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# Greenwheel Insights

## When AI solutions come around: AI opportunities in emerging and frontier markets


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**Executive Summary**


There is great optimism in the application of artificial intelligence (AI) in emerging and frontier markets to solve the most pressing social challenges and inequities. So far, we are seeing promising results.

AI solutions are equipping smallholder farmers with "smart" techniques to become more climate resilient. AI programmes are improving access to quality education and health services for underserved communities. AI-enabled analytics have expanded the reach of financial services to provide access to credit to the formerly "unbankables" and women-led micro, small, and medium-enterprises.

Yet, there are barriers to unleashing the full potential of AI. A key challenge is access to connectivity and mobile devices. The existing digital divide adversely impacts lower-income emerging markets, rural and remote communities, as well as women. This divide is further compounded by gaps in digital literacy, which can affect an end-user's ability to apply AI innovations.

Concerns remain regarding the right to privacy especially in absence of adequate legal frameworks; the lack of culturally relevant and representative datasets used to train models; and, the risks of using AI without humans-in-the-loop leading to discriminatory outcomes.

To help investors maximise the positive contributions of AI, Greenwheel has identified six key recommendations based on a review of AI-solutions in the agriculture, education, healthcare, and financial services sector:

1. **Understand and reduce the digital gaps**: AI products and services providers should assess the digital readiness of end-users and offer low-connectivity solutions as needed.

2. **Use emerging markets insights for emerging markets solutions**: Where datasets are not representative, providers should use synthetic datasets that reflect real world statistics or crowdsource new data.

3. **Protect and respect the right to privacy**: AI-solution providers should ask for an individual's informed consent to use their data and offer the ability to retract their information as requested.

4. **Keep humans-in-the-loop**: AI enhances but is not a replacement of people. Intervention is required across the AI lifecycle, from training to ensuring outputs are not discriminatory especially in determining access to essential services.

5. **Promote user readiness**: Additional efforts should be taken to increase uptake of new technologies, for instance, building social proof to gain buy-in or provide training and upskilling.

6. **Ensure benefits are equal and inclusive**: Conduct assessments to understand existing inequalities (e.g., gender, ethnicity) and apply interventions to promote equal and inclusive adoption.



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**Preface: The Investor Need**


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*As long-time investors in Emerging and Frontier markets, we have witnessed digital connectivity enable leapfrogging technologies that have advanced access to healthcare services through tele-health, expanded financial inclusion through digital financial services, enabled access to online education, amongst others. We believe that artificial intelligence (AI) is the next exciting milestone for technological advancement.*

*The impact of AI on all sectors of the economy is mesmerising; however, we also recognise that its rapid adoption and advancement may have serious negative consequences if they are not properly managed. In the many conversations that Jessica Wan, Greenwheel's Social Lead, hosted on this topic it became apparent to us that a balanced analysis that weighs the use case for AI and a Responsible AI framework was needed.*

## Solving social problems through AI in emerging markets

The reach of artificial intelligence (AI) is global. With this intelligence boom, **there is optimism that using AI can help emerging and frontier markets[1] 'leapfrog' traditional business and socioeconomic development models** to increase productivity and enhance the delivery of public goods and services that are essential to the enjoyment of human rights.[2]

Today, **AI solutions are applied across many sectors in emerging markets**. AI is helping address a myriad of social challenges, from promoting access to healthcare for underserved communities to equipping smallholder farmers with "smart" farming techniques to become more climate resilient. So far, the results are promising.

However, there are necessary conditions for emerging markets to fully realise the impact and potential of AI solutions. **Connectivity is a prerequisite to using AI products and services**. Literacy, especially digital literacy, is required for end-users to apply AI solutions. Given the current digital and skills divide, the most underserved communities may remain excluded from the benefits of AI.

## Mobile and internet connectivity in emerging markets

**Telecommunications services play a critical role in providing the infrastructure to run AI solutions.** Connectivity is important to both AI products and services providers as well as end-users. While providers require connectivity to run AI models and process large datasets, end-users

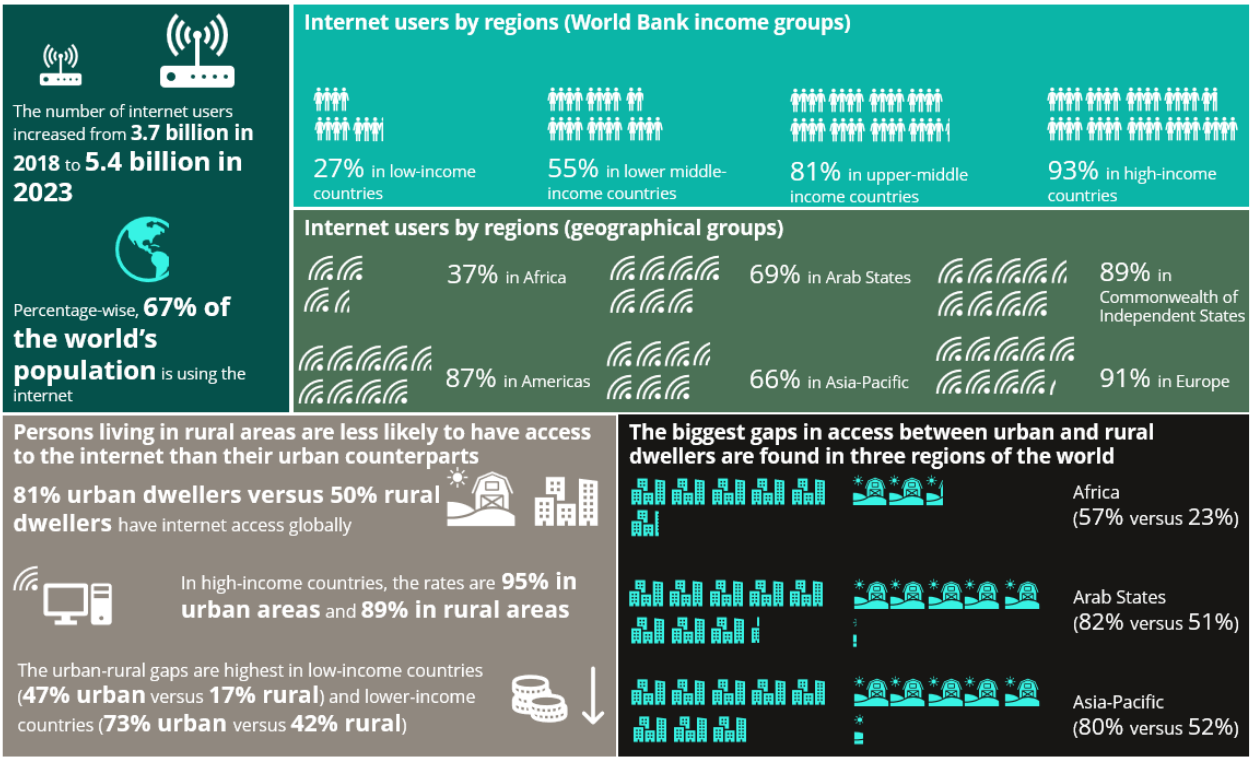
also rely on connectivity to facilitate data transmission to process inputs to generate outputs. As such, access to the internet, particularly through mobile data, is a key enabler for emerging markets to maximise benefits gained from AI products and services.[3]

**The world is digitising exponentially through access to the internet and mobile phones**. Between 2018 and 2023, the number of internet users globally increased from 3.7 billion to 5.4 billion. Today, 67% of the world's population is using the internet.[4] 4.6 billion people (or 57% of the world's population) are using mobile internet on their own devices. 96% of the world's population live in areas covered by mobile broadband.[5]

An estimated 5.6 billion or 69% of the world's population has subscribed to a mobile service by the end of 2023.[6] However, **3.4 billion persons remain unconnected**, even though 90% of them live in areas covered by mobile broadband services.[7]

**There are clear gaps in access based on geography, rural-urban settings, and gender**. The vast majority of individuals in high-income countries (93%) are internet users (Figure 1). In contrast, the percentage of the population in low-income and lower middle-income countries using the internet is significantly lower (27% and 55% respectively).[8] Unsurprisingly, the biggest connectivity gaps are found in rural, poor, and sparsely populated areas in lower-income countries, least developed countries, landlocked developing countries, and small island developing states.[9]

**Figure 1**: **Internet access around the globe**



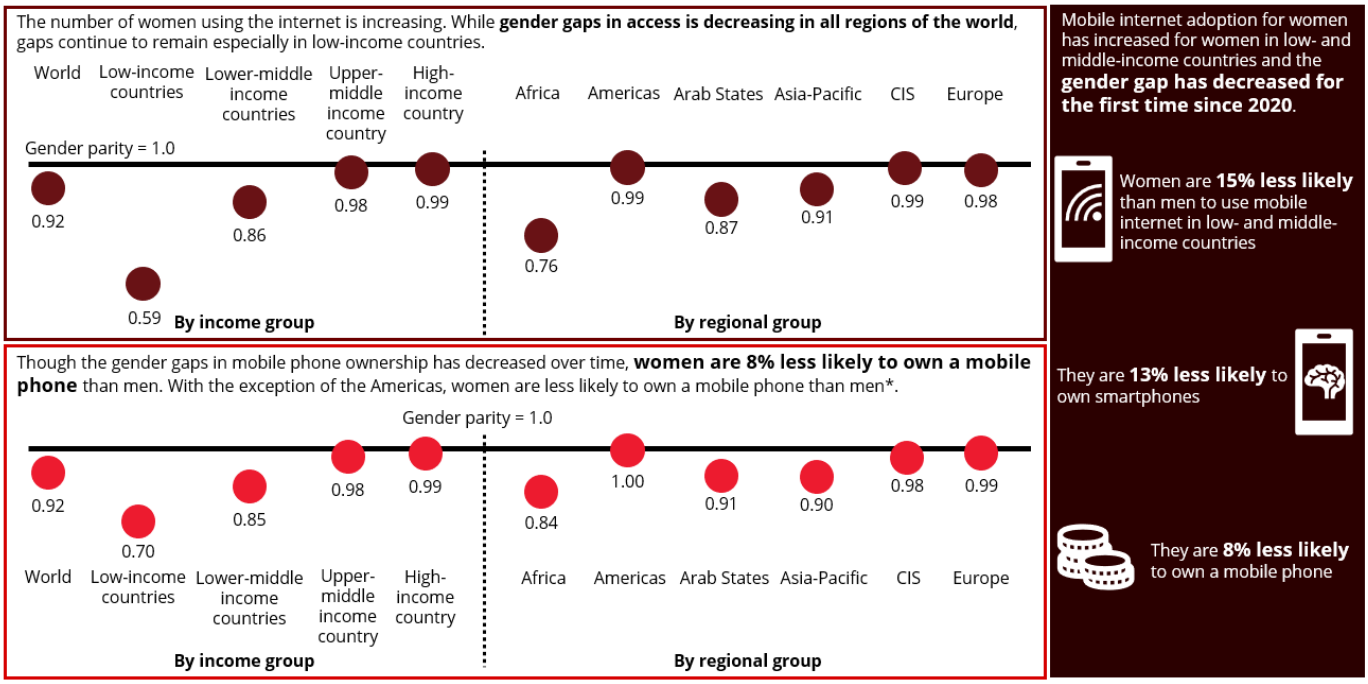

**Note:** Data for persons above the age of 10. Income groups are labelled according to World Bank Country and Lending Groups (World Bank, 2024) **Source**: ITC, 2024; created by Greenwheel.

The three regions with the lowest share of internet users are also the regions with the biggest disparities between urban and rural users. Africa remains the region with the lowest share of internet users (37%). This region also holds the biggest gaps between urban and rural internet users (57% versus 23%). Asia Pacific (66%) and Arab States (69%) see similar levels of urban and rural disparity of 32 and 31 percentage points respectively.[10]

**Although gender gaps in access to the internet, mobile phone ownership, and mobile internet usage have decreased over time, gaps continue to remain in lower-income regions** (Figure 2).

Globally, low-income countries have the lowest level of gender parity in internet use (59%) and mobile phone ownership (70%). They lag significantly behind the next income country group (86% in lower-middle income countries). Regionally, Africa has the lowest gender parity in both internet use (76%) and mobile phone ownership (84%), followed by Arab States (87% and 91%) and Asia-Pacific (91% and 90%).[11]

**Figure 2: Gender gaps remain in accessing the internet and mobile phone ownership**

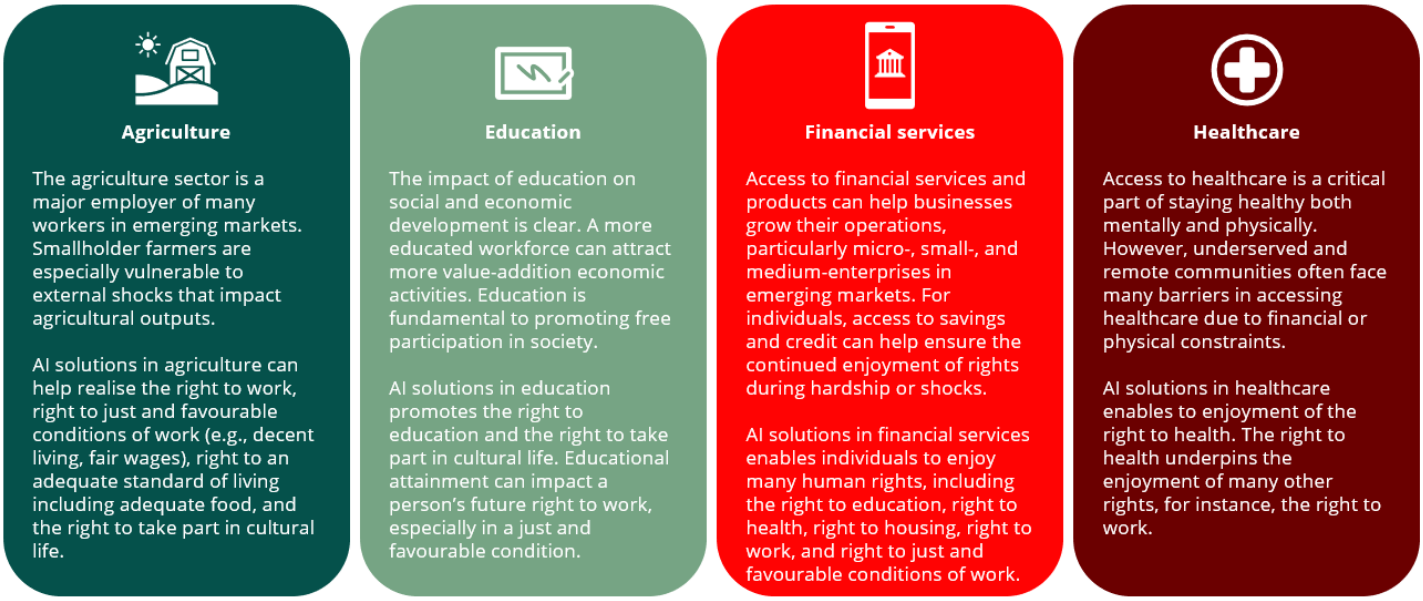



**Note:** Data for persons above the age of 10. Gender parity calculated as proportion of women who own mobile phones or use the internet divided by proportion of men. **Source**: ITU, 2024 and ITU, 2023, GSMA, 2024c; created by Greenwheel

**Unleashing the power of AI by sector**

Despite the digital gaps across and within emerging markets, AI solutions are currently being implemented across key sectors in these regions. Greenwheel has highlighted four key sectors where AI shows initial success and offers potential in addressing the social challenges facing emerging markets (Figure 3).

**Figure 3: A human rights lens to AI's potential across key sectors in emerging markets**




**Source:** FAO, 2022, IFC, 2021, United Nations, 1966; created by Greenwheel.

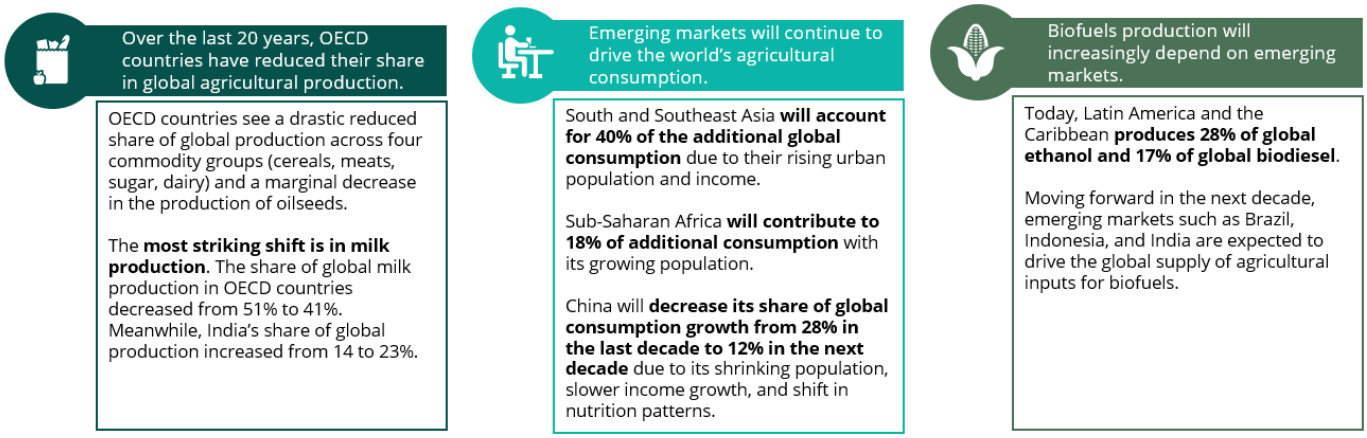
## 1. Agriculture

### The importance of the agricultural sector in emerging markets

Over the last twenty years, **emerging markets have been driving the world's agricultural sector** both because of increased consumption in low- and middle-income countries and improved production through technological advances. In the next decade, **global food production is projected to grow by 1.2% annually**. Most of the demand will come from emerging markets, with approximately 94% of additional consumption stemming from low- and middle-income countries (Figure 4).[12]

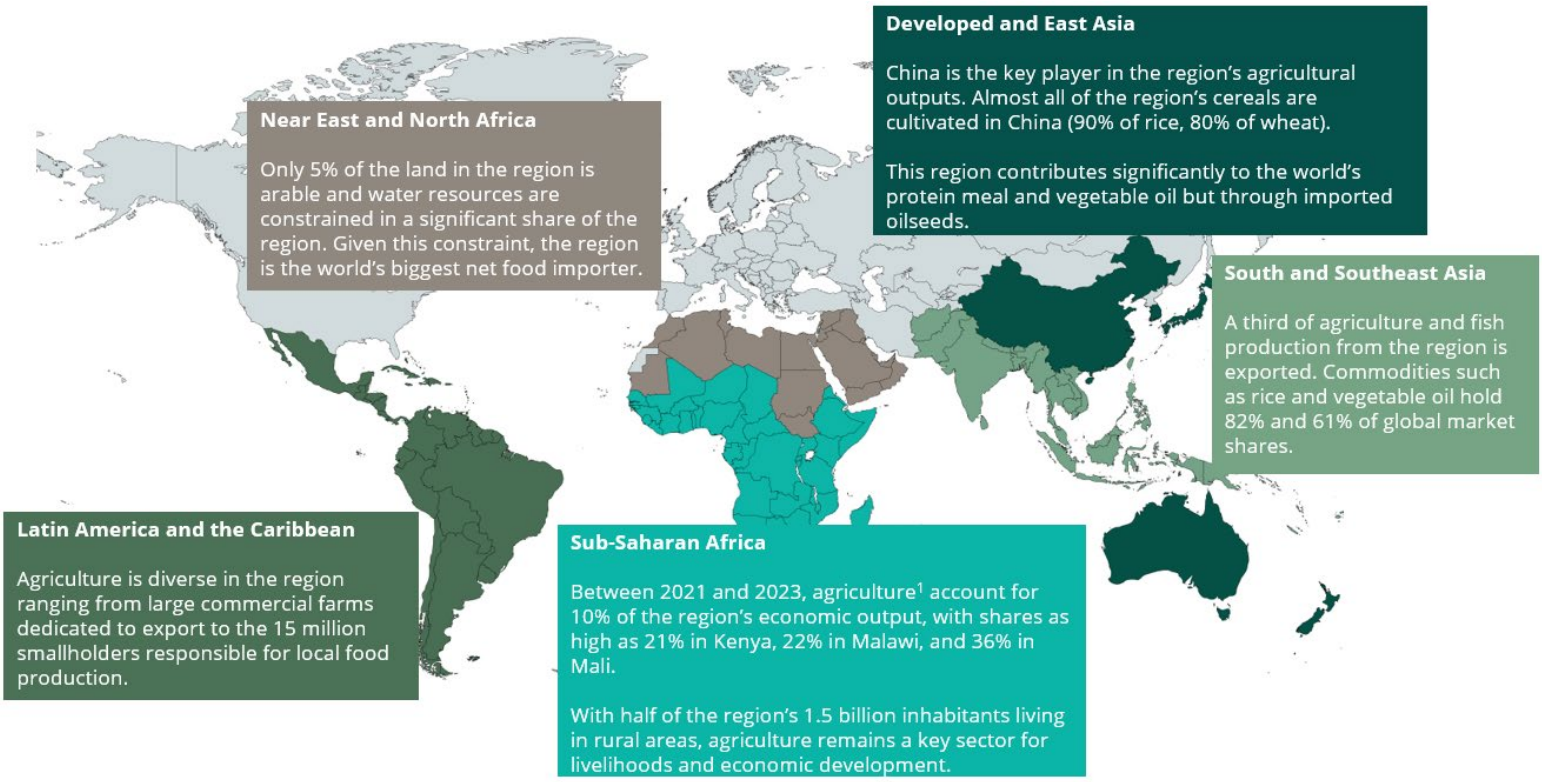
In many emerging markets, the agricultural sector is a key contributor to economic development and growth (Figure 5). Yet, **the dependency on agriculture exposes emerging markets to volatility due to external shocks**. In particular, climate change will pose significant challenges to the agricultural value chain that can hamper the economic and social development (Figure 6).

**Figure 4: A shifting global agricultural market**



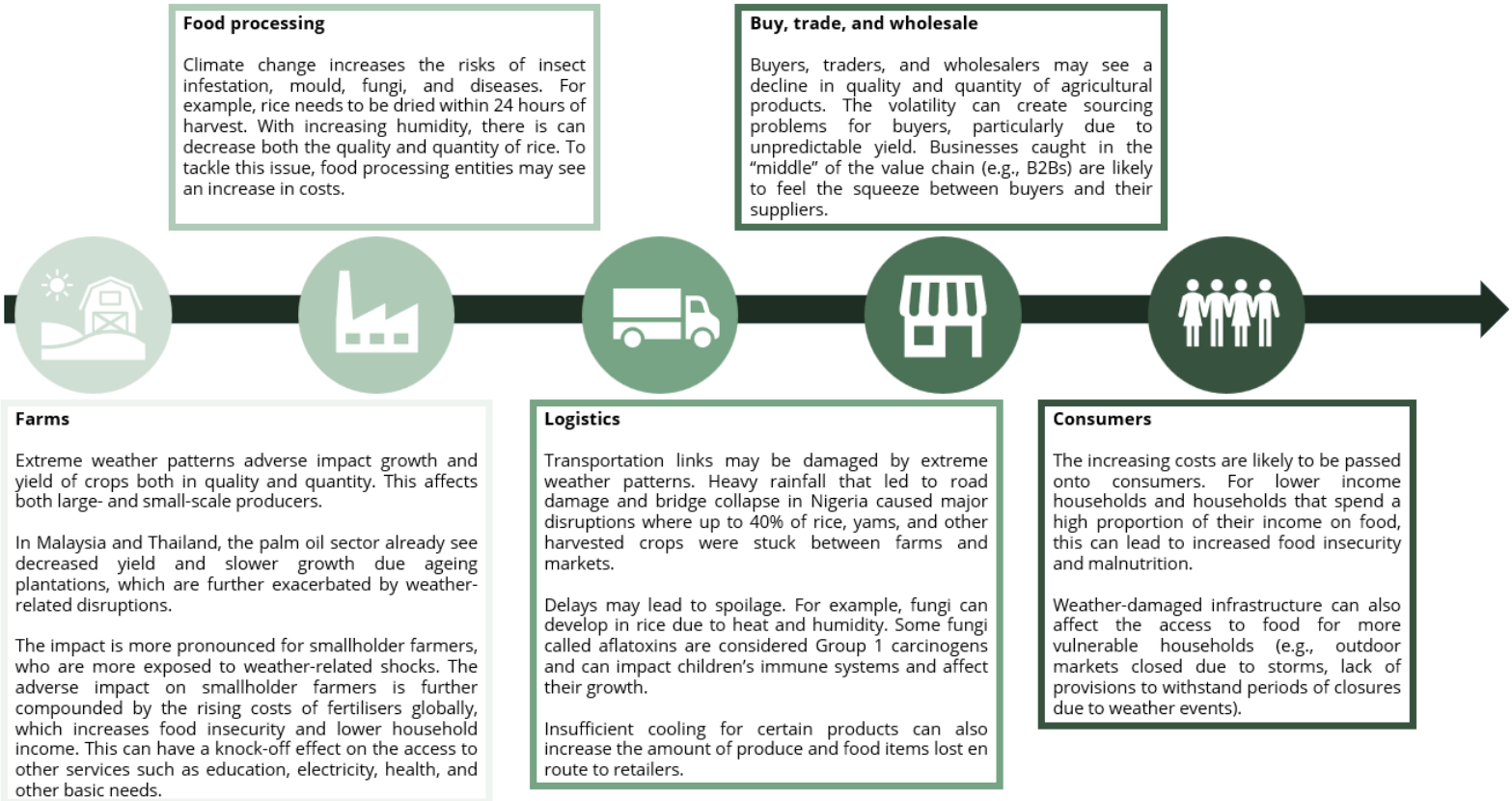

**Source**: OECD and FAO, 2024; created by Greenwheel. Forecasts and estimates are based upon subjective assumptions about circumstances and events that may not yet have taken place and may never do so.

**Figure 5: Key agricultural trends in emerging markets**




**Source**: OECD and FAO, 2024; created by Greenwheel using MapChart.

**Figure 6: The social cost of climate change on agricultural value chains in emerging markets**




**Source**: WRI, 2024, OECD and FAO, 2024, WEF, 2023, WEF, 2022, World Bank, 2022, Abubaker, 2021, and Gates Foundation, 2021; created by Greenwheel.

In addition to climate change, **variables such as access to infrastructure and markets are preventing emerging markets from unleashing the full potential of the agricultural sector**. For instance, in Sub-Saharan Africa, the vast majority of its arable land are situated in remote areas, which can limit market access for both small and medium-scale producers.[13] Promoting market access and agricultural innovations can contribute to both economic growth and poverty reduction.[14]

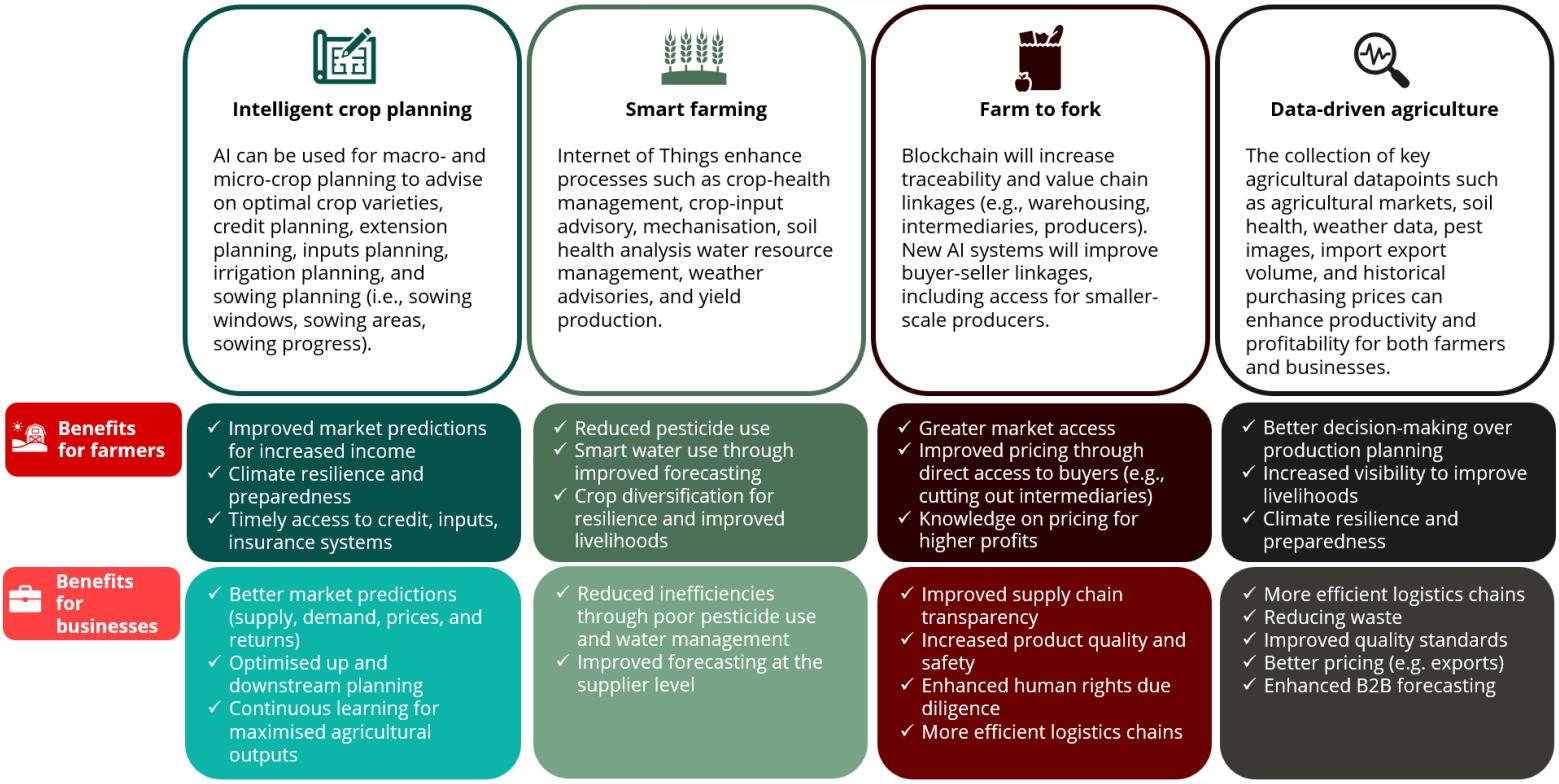
This is especially the case for the world's smallholder farmers. While they are responsible for producing a third of the world's food and feeding between 4.5 and 5.5 billion people, they are the least protected from the exogenous shocks such as climate change and increased production costs in addition to facing the most barriers to market access.

### AI solutions in agriculture in emerging markets

**The integration digital technologies into agriculture, or "digital agriculture", has enhanced conventional agricultural methods through data-driven precision farming**. Using digital technology, farming decisions, planning, and practices can be informed by real-time data on variables including but not limited to crop health, livestock data, meteorological conditions, and soil moisture.[15]

Though current technologies such as sensors are already in use to gather information on soil moisture, temperature, and humidity, AI can expand the existing capabilities through more comprehensive data collection, analysis, and forecasting drawing from large datasets (Figure 7).

**Figure 7: The deployment of AI in the agricultural sector**




**Source**: WEF, 2021; created by Greenwheel.

**AI solutions in agricultural can be categorised into four functions: intelligent crop planning, smart farming, farm to fork, and data-driven agriculture** (Figure 8). These solutions tackle the challenges facing farmers in emerging markets. For smaller-scale producers, AI can bridge the gaps in access to information and technological innovation, particularly through AI solutions on mobile applications.

**In practice, many AI solutions build on technology that some farmers are already using**. Chatbots can leverage existing social media platforms such as WhatsApp. Mobile phone cameras can take pictures, even low-quality photos, that are then used to for crop analytics.[16] AI solutions can build on existing agricultural research and datasets (e.g., Artemis Project) to create models that can help farmers speed up phenotyping and breeding, which can offset the adverse effects of climate change on yield. This technology is historically unaffordable for smaller producers in emerging markets but is becoming increasingly accessible.

While existing AI solutions in agriculture are promising, there are possible limitations to their development and deployment. **Large datasets are required to develop AI solutions**. This may impact the applicability of some solutions depending on the underlying dataset (i.e., an AI solution may draw inferences from large-scale farms that is not directly applicable to small-scale settings).[17] There are also practical challenges in the deployment of AI solutions. **It is important to incorporate strong social and cultural lens in introducing new technological solutions**. Drawing from the experience in rolling out agricultural interventions, smallholder farmers face many barriers to adoption due to the low levels of digital literacy, access to mobile devices and connectivity, and language barriers.[18]

In addition, behavioural change is complex, as farmers may be reluctant to adopt new farming technologies, new innovations, or listen to external experts.[19] International development interventions have shown that **successful technological deployment require a shift in social norms**, which can occur by demonstrating social proof (i.e., successful adoption in local contexts with clear results) or applying social pressure (i.e., changed norms or expectations within a community).[20] These lessons can be applied in the context of rolling out AI solutions.

**Figure 8: A snapshot of AI solutions for agricultural producers in emerging markets**

| Challenge | Targeted group | AI solution | Impact |
|---|---|---|---|
| Information asymmetry | Smallholder farmers | Gramhal's mobile platform collects real-time and credible price information across the value chain to provide actionable data for farmers. Farmers can contribute crop sale data through submitting receipts. | Since its launch in 2023, there have been more than 250,000 data points shared by farmers and more than 2000 subscribers (those who cannot contribute data but purchase data through the platform). Farmers can use the data to improve their decision-making around sales and negotiate for better prices at the farmgate. |
| Access to capital | Smallholder farmers | Heifer International and FruitPunch AI supported Nepalese women smallholder farmers to transition from paper-based recordkeeping (e.g., loan records) to digital systems using optical character recognition technology (i.e., scanning texts from photos of paper documents). | The digitised historical data for farmers can be leveraged to facilitate access to loans at a lower rate supported by data to show repayment history. |
| Detecting diseases and pests | Large-scale and smallholder farmers | Tumaini is an AI based solution that assists farmers and farm workers in identifying and managing crop diseases. The app allows users to upload photos, which are analysed through AI to provide a diagnosis and real-time disease mapping through georeferenced data. Though the solution started with bananas, it has expanded to beans. | Tumaini has enabled farmers and workers to detect symptoms in different parts of the crop. Deployed in China, Colombia, Democratic Republic of Congo, India, Ecuador, India, and Uganda, the models have a success rate of 70% to 90%. Tumaini is adapted to drone-captured images, with the potential of using satellite-connected network for real-time, large-scale pest and disease control. |
| Maximising yield in the context of unpredictable and extreme weather | Large-scale and smallholder farmers | The Melisa chatbot is an AI solution that provides yield forecasts for rice and maize based on agroclimatic, seed variety, and soil type. Melisa supports farmers in decision-making around sowing using non-technical language. It is a system available through multiple social media platforms including Meta, Telegram, and WhatsApp. | Although there are no results collected on the use of this AI solution so far, the chatbot has the capability of assisting farmers, both large- and small-scale, in improving their forecasts to improve yield. |
| Developing more climate resilient crops | Large-scale and smallholder farmers | The Artemis Project uses imaging technology and AI to enhance phenotyping and breeding of crops through collecting and analysing plant data. Traditionally, this technology is expensive and inaccessible to smallholder farmers in emerging markets. | Building on existing research on sustainable agriculture through the use of machine learning, AI, and perception technology, the application can expedite bean counting and analysis to shorten the selection method to increase genetic gain. |

**Source**: Alliance Biodiversity et al., 2024a, Alliance Biodiversity et al., 2024b, Alliance Biodiversity et al., 2024c, Fruitpunch AI, 2024, Gramhal, 2024, and Natchev, 2024; created by Greenwheel.

**Moving forward: key considerations or investors**

We believe that the innovations in AI solutions in agriculture show promising results in their possible application in both small- and large-scale settings. Greenwheel highlights four key takeaways for investors:

- **AI solutions in agriculture are here and now**. While some of the solutions are more applicable to large-scale producers due to data availability and/or readiness to adopt technological innovations, solutions are nonetheless adapted and created to support smallholder farmers.

- **AI has the potential of supporting the most at-risk producers**. Pockets of evidence show that AI solutions can bridge the gaps facing smallholder farmers, from greater access to market information to negotiate better pricing to supporting farmers in increasing climate resilience and preparedness.

- Though in its infancy, **AI solutions can be applied to promote greater supply chain transparency and traceability** (e.g., digitising records of smallholder farmers to accurate geolocation of sourcing destinations). In light of the regulatory changes in European markets (e.g., Deforestation Act, Corporate Sustainability Due Diligence Directive), these solutions can help businesses respond to the new norms around due diligence.[21]

- **The development and deployment of AI solutions should take a human-centred approach**, from using representative datasets to understanding the social nuances of introducing new agricultural technologies to producers. Behavioural change campaigns should accompany the rollout of new technologies in order to reach widespread adoption.

**2. Education**

**Education is a fundamental human right and a key driver of development and economic growth**.[22] Global school attendance, tertiary education enrolments and adult literacy rates have increased since 2015. Yet, across many regions, learning outcomes have worsened for students in lower secondary school.[23] Globally, poor educational outcomes stem from the shortage of teachers, high student-teacher ratios, and inadequate training for teachers. The educational gaps are most pronounced in poorer countries and remote communities (Figure 9).[24]

Education is particularly important in light of the rapid technological change that requires continuous reskilling to meet the evolving demands of the job market**. By 2030, an estimated 400 million workers will have to change jobs due to technological advancements**, illustrating the importance of education in adequately preparing the workforce for such changes.[25]

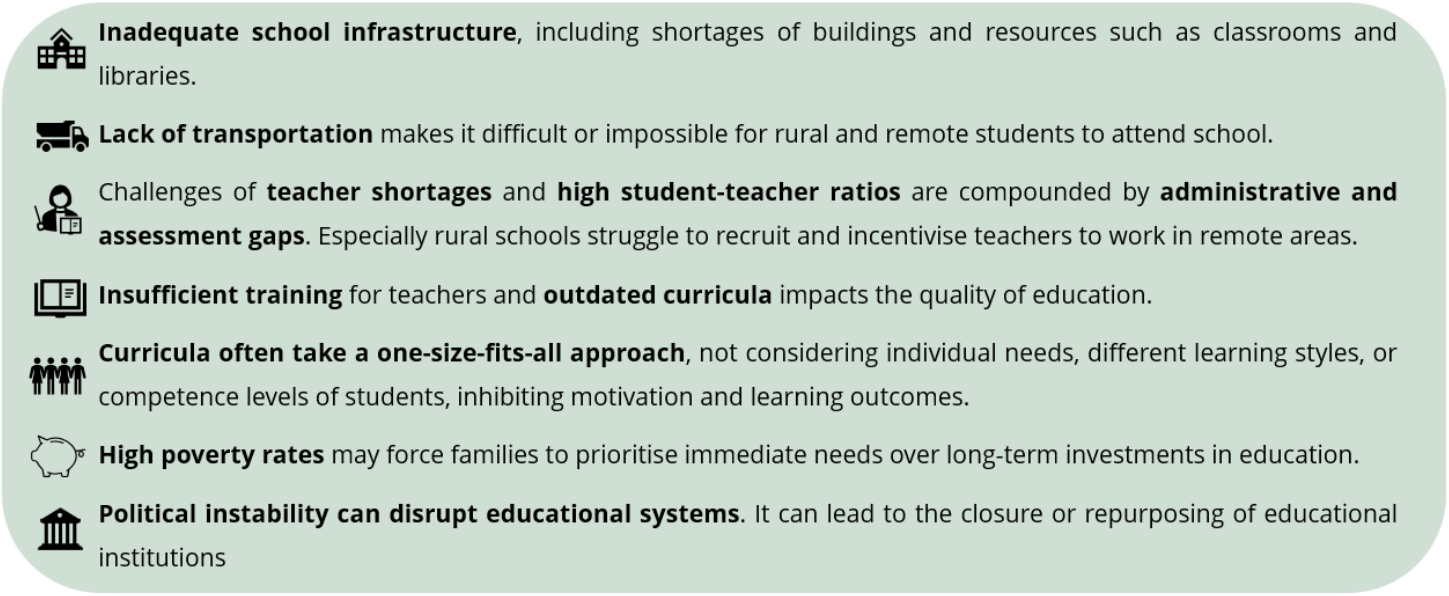
Moreover, **COVID-19 instigated a long-term learning crisis that resulted in nearly 147 million children missing more than half of their in-person schooling** between 2020 and 2022, with the most vulnerable running a risk of dropping out of education completely. Low-income and rural households as well as people with disabilities in low- and middle-income countries were most affected.[26]

**Figure 9: An overview of global educational outcomes**


**Sources**: World Bank, 2024, UN, 2023, UNESCO, 2023a, World in Data, 2022, UNESCO, 2019, World Bank, 2018, and Patrinos, 2016. Created by Greenwheel.

In emerging markets, low-income households and rural communities face unique barriers when it comes to accessing quality education (Figure 10).

**Figure 10: Barriers to quality education in emerging market**



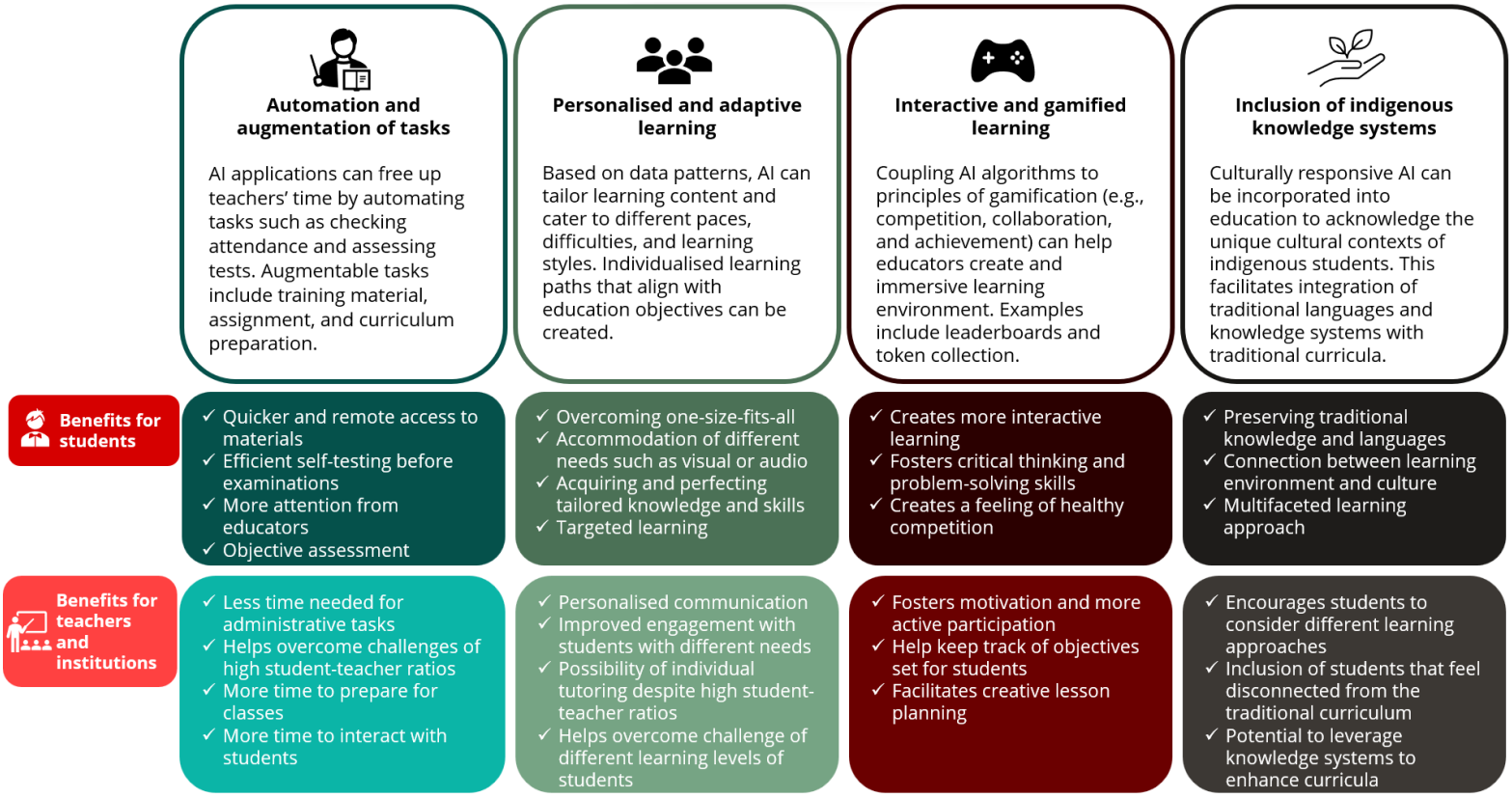

**Sources**: Vealey, 2023, UNESCO, 2023b and WEF, 2024b; created by Greenwheel.

**Another crucial issue in education is the marginalisation of indigenous knowledge systems in global education**. Ancestrally derived knowledge of indigenous communities is often recognised as inferior and unscientific in education, which results in barriers to the integration of these epistemologies in national teaching curricula.[27] Consequently, indigenous students may feel disconnected from their cultural backgrounds as they attend schooling environments that focus solely on westernised or nationalised perspectives, which disregards of other ways of knowing and learning[28]. Such single faceted educational systems lead to the erosion of traditional knowledge and local languages[29].

**AI solutions to improve access to quality education in emerging markets**

**AI is revolutionising the future of learning across all levels of education. It offers ways to reshape global education systems and address the barriers of accessibility to quality education**.[30] If deployed well, AI technologies in e-learning platforms present tremendous opportunities worldwide for learners and educators by overcoming affordability, infrastructure, and qualified teacher shortage constraints (Figure 11). Leveraging AI can reduce education gaps within and between countries, enhancing social stability, employment, and economic growth. AI can also be mobilised to be inclusive of indigenous knowledge systems.[31]

**Figure 11: Incorporation of AI in global education systems**




**Sources**: Hamilton, 2024, Planet Teachers AI, 2024, WEF, 2024b, ISBF, 2023, and IFC, 2021; created by Greenwheel.

AI solutions are already adopted in education systems around the world (Figure 12). Programmes such as Gradescope and Letrus have reduced the amount of time teachers have to spend on tasks that take away from individualised attention to students (e.g., grading, developing personalised learning plans). Other applications such as Kabakoo provide virtual mentorship and interactive gamified learning in underserved areas to equalise access to quality education.

**Figure 12: Use cases of AI in education**

| Challenges | Targeted group | AI solution | Impact |
|---|---|---|---|
| Shifting educators' time from repetitive grading to teaching | Teachers | Gradescope is an AI-powered grading programme grades students' submissions. It is a platform for students to submit their work (e.g., taking photos through their smartphones) which is then uploaded into Gradescope. The app can detect handwriting and read bubble sheets. It also can anonymise submissions for bias-free grading. Though submissions can be auto-graded, educators can manually input grading and feedback. | Gradescope enables flexible and uniform grading for teachers and frees up time for teachers to focus on other tasks such as curriculum design or one-on-one coaching. By grading over 700 million questions, Gradescope supported 140 thousand instructors and reached more than 3.2 million students in both developed and emerging markets. |
| Overcoming literacy gap between low- and high-income students | Students and teachers | Letrus is a school literacy programme that uses natural language processing AI to develop students' writing and reading skills. The programme's key objective is to reduce the literacy gap between low- and high-income students in Brazil. Letrus focuses on personalised learning through AI, presenting immediate feedback to students, generating real-time student performance data for teachers, and creating monitoring tools. | Letrus is freeing up time for educators to spend on teaching and is improving literacy rates around Brazil. The programme has so far impacted the learning experience of around 780,000 students in 3,500 schools. In 2022, the Letrus programme was implemented in public schools of the state Espirito Santo where it helped students attain second place in the national writing exams compared to eighth position achieved by the control group. |
| Transforming upskilling of young people | Learners | Kabakoo is an educational technology that uses a 24/7 AI-enabled virtual mentor to support learners. The virtual mentor provides advice and guidance as a way to complement in-person mentorship. The AI mentor provides feedback on learners' assignments. Using a gamified virtual token, the solution promotes a dynamic and fun learning environment. | Today there are 32,000 registered users, with the aim of reaching 1 million learners by 2030. So far, the results show that there is a 23% increase in growth mindset among learners and a 44% increase in income six months after completing the programme for learners. |
| Preserving indigenous knowledge[1] | Indigenous peoples, indigenous youth | An augmented reality experience is designed for people to learn the indigenous language of Kwak'wala. The experience simulates scenarios where learners have to gather materials for a potlatch, chatting in Kwak'wala and finding ingredients. This is to simulate a more natural way of learning language. | Gamified AI educational solutions can provide an opportunity to preserve indigenous languages that are at risk of extinction. |

[1]The example on indigenous knowledge is from developed markets but can be applied to emerging markets.

**Sources:** Gradescope, 2024, Kabakoo, 2024, Letrus, 2024, WEF, 2024, Newitz, 2023, and IFC, 2021; created by Greenwheel.

While AI-based technologies have the potential to close gaps in education, enhance learning, and incorporate indigenous language and knowledge into learning tools, there are some implementation limitations.

Low-income households and educational institutions **may not be able to supply students with necessary devices** such as laptops, computers, or mobile devices to access AI solutions.[32] Similarly, people and regions that could benefit most from AI face the **challenge of limited internet access especially in more rural schools and remote households**. Public and private sector action to improve internet connectivity and affordability is necessary to fully leverage AI's potential in education.[25]

Successful AI deployment in education could also be **challenged by the lack of digital literacy** in both students and teachers as this is vital in understanding and using AI applications. For instance, teachers require some level of upskilling to be able to use an AI solution for grading or lesson planning. Students, too, have to be trained on how to submit their homework or access mentorship or guidance advice.[30]

**AI solutions in education are not a substitute for in-person quality education.** Research on the impact of remote learning during the pandemic showed that while the move to virtual learning for children had no impact on some children, child learning losses were found in households that are of lower-income, with more limited access to technology, poor learning environment as well as students that lacked teachers' feedback and innovative remote resources. Learning gaps also increased for children with intellectual disabilities.[33]

**Moving forward: key considerations for investors**

Recognising the positive impact of AI solutions in education as well as potential challenges, Greenwheel brings together the following takeaways for investors:

- **AI is a powerful tool that can create a more conducive learning environment**, especially for underserved students in more rural and remote communities. AI can help educators overcome a one-size-fits-all approach to create more tailored learning objectives and plans for students. With the analytical capacities of AI programmes, teachers can identify more effective interventions for their students to accommodate for their learning needs and styles.

- **The positive impact on the right to education and culture is growing**. As AI models are trained in more languages (beyond English, Chinese, and the more dominant languages present in training datasets) and in different cultural contexts and nuances, solutions can be refined to be even more tailored and responsive to settings in which teachers and learners operate. Moreover, AI can play an important role in preserving rare or dying languages and traditional knowledge systems, including indigenous languages and cultures.

- **However, AI cannot and should not be seen as a replacement for teachers**. Teaching should remain a human-centred and human-driven field. AI is a complementary tool to free up time from tasks that take away from interacting with students and to enhance the learning experience for students (e.g., gamification).

### 3. Healthcare

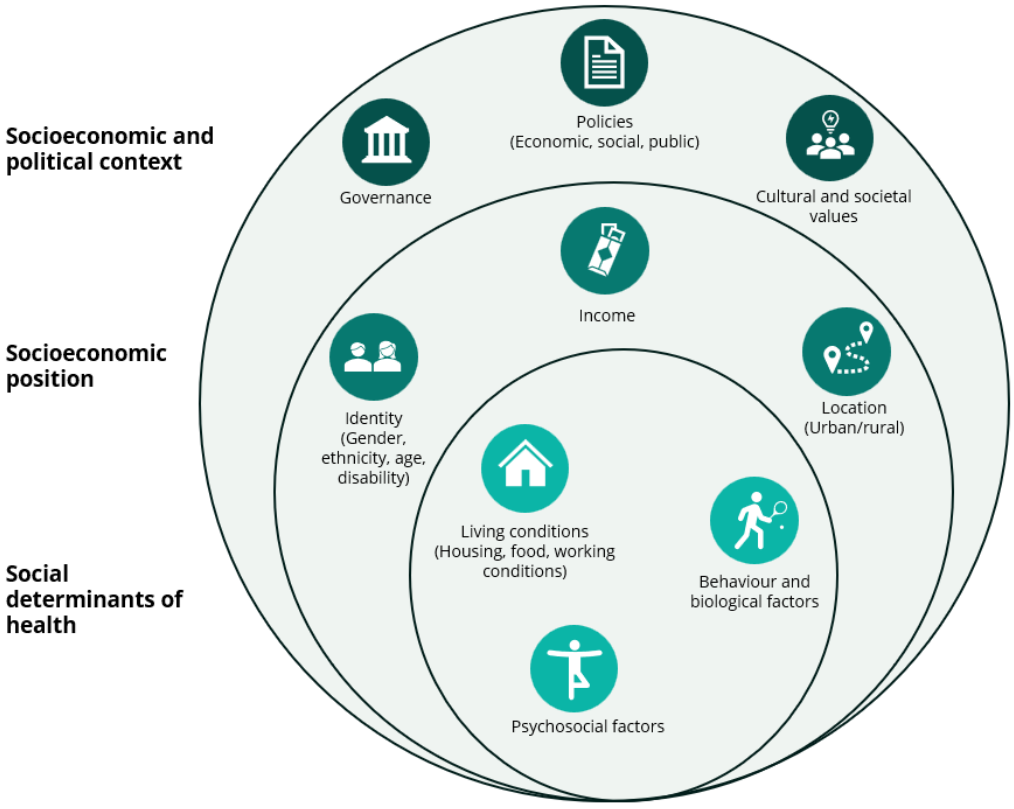
**Access to healthcare is defined as receiving high-quality health services during times of sickness at an affordable cost**, where individuals are not in financial hardship as a result of attaining services. This is often referred to as universal health coverage.[34]

Between 2000 and 2021, the global population not covered by health services decreased by 15%. Progress, however, has stagnated since 2015. Today, **4.5 billion people are not fully covered by essential health services**. 1 billion people continue to experience catastrophic out-of-pocket health spending and 344 million people are entering into extreme poverty due to health costs.[35]

**There are clear health inequities between developed and emerging markets**. The under-five mortality is eight times higher in Africa than in Europe. 99% of the world's maternal deaths are situated outside of developed markets.[36]

The global shortage of healthcare providers is disproportionately impacting emerging markets. Though there is a shortage of health workers globally, the World Health Organisation identifies 55 countries as vulnerable (i.e., low density of doctors, nurses, and midwives, and low universal health coverage). All countries listed are outside of developed markets, with the majority of countries in Sub-Saharan Africa (37 countries) followed by Southeast Asia (nine countries).[37]

**Figure 13**: **Social determinants of health outcomes**




**Source**: WHO, 2024; created by Greenwheel.

Although biological factors are a determinant of health, social factors play a key role in influencing a person's health outcomes. **An individual's health is largely driven by the conditions they are born, grow, live, work, and age in addition to their access to decision-making, power, and resources** (Figure 13).[38] As such, access to healthcare provisions is important to tackle the health gaps found in emerging markets, which is essential to the enjoyment of the right to health.

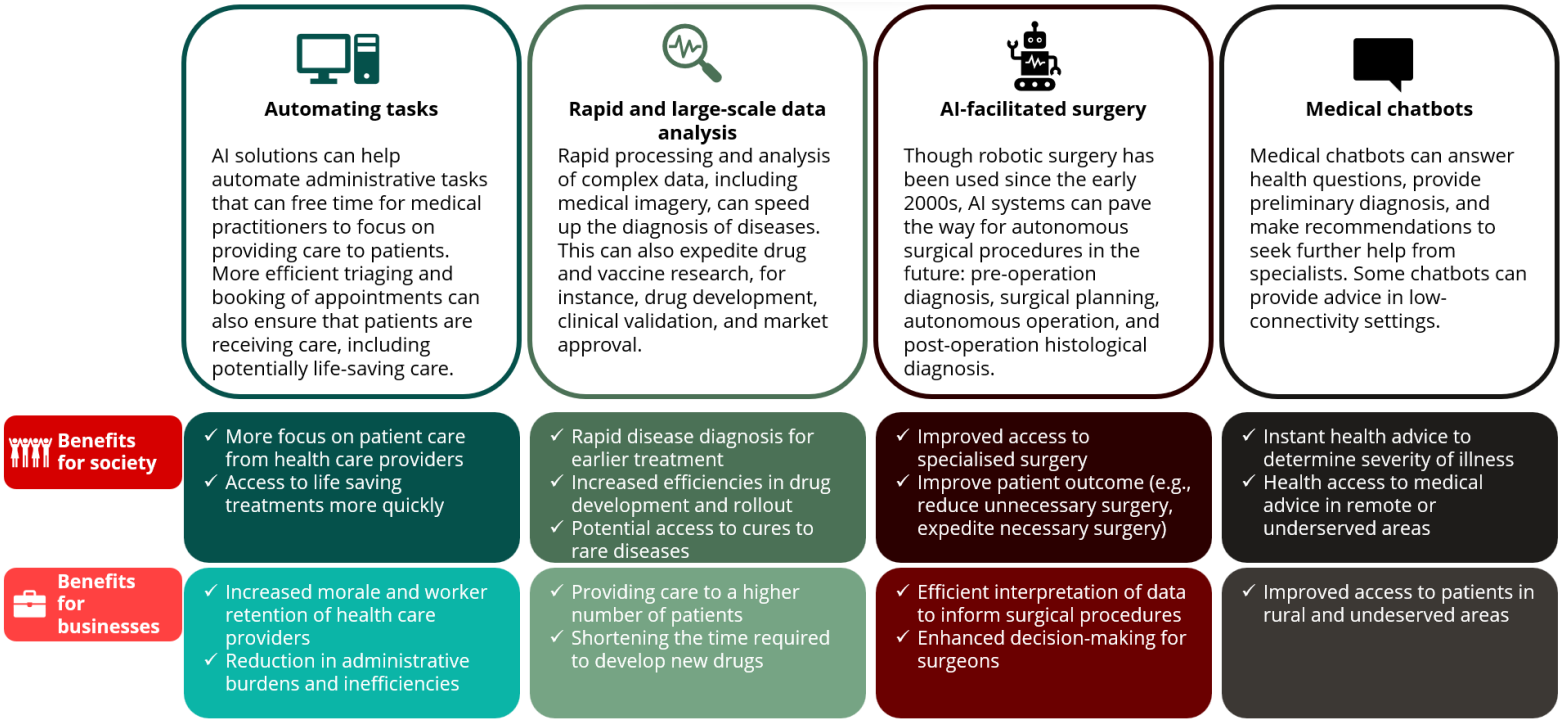
To meet the gaps in healthcare globally, an estimated 140 billion of private sector investment is required annually until 2030. In particular, investments in digital health and AI can help bridge the gaps in services.[39]

**Globally, the AI market for healthcare solutions is expected to reach $188 billion USD by 2030.**[40] The majority of investments in the AI healthcare market will be in the United States; its AI healthcare market is expected to grow from an estimated $11.8 billion USD in 2023 to $102.2 billion USD.[41]

In comparison, the AI healthcare markets in the two largest emerging markets of China and India are significantly smaller. During the same period between 2023 and 2030, the Chinese market is expected to grow from $1.6 billion USD to $18.9 billion and the Indian market may increase from $758.8 million USD to $8.7 billion USD.[42] Although the absolute size of the market are smaller for China and India, the relative growth rates are significant.

The use of AI in healthcare is not novel, as machine learning has been used in the sector since the 1990s, for instance, in identifying cancers and analysing medical images. **New AI products and services in healthcare are developed as solutions to gaps in services especially to vulnerable and/or underserved groups and to promote quality care** (Figure 14).

**Figure 14: The application of AI solutions in healthcare**




**Source**: Roppelt et al., 2024, Gu et. al, 2023, Kumar et al, 2022, and IFC, 2021; created by Greenwheel.

Despite the relatively smaller AI healthcare market in emerging markets, there are many solutions implemented today (Figure 15). For instance, AI systems are used to diagnose diseases through predictions or rapid analysis of medical imagery. Innovative programmes such as MedSol AI Solutions combine AI with the Internet of Things to screen for breast cancer in more remote settings, where expensive medical machinery or technical expertise may be less accessible.

**Figure 15: A snapshot of AI solutions in healthcare in emerging markets**

| Challenge | Targeted group | AI solution | Impact |
|---|---|---|---|
| Diagnosing cancer in remote clinics | Persons in rural and other underserved communities | MedSol AI Solutions offers real-time breast ultrasound scanning to detect breast cancer. The built-in WiFi ultrasound probe facilitates early detection through an AI system that predicts malignancy. Users can input personal data including symptoms and medical history to inform the diagnosis. | The probes provided are 65% less expensive than competitors. At an accuracy rate of 97.6%, MedSol AI promotes access to breast cancer screening in remote communities in South Africa. |
| Lack of access to health information | All groups, but especially remote communities | The DocsApp CLARA is a virtual care application that connects patients to specialists for the remote diagnoses and treatment of illnesses in India. Using machine learning, CLARA provides a probable diagnosis based on patient-inputted data such as personal details and health concerns. Based on the results, the app will refer patients to specialists where they can access virtual consultations, access lab tests, or obtain prescriptions. | CLARA allows remote communities to receive immediate health advice through a mobile application. The instant and preliminary diagnosis allows patients to seek further consultation with specialists virtually. |
| Providing low-cost healthcare | Persons in underserved communities | Salauno serves lower-income communities through the provision of eye care in Mexico. Artificial intelligence has allowed Salauno to operate with lower costs. Its AI-solution detects diseases such as diabetic retinopathy. Working with local partners (e.g., non-profit organisations, governments, private companies), its mobile application detects diabetic retinopathy and refers patients to specialised care as needed. | In its eight years of operation, Salauno has served 343,972 patients, performed over 49,461 surgeries, and provided 40,000 pairs of lenses below average market prices. |
| Promoting rapid diagnostics | All groups | Aidoc is an AI solution that improves efficiency in vascular and chest CT exams. The solution aims to improve the quality of diagnosis, operational efficiency, and productivity. A "read assist" solution helps radiologists increase in both efficiency and accuracy when examining imagery from CT exams. A "work assist" solution supports practitioners in prioritising urgent patients. | Since its pilot in Brazil, more than 4315 cases were evaluated using Aidoc with a reported 92.7% overall accuracy. Four cases that were missed by radiologists were identified through Aidoc. |
| Triaging of patients | All groups | Ping An Good Doctor is an online platform in China, which uses AI to pre-triage patients for 24/7 online consultation through its in-house medical team. Ping An Good Doctor provides a closed-loop healthcare system as a one-stop-shop for quality care through medical consultations, pharmaceuticals, and wellness services. | With more than 440 million registered users by June 2022, Ping An Good Doctor connects users with over 49,000 internal and external doctor teams, 3000 partner hospitals, and 208,000 partner pharmacies. The solution facilitates 24/7 drug delivery services in 80 cities. |

**Source**: IFC, 2024, MedSol AI Solutions, 2024, MIT, 2024, Ping An Good Doctor, 2024, and IFC, 2021; created by Greenwheel.

AI solutions can also promote access to healthcare for underserved communities. Virtual Chatbots trained on medical data can provide preliminary medical advice and identify cases where patients

need to seek further specialist attention. The savings and efficiencies gained through AI can also transfer into more affordable healthcare for communities.

As AI solutions in healthcare continue to grow in emerging markets, there may be barriers to their successful and inclusive development and deployment. The first key concern stems from the data quality in training AI systems. **Biased datasets can lead to incorrect assumptions and diagnosis, which results in poor or inappropriate care.** Historically, this disproportionately affects ethnic minorities and women, and is likely to affect emerging markets (e.g., models providing analysis and drawing conclusions using data from developed markets only).

Yet, this challenge can be tackled through the use of a more representative dataset; where it is not feasible, a synthetic dataset can be used to build AI models based on artificially generated or simulated information that reflects real world statistical data. Another solution is to crowdsource data.[43] As AI continues to grow in emerging markets, developers may consider collecting additional data to inform their solutions.

Another concern regarding data is related to privacy. **Patients may not be able to exercise their agency in giving their information**. For instance, patient data may be granted to private and/or public institutions through partnerships without explicit patient consent. There is a huge risk to privacy as data can be used to reidentify a specific individual even if data is anonymised or scrubbed of identifiers.[44]

In emerging markets that have weak regulatory frameworks on privacy and data protection, patients may unwillingly give up their personal data without informed consent. Although the regulatory aspect is the responsibility of governments, businesses and healthcare providers can nonetheless seek to actively inform patients and offer the right for patients to withdraw their data.

Another challenge pertains to the deployment of AI solutions in health. The successful adoption of AI in healthcare is driven by macro-economic readiness (e.g., IT infrastructure, supportive communities); technological readiness (e.g., appropriate AI solutions without discriminatory results); regulatory readiness (e.g., laws, political support); organisational readiness (e.g., organisational culture); and, most importantly, user readiness (e.g., healthcare providers, patients).[45] Particularly in the context of healthcare where there is an expectation to receive emotional care, **there is an extent to which automated processes or AI solutions cannot replace real-life human interaction**.

**Moving forward: key considerations or investors**

There is great potential to apply AI solutions in the context of healthcare, and it is unsurprising that this sector will receive significant investment globally over the coming years. Greenwheel has captured the following key takeaways for investors:

- **AI solutions are likely to improve the delivery of healthcare services, benefitting both practitioners and patients**. The efficiencies gained from applying AI solutions, from rapid diagnostics to lowered administrative burdens, allow practitioners to focus on delivering care and patient interaction. At the same time, there are examples of AI solutions reducing the cost of healthcare, which is important in tackling health inequities in emerging markets.

- From diagnosing cancer to preventing heart attacks, **learning algorithms are enabling the delivery of health services at scale in both urban and rural settings, especially for underserved communities**. Through natural language processing, virtual healthcare can be provided through chatbots that offer instantaneous communication to patients, including preliminary diagnosis.

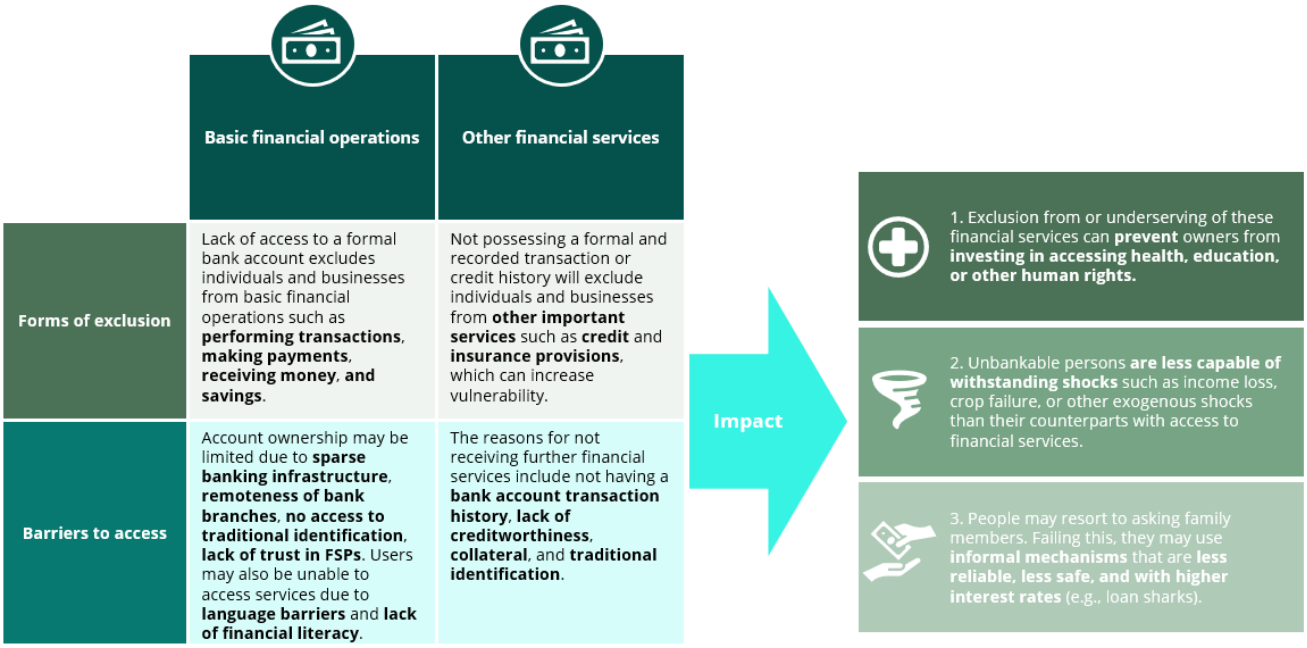
- **Despite the impressive innovations in AI in health care, humans should be in-the-loop**. Medical care involves working closely with patients to devise a care plan that allows patients to have autonomy over decisions they make.[46] Given the importance of the social and relational aspect of healthcare, human interaction is unlikely to be replaced by AI solutions.[47] Though AI solutions in diagnostics and analytics continue to improve over time, medical professionals are still required to ensure accuracy and address biases or discriminatory results.

### 4. Financial Services

**Financial inclusion ensures that individuals and businesses have access to formal financial products and services that meet their needs at affordable rates**. It is a key enabler of economic growth, poverty reduction, and gender equality. As well, access to financial services and products can facilitate the enjoyment of other human rights including the right to education, health, housing, and work. However, the gaps in access to financial services and products continue to be a significant challenge in emerging markets, especially for women, poor households, rural persons, persons in informal employment, and persons out of the workforce.[48]

**Account ownership is the primary measure of financial inclusion**. Account ownership is the main gateway to basic financial operations and constitutes a basis upon which financial services providers (FSPs) may provide individuals or businesses with further services (Figure 16).

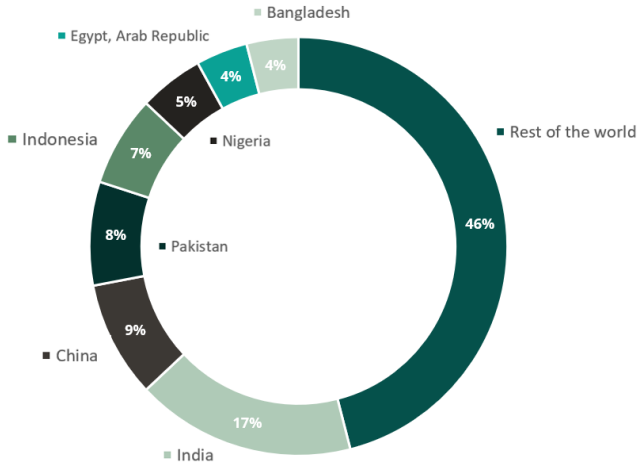
**Figure 16: The extent of financial exclusion**




**Sources**: IFC, 2021 and World Bank, 2021; created by Greenwheel.

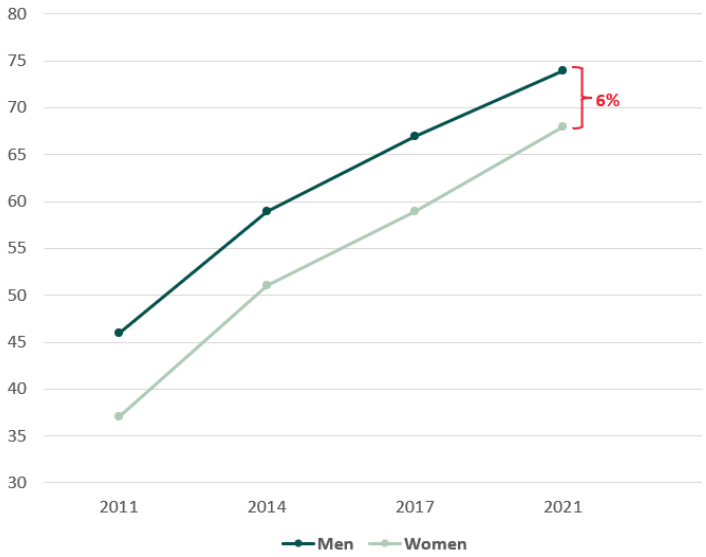
Although account ownership worldwide has increased by 50% since 2011 to reach 76% of the global adult population by 2021, **around 1.4 billion adults remain unbanked**.[49] Account access also varies by country and gender. Most of the world's unbanked adults remains in emerging and frontier markets, with more than half of that population living in just seven economies (Figure 17). Gender gaps persist in account ownership as the proportion of men with accounts is higher than the proportion of women with accounts in emerging markets (Figure 18).[50]

**Figure 17: Unbanked adults concentrated in seven economies**




**Source**: Ansar et al., 2023 and Global Findex Database, 2021; created by Greenwheel.

**Figure 18: Gender gap in account ownership in developing markets**




**Source**: Global Findex Database, 2021; created by Greenwheel.

Though Micro, Small and Medium Enterprises (MSMEs) are one of the key drivers of economic development and employment, **70% of MSMEs in emerging economies lack adequate financing**.[51] The MSME finance gap stands at $5.7 trillion USD and increases to $8 trillion USD when considering informal enterprises.[52] Women-owned MSMEs face even more persistent barriers to accessing financial resources.[53] Latest estimates suggest that women own 28% of MSMEs but account for 32% of the MSME financing gap.[54]

Another key obstacle to financial inclusion is that the **operational costs of providing services to underserved customers is often too high for FSPs** (Figure 19).[55] This can make FSPs reluctant to provide services to underserved and remote customers.

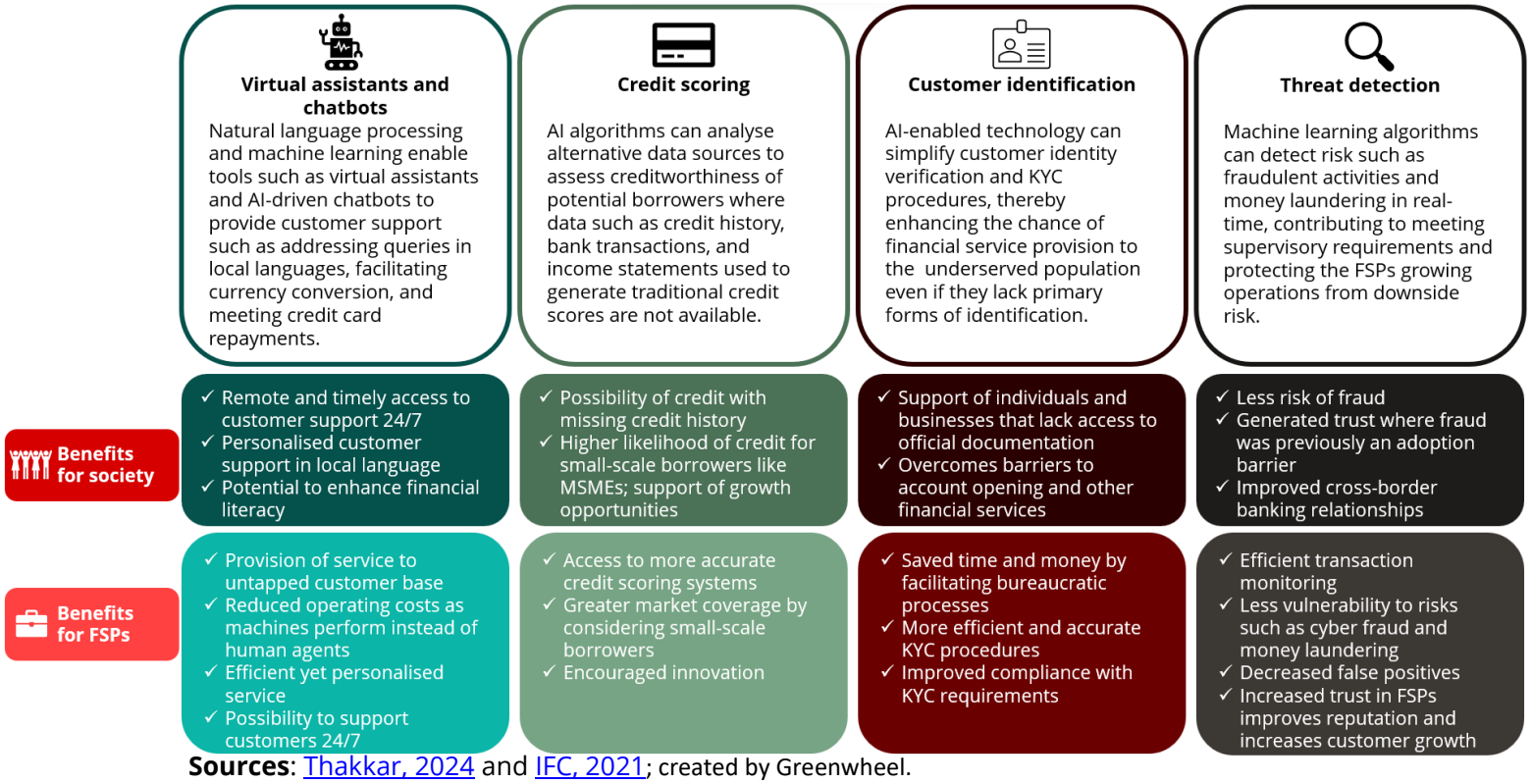
**Figure 19: Sources of operational costs for FSPs**

- **Human agents** providing **customer support** to respond to queries or help with financial operations.
- **Language** or **financial literacy barriers** can lead to time consuming customer engagement.
- Maintaining or building **banking infrastructure.**
- Processes for **assessing borrower creditworthiness** and overcoming limitations such as **lack of credit history and collateral**.
- Diverse **bureaucratic processes** such as identity verification processes and overcoming hurdles such as **lack of primary identification or official documents**.
- **Checking for compliance,** such as **Know Your Customer (KYC)** requirements.
- Cost of **transaction monitoring and fraud detection,** especially in the **case of detection errors.**

**Sources**: Thakkar, 2024, IFC, 2021, and Kshetri, 2021; created by Greenwheel.

### AI-Powered Financial Inclusion in Emerging Markets

**Figure 20: AI-powered inclusive financial service systems**




**Sources**: Thakkar, 2024 and IFC, 2021; created by Greenwheel.

**Artificial intelligence (AI) technology plays a transformative role in promoting more inclusive financial service systems and leapfrogging the needs of traditional banking infrastructure in emerging markets**.[56] Not only can AI applications leverage alternative data sources to overcome obstacles such as a lack of transaction and credit history, they can also automate processes that enable more low-value transactions, thereby reducing FSPs' reluctance to serve underserved individuals and small-scale borrowers (Figure 20).[57]

**Figure 21: Use cases of AI in financial services in emerging markets**

| Challenges | Targeted group | AI solution | Impact |
|---|---|---|---|
| Quick and affordable access to credit for underserved small businesses | MSMEs | Konfio is an online lending platform that revolutionised access to credit tools for MSMEs in Mexico. While the company uses alternative data sources and AI in its overall lending decisions, Konfio's core strength lies within the enormous processing power of their systems which, with the help of advanced algorithms, make credit approval and loan disbursement processes more agile and less complex. | By 2022, Konfio extended loans to more than 27,600 MSMEs in Mexico. Compared to similar MSMEs that were excluded from financing, analysis has shown that the average sales growth of Konfio clients was 19.4% higher after two years of receiving the loan. The average sales growth women-led MSMEs was 41.9% within two years of receiving the loan. |
| Solving enhancing customer support and facilitating customer experience | Individual customers | Axis Bank in India has launched its virtual assistant "Axis AHA!" and has updated it to create the 2.0 Chatbot version. The 2.0 Chatbot provides 24/7 customer support in Hindi or English and delivers services such as speech-to-text. The assistant can help users access and understand operations such as account statement generation, debit and credit card services, and KYC identification. | Axis AHA! 2.0 bridges the gap between Axis bank and its customers, enhancing customer experience for their 22.6 million mobile banking customers and lowering accessibility barriers for new customers. |
| Assessing creditworthiness of customers with no credit history or savings | Individual customers | Branch International uses machine learning algorithms to process thousands of data points from smartphones to determine customer creditworthiness in emerging markets. Data sources such as handset details, SMS logs, GPS data, contact lists, and repayment history are used to generate personalised loan options. | Branch International has issued over 29 million loans and disbursed more than 1 billion USD. Customers previously excluded from credit access are enabled to loan services in a convenient and secure manner. |
| Accurate and rapid fraud detection | Banks | Mastercard's Decision Intelligence (DI) is a real-time decisioning solutions that helps banks assess and safely approve 143 billion transactions a year. The company is now adopting additional generative AI techniques to create "DI Pro", with which one trillion data points can be scanned to predict potential fraudulent transactions. | Initial modelling demonstrated that DI Pro has potential to increase fraud detection rates by on average 20% and up to 300% in some instances. The tool can scan for risk in less than 50 milliseconds and can also reduce the number of false positives by around 85%, enhancing the data provided to banks and therefore their customers. |

Sources: Citibank, 2022, IDB Invest, 2024 , Axis Bank, 2024a, Axis Bank, 2024b, Branch International, 2024, and Mastercard, 2024. Created by Greenwheel.

Some FSPs are implementing AI applications in emerging economies to enhance financial inclusion and promote market access (Figure 21). AI solutions are increasing the access to credit to both MSMEs and individuals. Konfio used AI to enable lending to MSMEs, particularly women-led MSMEs, through analysing alternative data sources to assess credit-worthiness to inform lending decisions. Similarly, Branch International uses machine learning to analyse non-conventional data points to determine credit worthiness (e.g., SMS logs, contact lists). This enabled the disbursement of loans to previously excluded customers.

The use of AI by FSPs in emerging markets show promising results in enhancing financial inclusion to both individuals and MSMEs. However, AI-powered solutions presents some obstacles in its implementation.

As AI tools are mainly used to enhance digital banking applications and wallets, leveraging AI in financial services depends largely on **people's connection to the internet and access to mobile devices**. While some technology companies have managed to design service platforms that function in offline settings, 3.4 billion persons remain unconnected from mobile device services.[58] Barriers to using mobile internet and digital services are especially persistent for women and women-led MSMEs. The effectiveness of AI applications in enhancing financial resilience is also contingent on **financial literacy and digital literacy** as a prerequisite.[59]

AI tool adoption could be challenged by **data privacy and security** issues. AI-powered solutions such as more accurate credit rating collect and process vast amounts of sensitive financial and personal data. To demonstrate credit worthiness, potential customers may have to hand over extensive personal data (e.g., SMS, chatlogs, contact lists) that would otherwise be not required for customers with credit history. FSPs in emerging markets should ensure that the right to privacy is respected wherein customers give their prior and informed consent in sharing information and understand how and why their data is use.[60]

To ensure responsible adoption of AI tools that facilitate lending practices, FSPs must **hire suitable staff with the right skills** in deploying AI technologies and keep humans-in-the-loop to address potential discriminatory results. Otherwise, there is a risk that AI innovations increase the vulnerability of underserved consumers, erode trust, and contribute to more harm than good.[55]

**Moving forward: key considerations for investors**

AI-powered applications evidently provide innovative ways for FSPs to extend financial services to previously underserved individuals and MSMEs, thereby enhancing financial inclusion in emerging markets. Greenwheel highlights four key takeaways for investors:

- **AI-powered solutions in financial services promote access in two ways**. Not only does AI enhance financial inclusion by promoting access of financial services to underserved individuals and MSMEs, but its capability to automate enables more low-value transactions and therefore increases market coverage of FSPs by providing access to new customers, especially lower-income and "unbankable" persons.

- **Leveraging AI in financial services has the potential to reduce existing inequalities**. Examples show how AI solutions can bridge financial inclusion gaps between developed and emerging markets, larger businesses and MSMEs, as well as men and women. By facilitating access to finance for women-led MSMEs, AI can also boost women's entrepreneurship development. **Keeping humans-in-the-loop** is an essential part of financial inclusion through AI to ensure that there are no discriminatory results.

- While AI-based technologies are promising for FSPs, **potential benefits come with certain caveats**. Mobile connectivity of new target customers is a prerequisite for AI to be fully leveraged as the AI tools are mainly used to enhance digital banking services and access thereto. Similarly, basic financial literacy is crucial so that customers understand the benefits the applications can provide them with and how to use the new technologies.

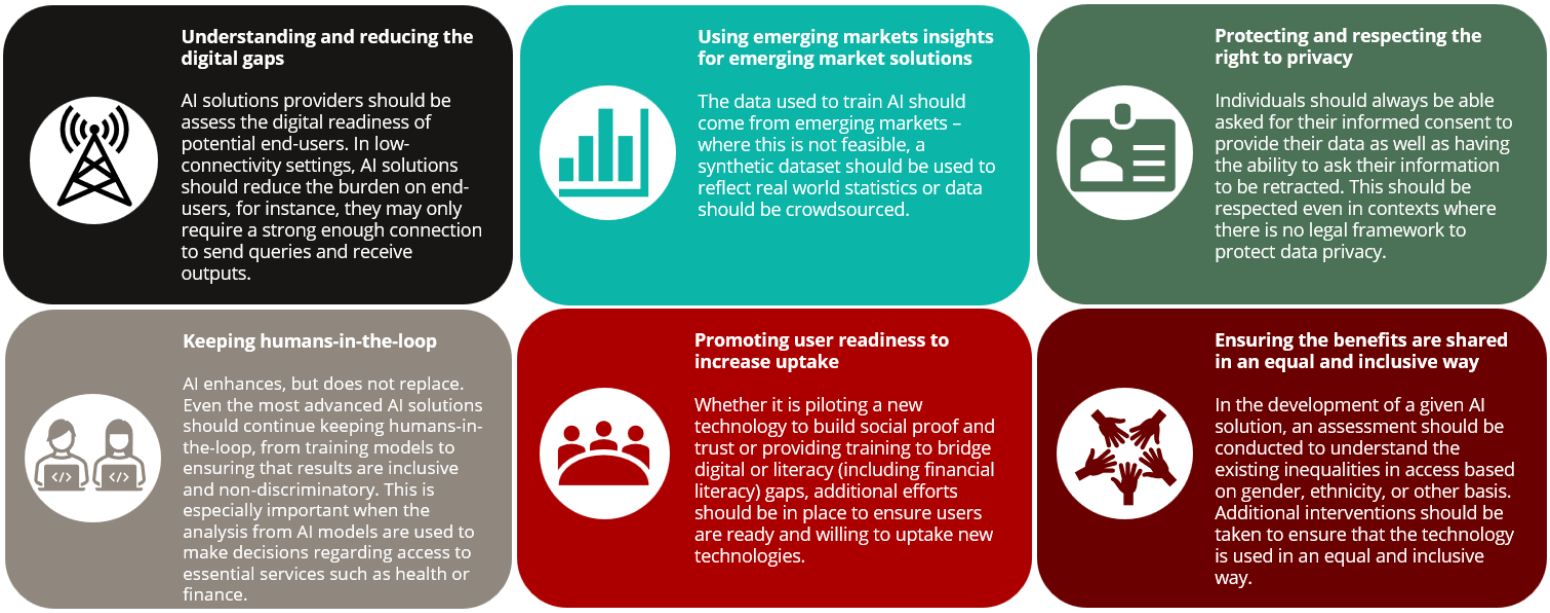
- **Enhancing financial inclusion with the help of AI can improve financial resilience across other sectors and facilitate the enjoyment of human rights**. For instance, in the event of crop failure, farmers would be better equipped to withstand the financial shocks if they had access to services such as payments, savings, credit, or even insurance services. Being financially included also permits individuals to invest in other services such health and education even during times of financial shocks.

**The role of businesses and investors in leveraging AI innovations in emerging markets**

There are obvious positive impacts in deploying AI solutions across the agriculture, education, financial services, and healthcare sectors in emerging markets. The many solutions highlighted here are still in a nascent stage, with the potential to scale and further evolve over time. The full potential of AI solutions is yet to be seen.

To maximise the social contributions of AI solutions and drawing from the application across four sectors, Greenwheel provides six key recommendations to businesses and investors (Figure 22).

**Figure 22: How businesses and investors can support the inclusive rollout of AI solutions**




**Source**: Greenwheel, 2024; created by Greenwheel.

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[1] Hereafter, emerging markets will be a shorthand for emerging and frontier markets.
[2] IFC, 2021 and World Economic Forum, 2023.
[3] WEF, 2024a.
[4] ITU, 2024.
[5] GSMA, 2024a.
[6] Users and subscribers are distinct concepts. Users entail anyone that can use the internet or mobile services regardless of whether they have subscribed to a service (e.g., a household could have one individual subscribed but share access with the rest of the household). The latter may not fully capture the scale of reach. As such, internet users and mobile users are provided to paint a more accurate picture.
[7] GSMA, 2024b.
[8] ITU, 2024.
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[10] Ibid.
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[54] UNIDO, 2022. Note that the latest estimate was made in 2017.
[55] IFC, 2021.
[56] Thakkar, 2024.
[57] Kshetri, 2021.
[58] Simprints, 2024.
[59] Kass-Hanna et al., 2022.
[60] World Finance Council, 2024.

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