incremental and indirect.

Food production, processing, and transport are also associated with the advances of the Second Industrial Revolution. In the 20th century, food production was revolutionised through large-scale mechanical power and synthetic fertiliser application.

The bulk of food produced in Southern Africa is produced by commercial farmers and distributed through conventional market mechanisms. As far as food as an energy source is concerned, this is a very efficient mechanism because conventional commercial agriculture is so much more efficient compared to small-scale agriculture. This is not necessarily the case for all nutrients. According to a report by Statistics South Africa that is based on the General Household Survey of 2021, more than half a million (683,221) households with children aged five years or younger reported experiencing hunger in 2021 (StatsSA, 2023). Although absolute deprivation does exist (1.1 million or 6% reported that they experience inadequate access to food), most low-income households do not necessarily lack access to enough energy from their food but lack, especially, fresh vegetables and quality proteins. Labadarios et al. (2011) conducted a cross-sectional study (n=3,287) based on a face-validated 24-hour recall to measure dietary diversity in South Africans aged 16 years and older from all population groups. They concluded that “the majority of South Africans consumed a diet low in dietary variety. The tribal areas and informal urban areas were worst affected, and eggs, legumes and vitamin A-rich fruits and vegetables were the least consumed” (Ibid, p. 11).

The impact of the 4IR on large-scale commercial agriculture will likely lead to a further decline in human labour per unit of production in agriculture. The first such reduction in labour in modern times came through mechanisation. The 4IR introduces autonomous vehicles, robotics and sensors that enable the mechanisation of tasks such as weeding and picking

fruit that could previously only be performed by humans (see Tevel, 2023). The potential impact of the 4IR in agriculture will have to be addressed at the societal level. According to a report by the Food and Agriculture Organization of the United Nations (Davis et al., 2023), approximately 1.23 billion people were employed in the world's agrifood systems in 2019. Agrifood systems are defined as a combination of agriculture, forestry and fishing and the manufacture of products derived thereof. However, almost half the world's population (3.83 billion people worldwide) live in households linked to agrifood systems (Davis et al., 2023, pp. iii, 5).

Not many households in South Africa produce most of their own food. Based on the 2021 General Household Survey, Statistics South Africa (2023) reported that 3.1 million (17,3%) households engaged in agricultural activities. These households were mainly located in non-metro and rural areas. About 12% of those who produce at least some of their own food, i.e. approximately 2% of all households, reported their agricultural activities as the main source of food for the household.

Nova has implemented projects for small-scale household food production in both urban (Soshanguve, Gauteng) and rural settings (Letsitele area, Limpopo) (Reyneke, 2021). In our experience, efforts to increase small-scale household food production in urban and rural areas were substantially more difficult than we anticipated. In urban areas, space is limited, and where space may be available on an urban stand, the shade of nearby buildings may make it unsuitable for a vegetable garden. In rural areas, space to plant is more accessible, but access to water is often more difficult and stray animals such as goats and donkeys damage crops. 4IR technologies may not necessarily directly address issues with water supply and physical crop protection but may help to address problems that small-scale food producers experience with identifying pests and diseases. Understanding when to irrigate or fertilise is also important. A cursory investigation of the Google Play store shows that numerous applications already exist that use computer vision to identify insects and plants and diagnose plant diseases. In their extensive analysis of the application of

the IoT to agriculture, Ayaz et al. (2019) identified irrigation as one of the major application areas for 4IR. They state that “a precise soil and air moisture control system using the wireless sensors not only makes an optimal use of water but also leads to better crop health” (Ayaz et al., 2019, p. 129555)

Waste removal is an important issue for low-income households in South Africa⁴. The 2021 General Household Survey found that household refuse was removed at least once per week for only 60% of all households nationally (StatsSA, 2022, p. 39). Of households in rural areas, 86% disposed of refuse themselves. In urban areas, only 12% of households disposed of refuse themselves (StatsSA, 2022, p. 40). Once again, the advances of large-scale waste services are because of technologies originating in the Second Industrial Revolution, but these advantages have not reached a large proportion of households in South Africa.

It is not clear if there are 4IR technologies that apply to this problem at the household level. We do foresee that 4IR technologies may be used to improve service delivery at a municipal scale. One such improvement in service delivery may be through an improvement in the monitoring of waste collection. Multiple options for geographical tracking of waste collection vehicles are available. These vary from free Android applications to commercial fleet management software. AI-driven waste sorting facilities utilising waste sorting robots are already in use to sort recyclable waste at scale (see, e.g., Ampsortation, 2025). Such technology may make waste recycling more feasible for more municipalities.

The provision of **clothes** is a basic element of the household. The First Industrial Revolution already brought advances in the production of textiles, with the Second Industrial Revolution introducing mass production of clothes. The Fourth Industrial Revolution has already impacted clothes manufacturing, but greater impacts are expected in future. Altenburg et al. (2020) note that the manufacture of clothing can already be robotised, but expect that the robotisation of sewing

4 Editors' note: See the case studies discussed in Chapter 5.

will be more expensive than manual labour until approximately 2035 to 2040. The mass production and consumption of clothes means that for the large majority of even low-income households, clothes as a mere means of protection against the environment is not lacking. We observed low satisfaction rates with clothes, compared to other elements of the household (see for example Murray & Pauw, 2022, p. 14 for data from eMbalenhle, South Africa).

Localisation

Low-income residential areas are often dirty, unsafe, noisy, or crowded. Therefore, it is understandable that we observed low satisfaction with the *Localisation* element group. The *Localisation* element group contains four elements: terrain, air, house, climate, and sound.

Terrain

It is difficult to imagine 4IR technologies that would improve the **terrain** where low-income households are located, with perhaps the exception of crime prevention. As part of a broader policing strategy, networks of security cameras have been shown to reduce certain types of crime, while some types of crimes remain unaffected (Donkers, 2016, p. 129). In South Africa, public open street closed-circuit television (CCTV) surveillance systems operate in the central business districts of the main metropolitan areas (Minnaar, 2007). The implementation of these systems led to a reduction of especially street crime and bank robberies in the area under surveillance (Minnaar, 2007, pp. 193, 194). CCTV technology is not a 4IR technology but rather belongs to the group of technologies that constitute the Third Industrial Revolution. The 4IR version of surveillance networks pairs observation with enhanced abilities, e.g., the ability to automatically zoom in on objects of potential interest, as well as with advanced data processing capabilities that incorporate aspects such as facial recognition, motion analysis, number plate recognition and object recognition (typically firearms). These all have obvious applications for enhancing security. At the same time, it is easy to envision a dystopian future in

which a totalitarian state uses such technologies to enforce total control over a population. In fact, such a scenario is currently playing out in Western China (Shakir & Wang, 2021).

*Air*⁵

Air pollution has been a side-effect of industrialisation since the first industrial revolution. The quality of **air** breathed by households is determined by a combination of natural and anthropogenic sources at the regional, local, and micro scale. Local air quality is impacted in particular in the presence or absence of large- and small-scale fuel conversion technologies, traffic and dust sources.

Electric vehicles will have obvious air quality advantages for households that live in areas where vehicle emissions contribute significantly to air quality problems. The 4IR technologies are also relevant as far as monitoring air quality is concerned. Miniaturisation of certain types of air quality sensors is well advanced, for example: in 2016, *Wired Magazine* reported that “Half a dozen racing pigeons have been released into the capital (i.e., London) with GPS devices and a 35 g sensor to measure levels of nitrogen dioxide being produced in the city” (Wired, 2016).

There are several air quality monitors marketed for household use. The price of these devices means that there is no prospect for adoption by low-income households. Lower-cost air quality monitors have been mooted as an opportunity to extend air quality monitoring networks. The accuracy of these instruments does not currently compare with that of compliance-grade instruments. DeSouza et al. (2017) evaluated several low(er)-cost air quality sensors deployed in Nairobi. They found that these sensors have technical limitations, but that they can still provide indicative measurements of air quality that are valuable to local communities. They found that a low-cost sensor network increases public awareness of air quality issues and, therefore, can complement but not substitute high-

5 Editors' note: Air quality is extensively discussed in Chapters 3, 4 and 10.

quality and reliable air quality monitoring systems. Wernecke et al. (2021, p. 4) expressed the belief that low-cost sensors have the potential to generate epidemiological evidence and have a role to play in gaining a better understanding of exposures as part of a larger undertaking to understand and act upon pollution-related health impacts.

House

Most households that live in formal houses do not build their own **house**. As with other elements already mentioned, houses in South Africa are constructed with the products of the Second Industrial Revolution, such as mass-produced cement, bricks, tiles, steel, and wood products. According to the 2021 General Household Survey (StatsSA, 2022, p. 35), 11.7% of households in South Africa lived in informal dwellings. Assuming that there were 17.9 million households in South Africa in 2021 (StatsSA, 2022, p. 12), this amounts to just over 2 million households.

The Department of Human Settlements reported to the Portfolio Committee on human settlements (PMG, 2022), that the human settlements sector has delivered 3,431,382 housing units made up of stand-alone houses and units in multiple-storey or multi-unit buildings from 1994 to the end of February 2022. Most of these houses were built without appropriate thermal insulation.

One may reasonably expect that the 4IR may contribute to incremental improvements in the production of building materials, but this is unlikely to solve the housing needs of low-income households in Southern Africa, except if new materials or techniques could be found that will radically drive down building costs.

Three-dimensional (3D) construction printing is an example of one such new technique. Mahachi (2021, p. 4) finds that this technique may eventually be much cheaper than the conventional construction when taking into account the full life cycle cost, but that the conventional 'brick and mortar' home building industry remains competitive and that comprehensive, pragmatic research and practical implementation are needed

to ascertain the role of this technology in housing delivery in South Africa.

The last two elements of the environment in which households find themselves (the *Localisation* element group) are **climate** (which incorporates solar radiation, air temperature, humidity, wind speed) and **sound**. We do not foresee that 4IR technologies can reasonably impact the *ambient* climate. In areas where households are exposed to traffic noise, the use of electric vehicles may provide some relief.

Basic activities

The *basic activities* element group contains the elements of *care*, *work*, and *rest*. Many products are using 4IR technologies on the market aimed at supporting these basic activities – practically all of them are unaffordable to low-income households. The one platform for 4IR technologies to which large numbers of low-income households have access is mobile phones. Most of these are running on the Android operating system. The StatCounter Global Stats website (2024) estimated that Android accounted for 84% of operating systems on mobile phones in South Africa in 2024. The ten top-ranking applications by download on the Google Store in South Africa, as tracked by Similarweb (2024) included two shopping applications (Temu and Shein), three communication-focused applications (WhatsApp, Messenger, WhatsApp Business), three social network applications (Facebook Lite, TikTok, TikTok Lite), one banking application (Capitec Bank) and a PDF reader. Illidge (2023) listed the most popular Android applications for 2023. This list includes many of the same applications as given by Similarweb for 2024 (WhatsApp, Facebook Lite, TikTok, TikTok Lite, Capitec Bank, WhatsApp Business, Shein) but also includes a music application (Spotify). From a survey of 1,931 respondents aged 18 to 64 years who use a smartphone in 2023, Statista (2024) tabulated the most-used smartphone applications by type in South Africa. The top category was social media applications with 83% of devices, followed by email services (79%), Internet browsers (77%), messenger applications (67%) and music services (60%). About half of the respondents used game applications.

In general, the use of smartphone applications by low-income households is limited by the quality of network connection, the cost of data and the cost of the applications themselves.

WhatsApp, the most popular Android application, has an obvious application in the daily lives of households as it gives members a very cost-effective way to communicate with each other. It is important to note that WhatsApp provides a crucial function (general communication through text, files, and voice) and is free to install and use. The user pays only for data. If used correctly, WhatsApp can be extremely data-efficient. Therefore, WhatsApp is an example of the type of application that could serve low-income households: It is free, data-efficient, flexible regarding its utility and addresses a fundamental usage pattern (communications).

The reach of 4IR technologies is limited by external factors, but also by digital literacy. Regarding healthcare, MISTRA (2020, p. 299) notes that healthcare interventions focused exclusively on technology (particularly digital technologies) will likely fall short of addressing broader systemic and social determinants of health.

The impact of the 4IR on household **work** is easier to imagine for high-income households than for low-income households: gradually expanding automation of the home is taking place through smart technologies. The second industrial revolution brought appliances that minimised manual household work, such as washing machines, tumble dryers, vacuum cleaners and dishwashers. The 4IR brings connected digital appliances (such as Internet-enabled fridges) and even automation (such as autonomous vacuum cleaning robots). Low-income households in South Africa, as a rule, use a limited number of appliances, even from the Second Industrial Revolution, to ease domestic work (typically limited to electric plates and microwave ovens).

The question around economic work outside of the household is whether the 4IR will create or destroy jobs for low-income households. In the view of MISTRA (2020), the impact

of 4IR technologies will be determined by how they are used and managed. Although this seems like a sensible position, the term *manage* is unfortunate. Complex phenomena and systems like technological revolutions and economies cannot be managed by any one party.

There are already social media applications helping people to find lower-end jobs (Mehdi, 2020).

Rest

4IR also impacts **rest** and relaxation in the household. Amongst the most-used Android applications are entertainment-oriented social media applications (notably TikTok and TikTok Lite). Android games, many of which are free, as a category, also have a very high adoption rate.

Relationships

The *Relationships* element group encompasses relationships with oneself, one's intimate partner, household members, and non-household members. Relationships are not in the first place about technology or even about circumstances. In our quality-of-life research (Murray & Pauw, 2022), we found a certain independence between this element group and objective living conditions, with respondents in low-income households being relatively satisfied with the relational aspects of their lives as opposed to their physical environment or their objective standard of living.

Self

One's **self** is one's body. There are numerous 4IR technologies that people use to monitor and understand their own bodies. Numerous devices are available to monitor physical activities. These include pedometers, accelerometers, activity trackers, heart rate monitors, and smartphone applications (Åkerberg et al., 2017). There are also numerous devices, such as smartphone applications, e-scales, and wearable devices, that are used for self-monitoring dietary intake and weight management (Carpenter et al., 2022). The price of most of these devices

(see Carpenter et al., 2022, p. 6) means that, apart from free or low-priced Android applications, most of these devices will not be affordable to members of low-income households. The other recent technological breakthrough in self-monitoring technology is continuous blood glucose monitoring using photoplethysmography (PPG), which is a non-invasive optical technique. Very reasonably priced wearable PPG devices are already on the market. South Africa has a very high rate of non-communicable diseases such as diabetes and high blood pressure. These are not only diseases suffered by the wealthy. Significant proportions of members of low-income households also suffer from these conditions. The prevention and treatment for these conditions include lifestyle-related aspects of life, physical activity and diet, in which the 4IR technologies mentioned above have a definitive role to play.

Intimate partner

One's relationship with one's **intimate partner** and fellow **household members** is not primarily mediated by technology. In our research, respondents are generally satisfied with their relationship with their intimate partner and fellow household members, even when their satisfaction with their environment and physical standard of living is low. 4IR technology has facilitated significant cultural shifts in how people go about finding an intimate partner. A variety of services and applications that utilise artificial intelligence, machine learning and location sensing exist for this purpose. These services and applications vary in their focus and user communities, from people looking for functional long-term life partnerships (e.g., e-harmony) to those looking for casual sex. The cultural impact of these services and devices will likely first be seen in higher-income communities, but will inevitably also affect members of low-income households. The potential for using these services and applications for sexual exploitation by individuals or organised criminal groups is obvious.

There is a relevant phenomenon in the context of low-income households in South Africa where social media (a 4IR phenomenon, because communication is mediated by

algorithms) plays an important role: the blesser-blessee phenomenon. This phenomenon involves young women entering sexual relationships with older men who provide material and financial benefits, resembling a modern form of the ‘sugar daddy’ relationship. The difference is that these relationships are often publicly mediated through social media platforms and Internet sites such as *BlesserInc* and *Blesserfinder* (Basson, 2018, p. 4). The term is fairly recent. Palfreman (2020, p. 3), with reference to Mampane and Kinuthia, noted that “the terms have become prominent in the media only since 2016, with the adoption of the hashtag ‘#blessed’ used on pictures uploaded to social media showing money and gifts women have received from older men”. Basson’s study, conducted under the Youth Research Unit at Unisa’s Bureau of Market Research, found that the reasons why young women engage in such relationships are *varied and intertwined*. For some, it is part of a survival strategy amid poverty, but for others, the attraction of a flamboyant lifestyle and high social status in the eyes of peers is a strong motivation (Basson, 2018, pp. 4, 5, 11). In fact, without denigrating the role of poverty, unemployment and gender inequality in the South African context, Basson goes as far as saying that: “The literature suggests that there is a wider occurrence of transactional sexual relationships for fulfilling desires for status and gifts than for securing basic needs owing to poverty” (Basson, 2018:4, 5). Social media (Facebook, Instagram and Twitter) play a prominent role in the phenomenon. An interesting aspect is the fact that Instagram has become the vehicle through which assertions of status are advertised to peers. In the focus group interviews conducted by Palfreman, the participants identified Instagram as the platform blessees mainly use for self-promotion. Instagram, in addition to various Facebook groups, is also used for attracting blesser, and by blesser for finding blessee. They also noted that social media normalises the phenomenon and presents a positive image of blesser-blessee relationships and that it does not show the potential negative aspects (Palfreman, 2020, p. 30). Social media is clearly not the only factor, but it does add a new dimension to an older phenomenon, and it once again

demonstrates the speed at which new social phenomena can permeate society.

Non-household members

As with the other relationships, the relationship with **non-household members** is traditionally not primarily mediated through technology. A good example is Duolingo. Duolingo is a free Android application for language learning that follows a well-tested approach and incorporates user evaluation and dynamic adjustment to the syllabus. This application is not available for any South African language except isiZulu. It boggles the mind that after 30 years of democracy and with a government department tasked with promoting South African languages (Department of Sport, Arts and Culture), only one such implementation of a local language on an application such as this has seen the light of day.

Consciousness

The **Consciousness** element group contains the elements of faith, values, motivation, thought, learning, communication, and beauty. This is the element group about which, only a few years back, one would have thought that the technological developments would not have much of an impact. The public release of ChatGPT (Chat Generative Pre-trained Transformer) and the subsequent proliferation of the use of Large Language Models (LLMs), changed all of that. Faith, values, motivation and thought all have an internal locus (conscious and unconscious) but also an interpersonal aspect mediated through communication and participation. In this way, all technologies that facilitate the transmission of ideas and communal participation will impact the *Consciousness* element group. This has already been seen with the introduction of mass communication media during the Third Industrial Revolution.

In our empirical research on quality of life, we repeatedly found low satisfaction related to the household element of **learning**. This is to be expected, given the poor quality of education that the majority of people in South Africa received

(recall the earlier discussion of South Africa's PIRLS and TIMSS results). Informal and formal learning, however, is one area where 4IR technologies may have a significant impact. The current repository of good-quality information and learning resources available for free over the Internet is already incomprehensibly large (consider Wikipedia, MOOCs, Library of Congress, and the Gutenberg Project).

Khan Academy is an example of a superior educational resource that combines content delivery (lectures and notes) with individual evaluation. Khan Academy (2025) is a not-for-profit educational organisation founded by Salman Khan in 2008. It grew from his tutoring his cousin in 2004 and placing his videos on YouTube in 2006. In contrast to traditional institutional models that share characteristics with the industrial production process (batch processing and minimum quality standards), Khan Academy is based on the concept of mastery. The learning content itself is structured hierarchically, with each element linked to its prerequisite knowledge and skills. Material is not introduced to the learner if the prerequisites are not met. Learners have to consistently achieve at a high level in a certain learning element before they can move on to the next learning element. The fact that the technology enables each individual to master the material at their unique pace places the Khan Academy as part of the 4IR. Tertiary education institutions, notably Unisa, but increasingly since the lockdowns, most other universities, also employ e-learning platforms. These e-learning platforms are more akin to the communication revolution because the purpose of the platform is information exchange. A 4IR learning platform will involve a degree of responsiveness and automation, typically through the application of artificial intelligence.

It can be argued that the Internet has, for all practical purposes, removed the limitation of access to knowledge. For low-income households in South Africa, the remaining barriers are those of language, data cost, time, and motivation.

Members of low-income households' communication capabilities have revolutionised with the advent of mobile

phones and the technology options that make their use affordable, such as SMSs (short message services) and affordable messaging applications such as WhatsApp. Where the Third Industrial Revolution made it easier to communicate (through radio and television), social media connected to the mobile Internet gave people the ability to proverbially talk back.

Body structure

The *Body structure* element group is about one's **sex** and **development phase** (age). These are elements that cannot be fundamentally changed, but that one must accept and make the most of. These elements are the ones that, in our experience, respondents in our quality-of-life interviews are the most satisfied with.

Sex

A recent phenomenon relevant to this element group is the rise of a transgender movement that is mirrored in the emergence of rapid-onset gender dysphoria in teenagers (see Littman, 2018). How recent this phenomenon is can be gauged by the fact that a question related to being transgender was only included in the US CDC's *Youth Risk Behavior Surveillance System* (YRBSS) questionnaire in 2023. This can be seen by comparing question 65 in the YRBSS questionnaire (CDC, 2021) with questions 64 and 65 in the 2023 questionnaire (CDC, 2023). In an article in the *British Medical Journal*, Jennifer Block observes that the number of children and adolescents identifying as transgender and seeking medical treatment, especially in the US, has risen rapidly in the years before 2023 (Block, 2023). An analysis of Google searches for the term *transgender* shows the same, with searches for the term increasing markedly in 2015. The Cass Review (Cass, 2022, p. 32) describes this sudden increase in referrals to the UK's Gender Identity Development Service (GIDS): "From a baseline of approximately 50 referrals per annum in 2009, there was a steep increase from 2014-15 ... in October 2020 there were 2,500 children and young people being referred per annum, 4,600 children and young people on the waiting list, and a waiting time of over two years to first review."

Block observes that there is significant professional disagreement over the appropriate approach, with certain US medical groups supporting what they call “gender-affirming care”, including surgery, puberty blockers and hormones, while several European countries have issued guidance to limit medical intervention in minors. Block notes that concerns about the lack of strong evidence and the potential risks of early medical transition are coming from across the ideological spectrum, and calls for rigorous scientific review are increasing (Block, 2023). For example, a nationwide study in Finland comparing the cohort of all 2,083 sub-23-year-old gender-referred adolescents between 1996 and 2019 with 16,643 matched controls found no strong evidence to suggest that gender-questioning adolescents are at greater risk of suicide (Ruuska et al., 2024). The Cass Review also pointed to a lack of consensus on the conceptual understanding of gender dysphoria (Cass, 2022, p. 16), gaps in the evidence base (Cass, 2022, p. 15), and inconsistencies in service standards and approaches (referred to as a ‘clinician lottery’) (Cass, 2022, p. 16).

The recent release of the WPATH (World Professional Association for Transgender Health) files gives insights into the workings of the gender transition industry. In analysing these leaked correspondence and discussions between members of WPATH (Public News, 2025). Hughes (2023) argues that WPATH is advocating for unethical, unscientific, and harmful medical practices based on a consumer-driven, politically motivated agenda that is causing serious harm to patients. She draws parallels between WPATH’s actions and past medical scandals, such as the widespread and officially approved administration of lobotomies and ovariectomies (Hughes, 2023).

This phenomenon is important in the context of the 4IR because it is a social change that had an extremely rapid onset (recall that there was not even such a question in the 2021 YRBSS), which is very polarising. The phenomenon is furthermore important because of the role that algorithm-driven social media, in particular YouTube (Littman, 2018, p. 2), TikTok (see Dillon et al., 2023) and Tumblr (Littman, 2018, p. 4) may play in this regard. Grace (2023) provides a case study of the

role of TikTok in this regard. In this context, Dillon et al. point to the fact that social media sites “are driven by algorithms that filter, manage, and direct content from creators in positive and negative ways, which users can resist or at other times cannot”. Littman (2018, p. 2) analysed parental discussion groups and found numerous accounts of immersion in social media preceding gender dysphoria. When thinking of the role of social media, transgender influencers immediately come to mind (see for example SociallyPowerful, 2024), but Cass (2022, p. 46) adds an interesting perspective by observing that some see social media as perpetuating unrealistic images of gender and setting unhealthy expectations. Although technology is certainly not the only factor, this example demonstrates the speed at which new ideas can impact society and how institutional, social, and technical factors converge in the time of the 4IR.

Development phase

4IR technologies promise dramatic improvements for older people. Wearable sensors exist that can alert someone if an older person experiences a health emergency, such as a fall or stroke. Autonomous vehicles or e-hailing and mobile phone-activated grocery deliveries mean that older people will be able to retain their freedom for longer. Even for people whose vision is deteriorating, text-to-speech technology offers an alternative to reading. All these developments can keep older people independent for longer. The limitation is, however, that not all of these are affordable in the context of low-income households.

3. A framework for future projects: navigating uncharted territories

We touched on the interface between the elements of the household and established and emerging 4IR technology. It is clear that the 4IR has, and will increasingly, impact the lives of even low-income households.

Generally, products currently on the market for use by households that use 4IR technology are focused on higher-

income consumers. Low-income households in South Africa have practically no chance of ever owning or using the iconic 4IR products, such as autonomous electric vehicles or smart home systems. We did see, however, that there are several groundbreaking free-to-use services (numerous Android applications, general-purpose LLMs such as ChatGPT and Google's Gemini, education services such as Khan Academy and free MOOCs) that are more accessible to low-income households or could be made accessible fairly easily.

3.1 Central or distributed?

The 4IR technologies have the potential to centralise power. We referred in passing to the truly dystopian scenarios that are possible with the advent of the 4IR. The use of extensive AI-enabled public monitoring networks by totalitarian regimes engaging in widespread human rights abuses is already a reality. The United States Holocaust Memorial Museum describes the Chinese government's campaign against the Uyghurs in Xinjiang as multi-faceted and systematic. This campaign includes "identity-based persecution, mass detention, surveillance, enforced sterilizations, forced labor, and forced assimilation" (USHMM, 2024).

Not only totalitarian regimes but also institutions in democratic countries are using information and communication technologies to manipulate public opinion. The so-called *Twitter Files* (Taibbi, 2023) is a collection of internal documents made available to a group of writers and journalists after Elon Musk's takeover of Twitter. It evidences the collaboration between state agencies such as the Department of Homeland Security (DHS) and the Federal Bureau of Investigation (FBI), certain NGOs, and social media companies. The documents reveal how a collaborative group undertook to suppress *disinformation* and *misinformation* by removing, reducing the impact of, or appending warnings to messages. These actions initially targeted malicious actions such as false automated accounts (*bots*) from suspected foreign state actors such as Russia and Iran, but ended up suppressing domestic *malinformation*. *Disinformation* is lies, *misinformation* is errors, but *malinformation*

is the truth that is deemed damaging by the censors. Wardle (2020) defines malinformation as true but with malicious intent (of which the censor is the judge – so this is equivalent to the above definition). One example in the *Twitter Files* is an email from the Virality Project recommending the suppression of stories of true vaccine side effects (Taibbi, 2023, see #32). The *Twitter Files* also evidence the successful suppression of the New York Post’s reporting on the content of the Hunter Biden laptop (Shellenberger, 2022). This is another example of the suppression of true information that is damaging to a certain interest group. In his Twitter thread, Shellenberger provides files showing the involvement of the FBI in orchestrating the suppression of this news. He further elaborates on this aspect in his evidence before the US Congress (Shellenberger, 2023, p. 22). In this testimony before the Energy and Commerce Committee of the US Congress on *Preserving Free Speech and Reining in Big Tech Censorship* on 28 March 2023 (United States Government Publishing Office, 2023), Schellenberger referred to the cooperation between the intelligence community, the social media giants, and NGOs as the *censorship industrial complex* (a term also used by Taibbi). He defines the censorship industrial complex as “a network of ideologically aligned governmental, NGO, and academic institutions that discovered over the last few years the power of censorship to protect their own interests against the volatility and risks of the democratic process.”

Social media provides a platform for large organisations, such as states, corporations, and media houses, as well as small enterprises and individuals, to express their views; therefore, it is the apex of the communication revolution (i.e., the Third Industrial Revolution). However, the operation of algorithms that propagate or effectively hide messages makes social media a 4IR phenomenon. Social media enables both automated propaganda bots (of which the so-called *Guptabots* – see Fraser, 2017 – is a local example) and algorithm-based censorship. Recent advances in generative AI bring the possibilities for sustained, large, sophisticated, multi-layered propaganda operations into view. How citizens, even in democratic societies, will know the truth and maintain their freedom in

the public discourse to search for and test the truth remains a critical question.

There are 4IR technologies that will lead to greater centralisation in some industries. The mechanisation of agriculture resulting from the Second Industrial Revolution already gave rise to larger farms engaging in more capital-intensive and less labour-dependent production. Robotic precision farming is likely to reduce reliance on labour even more, even for applications where a human eye and a human hand were needed in the past (such as weeding and fruit harvesting).

The question is whether there is also a contrary momentum; namely, that the 4IR will enable the emergence of small- and micro-scale production entities. How YouTube has transformed media is enlightening in this regard. YouTube provided a platform for a new generation of independent content creators that would not have been possible in the absence of the platform. These content creators are, however, not independent from the platform and are exposed to the risk of their accounts being suspended and their videos being removed or demonetised by the platform. Their popularity is also not only a function of their content but also of the suggestion algorithm. It is understandable that a platform will have rules and must implement those rules, but it shows the interaction between the centralising and decentralising tendencies of the Internet as a technology.

The question is whether this decentralising tendency (which is nothing else than the expansion of individual capability) will also manifest in physical production processes. Additive manufacturing technologies certainly provide a fast and cost-effective path from a design stored on a computer to a physical object and are available for a wide range of materials (from plastic to titanium); therefore, it has the potential to be used by small, decentralised, and possibly independent manufacturers for a variety of applications.

D'Aveni (2015) notes that it is also likely that digital platforms for enabling design-to-print activities and design

sharing, and fast downloading are likely to emerge for 3D printing. This is where the true growth is likely to be: He predicts that such platforms “will orchestrate printer operations, quality control, real-time optimization of printer networks, and capacity exchanges, among other needed functions. The most successful platform providers will prosper mightily by establishing standards and providing the settings in which a complex ecosystem can coordinate responses to market demands.” Once again, the decentralising and centralising tendencies of technological development co-exist.

3.2 The human touch

More than 30 years ago, Manfred Max-Neef, Antonio Elizalde and Martín Hopenhayn called for a change in the development paradigm to *human-scale development* (Max-Neef et al., 1991). This paradigm wants to shift the attention away from the macro-economy to the scale where the individual matters. A common theme that we found while evaluating 4IR technologies in the context of the low-income household is the interaction between social and technical elements. An ideal future scenario would be a future where 4IR technologies amplify individual creativity, understanding, and freedom and deepen relationships while delivering a higher material standard of living. The opposite, dystopian scenario is a future where totalitarian regimes use 4IR technologies to control their populations through AI-augmented mass surveillance and AI-orchestrated multi-layered, immersive propaganda, and where established political and industrial elites in democracies achieve practically the same result by dominating all institutions from production (mostly performed by robots) to media and the organs of state. To pose the question concisely: Will the technologies of the 4IR make us more human or less human?

Max-Neef et al. (1991) emphasised the importance of micro-macro articulation: how the human scale interacts with the macro-scale. The realisation of the ideal scenario where technology enables the flourishing of the individual will not be determined so much by the technology as by the social relations and institutions that use the technological possibilities

to actualise their values and objectives. The Khan Academy is a useful example: according to its 2022 annual report, it has 140 million registered users (Khan Academy, 2022, p. 17). The fact that it is there and that it fulfils a dire need does not mean it will be used at scale in South Africa. This is not only because of limited Internet access. Even for groups where Internet access is unproblematic, widespread use does not occur. A learning platform such as that provided by the Khan Academy functions within a social and institutional context. Some learners use the platform independently out of interest or curiosity, almost like other children will use YouTube or play video games. Others are encouraged or directed by parents or teachers. There are also examples of institutional integration. Some independent schools, such as Action Academy, formally include the Khan Academy platform as part of their curriculum. The platform can thus be used independently, in support of another curriculum or as a formal curriculum. The scale of the impact of a specific technology will be determined by the social context within which it operates. For a platform such as Khan Academy to have a systemic impact on education in South Africa, it should function within an alignment of large-scale societal structures and the immediate social context of learners. The large-scale societal structures are education policies, including admission policies at tertiary institutions. The immediate social contexts are the classrooms, peer groups and households of children. We hypothesise that it is this integration of potentially beneficial technology institutions and people's immediate social contexts that will provide systemic breakthroughs.

The possibilities of embedding several other technologies in social structures come to mind: Language learning applications that combine the application with the facilitation of interaction with a real person speaking that language. Such approaches already exist (See, for example Fisher, 2024)

Small-scale food production is another domain of application where the embedding of technology within a social context could be beneficial. In our experience at Nova, home-scale and small-scale vegetable producers often struggle with management aspects such as knowing when to plant, what plant

spacing and rotation to use, when to water, how much to water, and what to do if plants become diseased or are attacked by pests. The extent to which a combination of AI tools and social support (personally and virtually) can be used to overcome these challenges and scale up domestic food production is worth further investigation.

One also wonders if the combination of social support and technology can be used to address the high prevalence of lifestyle-related diseases such as metabolic syndrome. A social support model for weight control is nothing new (*Weight Watchers* is a well-known example). How continuous blood glucose monitoring using photoplethysmography and AI-empowered food trackers on mobile phones could be integrated into a supportive social context (with personal and virtual aspects) warrants further investigation.

4. Conclusion

It is impossible to predict the impact of the 4IR on low-income households in Southern Africa in the Anthropocene, except that one can confidently predict that things will not remain as they are. The complexity of the situation is apparent from the presence of opposing forces simultaneously favouring centralisation and decentralisation, massification and miniaturisation, amplification of the individual voice and influence of central authorities or hegemonies. The extent to which members of low-income households and low-income communities as a group will be empowered will depend on how these forces balance out and on the constellation of social institutions into which these technologies are embedded.

The affordability of technology is an important determinant that will tip the scales towards either the decentralisation-miniaturisation-individualisation or centralisation-massification-institutionalisation side. The introduction of a pay-as-you-go model for mobile phones is a good example of how changes in affordability changed a whole industry. This change in affordability was not even caused by changes in the underlying production costs. Changes in the

fundamental cost of production will have an even more dramatic impact. The long-term decline in the unit cost of computer processing power is a good example of such a trend. It remains to be seen if high-quality 3D printers and agriculture robots will follow the same trend. If they do, this will tip the scales towards the direction of small-scale production.

Another factor favouring the decentralisation / miniaturisation / individualisation pole is ease of use. The less arcane technical knowledge is required, the more this pole will be favoured. The public launch of free-to-use large language models such as ChatGPT and Gemini made interaction with AI as easy as typing a conversation for many people. Voice recognition is already highly advanced and widely used. It is likely that soon large numbers of people will be conducting conversations with AI entities on their mobile phones as if it were a normal human conversation. Overcoming the need to type and, in some cases, the language barrier will truly mainstream AI use. Since large language models are trained (the P in GPT), the incorporation of LLMs into the daily life of most people will simultaneously give enormous power to the selectors of the training corpora for these LLMs.

The physical backbone on which most 4IR technologies depend is the communication infrastructure that enables the Internet (especially high-speed Internet). The physical extent of the spread of many 4IR technologies will be limited by Internet coverage and reach. Some technologies provide access to the Internet to users outside fixed-line or cell phone networks. Starlink is perhaps the best known of these. Political factors currently inhibit the implementation of Starlink in South Africa (Africanews, 2024).

A comparison of the 25 elements of the household shows that there is hardly any aspect of daily life that is not or will not be impacted by the 4IR. Although the iconic products of the 4IR, such as autonomous electric vehicles, are out of reach for low-income households, other 4IR technologies utilising the mobile Internet present many opportunities for services to low-income households.

The 4IR also brings with it new dangers for entrenching inequality and enabling coercion on both the personal and societal scale.

We propose that there is a need for research, development and testing of social-technical compacts that can benefit low-income households in the Anthropocene. Such a compact will involve a technical component, but also a social component and sometimes an institutional component. The social component will involve physical and virtual interaction with peers that is minimally structured, authentic, and spontaneous, but it will centre around a shared objective and a shared ethos (which may be expressed as a code of conduct if the setting is formal). The technical component may be a practice, technology, or group of technologies that can be used to achieve the shared objective.

Another equally important area of enquiry is the question of how low-income households and communities may be protected from manipulation and exploitation in the time of the 4IR.

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