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CHALLENGES AND OPPORTUNITIES FOR WOMEN ENTREPRENEURS IN AFRICA: A SURVEY OF SCIENCE AND TECHNOLOGY USAGE

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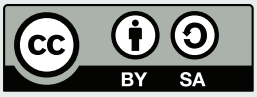

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Challenges and opportunities for women entrepreneurs in Africa: a survey of science and technology usage

AT A GLANCE

- Between October and December 2019, UNESCO and the Africa Women's Forum surveyed 427 women entrepreneurs in Africa to determine the extent to which they were using science and technology and the challenges they faced. Women entrepreneurs were interviewed in ten countries: Benin, Democratic Republic of Congo, Djibouti, Ghana, Madagascar, Morocco, Mozambique, Senegal, South Africa and Tunisia.

- In eight of the ten African countries surveyed, at least half of the women entrepreneurs interviewed held a bachelor's or higher degree. This finding calls into question the assumption in Africa that women launch their own business because they are uneducated.

- Less than 11% of the women entrepreneurs attributed their decision to launch their own business to a lack of employment opportunities or poor treatment at the hands of their previous employer. This finding casts doubt on the assumption in Africa that women launch their own business for lack of other career options.

- The majority (80%) of the female entrepreneurs interviewed used science and technology in their work, ranging from traditional and solar ovens to digital design software and social media networks. Most of these women worked in the food sector (26.4%), followed by textiles (13.8%), services (such as accounting) [11.5%], web platforms (8.3%), beauty and personal care (6.9%) and digital marketing and services (6.9%).

- Almost one in four (23.9%) reported that they had innovated. A further 5.6% expressed uncertainty about whether they had innovated or not. Eight women had created an application for a mobile phone.

- Of the 104 women who affirmed that they had innovated, 17 (16.3%) had patented their invention. Others had registered their product with regulatory bodies like the Food and Drugs Board in Ghana. Five women said the process for registering their intellectual property was lengthy, costly and/or bureaucratic. Some of the women lamented the lack of information and guidance and one suggested that it would be helpful to find documentation on the Internet and/or a specialist lawyer to help with the process.

- Some of the women surveyed were reluctant to register or patent their product or process, as they ran an informal business. Reasons given for not formally registering their business included considerations of cost and the complexity of bureaucratic procedures.

- For seven out of ten (70%) respondents to the UNESCO survey, access to finance was the greatest barrier they had faced when starting their own business.

- More than one-third (39%) of respondents were aware of the existence of a local incubator for tech start-ups and one-quarter of these women (24%) reported having received support from one. The most common form of support (57%) was training, followed by finance (27%), encouragement (25%), co-working space (14%) and equipment, including software (10%). In some cases, the women benefited from more than one of these services.

- Of the 125 women who specified that their start-up finance had come from a source other than a start-up incubator, one-third (42 respondents, 33.6%) had used their own funds or those of their family or close friends and half (62 respondents, 49.6%) had obtained a bank loan. Another six women had accessed microfinance and two were members of a local women's co-operative lending scheme. The remaining respondents mentioned receiving funds from private loans (2), philanthropic organizations (5), non-governmental organizations (3) and international aid (3).

Challenges and opportunities for women entrepreneurs in Africa: a survey of science and technology usage

INTRODUCTION

Rationale for the study

In 2019, when UNESCO set about preparing the *UNESCO Science Report*, its quinquennial report monitoring trends around the world in science governance and scientific research, it was confronted with a dearth of available information on demand for science and technology by small and medium-sized enterprises (SMEs) in Africa. Even less was known about female-owned businesses and start-ups specifically. These gaps in our knowledge undermine policy efforts to understand and respond to the needs of local entrepreneurs.

Fortunately, this blind spot is attracting growing research attention. Ojong *et al.* (2021) noted that 74 peer-reviewed articles had been published about female entrepreneurship in Africa between 2015 and 2019, more than in the previous 27 years combined. However, of the 54 countries within Africa, only three – Ghana, Nigeria and South Africa – were the focus of ten or more of these studies. Some countries, such as Benin, Djibouti, Madagascar and Mozambique, were present only in multicountry studies. Other countries were not visible in the literature at all (see Figure 2 in Ojong *et al.*, 2021).

This state of affairs prompted UNESCO to undertake a survey of women entrepreneurs in Africa in 2019, in order to understand how they were using science and technology and the challenges they faced. This focus reflects the Organization's two global priorities of Africa and gender equality. The present report summarizes the findings of this survey and cites relevant public policies that have been adopted in recent years to improve the environment for micro- and small and medium-sized enterprises, largely drawn from the *UNESCO Science Report: the Race Against Time for Smarter Development* (2021).

Overview of the innovation ecosystem in Africa

Africa is a continent of extremes. Whereas countries such as Madagascar, Malawi and the Democratic Republic of Congo are still battling inequality and extreme poverty, with more than 70% of the population living on less than US$ 1.90 per day (UNESCO, 2021, p. 535), Africa is also home to a growing number of tech hubs (Table 1), which more than doubled between 2016 and 2019 from 314 to 744 (see Figure 20.2 in UNESCO, 2021). Fourteen African countries count 15 or more active hubs: Angola, Cameroon, Democratic Republic of Congo, Ghana, Côte d'Ivoire, Egypt, Kenya, Morocco, Senegal, South Africa, Tanzania, Togo, Tunisia and Uganda. South Africa ranks among the top 20 countries in the world for the share of professionals with skills in artificial intelligence (AI), 28% of whom were women in 2017 (see Figure 3.2 in UNESCO, 2021).

In spite of the influx of seed funds and grants, many African tech hubs struggle to raise sufficient capital. The near absence of local business angels and seed capital remains the biggest challenge. For instance, in Nigeria, which is home to 101 tech hubs, almost 80% of investment in tech hubs comes from offshore sources (UNESCO, 2021).

In terms of human resources in science and engineering, there are wide disparities between North Africa and sub-Saharan Africa, as well as between South Africa and the rest of sub-Saharan Africa. In 2018, there were 124 researchers (in full-time equivalents, FTE) per million inhabitants in sub-Saharan Africa, compared to 866 FTE researchers per million inhabitants in North Africa. South Africa counted 518 FTE researchers per million inhabitants (see UNESCO, 2021).

The same variation can be seen in terms of technicians, who will be vital to the Fourth Industrial Revolution, with its emphasis on sophisticated digital technologies to drive advanced manufacturing, agriculture and services. In 2018, sub-Saharan Africa counted 39 FTE technicians per million inhabitants, compared to 215 for North Africa and 130 for South Africa (in 2017).

Women make up a greater share of researchers (in head counts) in North Africa and South Africa (45%) than in sub-Saharan Africa (34%), although there are wide variations between countries (see Table 3.2 in UNESCO, 2021).

The share of women among tertiary graduates in science and engineering fields also varies considerably from one African country to another (Table 2).

Implications of Africa's digital transition for women entrepreneurs

Access to an affordable, reliable Internet connection is one of the most basic services required by most modern businesses. Despite the expansion of telecommunications infrastructure, Internet remains costly for many African businesses and citizens. For instance, Madagascar had the second-fastest fixed broadband Internet service in Africa after Ghana by October 2020, having connected to the Eastern African Submarine Cable System ten years earlier, but only 5% of Malgache had access to Internet in 2016. Between 2015 and 2019, Internet access progressed by only 0.24% to reach 24.2% of the African population (see Table 19.2 in UNESCO, 2021). Whereas every second person in North Africa (50%) has access to Internet, this is the case for only one in five Africans living south of the Sahara (18%).

Table 1: **Selected socio-economic indicators for the ten countries surveyed, 2017–2020**

	Population	Economy	Employment	Access to services				Innovation
	Population (000s)	GDP per capita (constant 2017 PPP$)	Unemployment rate, females (%)	Internet access per 100 inhabitants	Mobile cellular subscriptions per 100 inhabitants	Cost of mobile connection (PPP$)	Share of population with electricity access (%)	Number of active tech hubs
	2019	2019	2019	2019	2019	2019	2018	2020
Benin	11 801	3 287	2.5	29.0*	87.7	40.99	41.5	12
Congo, Dem. Rep.	86 791	1 098	3.2	12.5*	42.8	73.53^{+1}	19.0	22
Djibouti	974	5 519	11.3	59.0*	41.2^{-1}	77.46	60.4	3
Ghana	30 418	5 413	4.3	53.0*	134.3	30.47	82.4	36
Madagascar	26 969	1 646	1.7	15.0^{-1}*	40.6^{-1}	40.96	25.9	6
Morocco	36 472	7 537	10.5	74.4	128.0	14.54	99.6	49
Mozambique	30 366	1 280	3.5	15.1*	47.7^{-1}	22.21^{+1}	31.1	6
Senegal	16 296	3 395	7.0	39.5*	109.7	72.17	67.0	22
South Africa	58 558	12 482	30.5	68.2*	165.6	69.78	91.2	93
Tunisia	11 695	10 756	22.4	66.7	126.3	16.37	100.0	41

*ITU estimate

-n/+n: data refer to *n* years before or after reference year

Note: The unemployment rate reflects the unemployed share of the female labour force based on a modelled estimate by the International Labour Organization. For comparison, the cost of a comparable mobile connection in France was PPP$ 32.45.

Source: World Bank's World Development Indicators, October 2020; for active tech hubs: Figure 20.2 in UNESCO (2021); for cost of mobile connection: Mobile data and voice high-usage: 14v0 min + 70 SMS + 1.5 GB, ICT Price Baskets, International Telecommunication Union (ITU) historical data series, March 2021 release

A lack of market competition in the telecommunications sector has resulted in high costs and low uptake of Internet by businesses and consumers, placing tech-reliant start-ups in Africa at a disadvantage and compromising the continent's chances of seeing a significant share of intra-African trade take place on the Internet once the African Continental Free Trade Area is up and running.

Moreover, according to the International Telecommunications Union (ITU), Africa's gender parity score for Internet usage dropped from 0.79 in 2013 to 0.54 in 2019, the lowest regional score in the world (ITU, 2020).[1] In 2019, an estimated 20% of African women were using the Internet, compared to 37% of African men (ITU, 2020).

Women in disadvantaged communities, in particular, are being left behind. For example, a 2015 survey by the Web Foundation found that, in the low-income districts of Maputo in Mozambique, only one-third of women were connected to the Internet, compared to almost two-thirds of men.

In parallel, there has been consistent growth in mobile phones and digital payment systems with advanced functionalities that draw on the confluence of mobile money and the Internet of Things. Kenya is one of the most mature digital credit markets in developing economies, where the volume of digital loans surpassed traditional loans in 2015. In 2020, Tanzania's National Data Centre launched the N-Card enabling digital payments (UNESCO, 2021, p. 39).

Digitalizing the economy presupposes that citizens have bank accounts and credit cards that allow them to engage in online transactions. The establishment of a digital payment system will support the emergence of e-commerce and combat tax evasion and corruption but it is also likely to heighten the vulnerability of those employed in the informal economy where cash payments are the norm (UNESCO, 2021, p. 11). Egypt has mandated the use of cashless payments by public and private entities (through Law No.18 of 2019) and is striving, in parallel, to integrate women better in the economy. The share of women with a bank account rose from 9% to 27% between 2015 and 2017, following implementation of the Egyptian Financial Inclusion Programme. The Central Bank of Egypt has outlined plans to promote gender-inclusive finance. In 2020, the bank was working towards a unified definition for women-led businesses, a gender-disaggregated database to measure trends in financial inclusion and the provision of further incentives to banks to lend to microfinance institutions (UNESCO, 2021).

In October 2019, African ministers with a communication portfolio adopted the *Sharm El Sheikh Declaration* proposing a continental *African Digital Transformation Strategy*, with the aim of creating a Digital Single Market by 2030. The ministers invited member states to ratify the *African Union Convention on Cyber Security and Personal Data Protection* (the *Malabo Convention*, 2014), which calls upon countries to set up a cashless financial system to nurture digital marketplaces and combat corruption, as well as to develop regulations to protect domestic data. For the Malabo Convention to enter into force, 15 African countries must ratify it. As of May 2020, only eight had done so: Angola, Ghana, Guinea, Mauritius, Mozambique, Namibia, Rwanda and Senegal (UNESCO, 2021).[2]

A survey of more than 400 women entrepreneurs in Africa

To understand how women entrepreneurs are using science and technology in Africa, UNESCO commissioned a survey in mid-2019 from Korchi International Affairs of women in ten countries, in partnership with the Africa Women's Forum, a pan-African non-governmental organization headquartered in Morocco with offices in several African countries.

Countries were selected for the study by the Africa Women's Forum based on geographical representation and the availability of Forum members to identify and interview local entrepreneurs. The ten countries surveyed were: Benin, Democratic Republic of Congo, Djibouti, Ghana, Madagascar, Morocco, Mozambique, Senegal, South Africa and Tunisia.

A standardized questionnaire was drafted in English and French (Appendix 1). The information received from respondents was used to identify their perceived level of use of science and technology, as well as the barriers that women-led start-ups face in the ten African countries surveyed. The survey also solicited the women's views on what policies were needed to support female entrepreneurship in Africa (Appendix 1).

The investigators who conducted the in-person surveys were activists working on women's rights, most of whom were members of the Africa Women's Forum. The investigators were financially compensated for their time. They were instructed to request interviews with women from diverse backgrounds: residents of both urban and rural areas, of varying ages, both with and without a tertiary education. However, for logistical reasons, the surveys were carried out in capital cities and their peripheries. Urban residents ultimately accounted for 81.0% of respondents and those living in peri-urban zones for a further 15.2% (Table 3). The investigators were instructed not to speak to the women's relatives.

In all, 427 women responded to the survey. Over half (52.5%) held a bachelor's or master's degree and a further 3.5% a PhD.

Naïma Korchi, co-ordinator of the present survey in her capacity as CEO of Korchi International Affairs and founder of the Africa Women's Forum, regretted being unable to interview more women living in rural areas. 'A growing number of initiatives are introducing women and girls to new technologies with the intention of increasing their presence in Industry 4.0,' she said, 'but these often exclusively benefit urban women who already have a higher level of education and access to technology. Rural women have expressed their disappointment to us that most forums invite educated, wealthy women but never illiterate women who may, nevertheless, be very active traders.'

The surveys were conducted simultaneously over a period of three months from October to December 2019. In each of the ten countries, 100 women were invited to answer the questionnaire. Some 60 women, on average, took up the invitation. Some were eliminated because they would only answer questions in return for payment. In at least one instance, the local police asked for a bribe to permit the survey to go ahead. In some cases, mistrust was a challenge, with one woman stating that 'it is the power in place that has sent you to register us for their political party' and another fearing that 'you want to steal our projects'. Some women feared that their responses would be used to enact or increase their taxes, including one woman who suggested the interviewer was sent to target members of the political opposition. Others participated in the survey but were unwilling to provide any details of the process or product that they had developed for fear of others benefiting from their 'secret'. Once all the responses had been transcribed and analysed, data quality control reduced the average number of respondents per country to 43.

Respondents were not obliged to answer every question, so the number of responses varied. Consequently, percentage values are calculated as the share of the total respondents

Table 2: **Share of female tertiary graduates in the ten African countries surveyed, by field, 2018 or closest year (%)**

	Agriculture	Engineering	Health & welfare	Natural sciences	ICTs	Social sciences & journalism	Business, admin. & law	Arts & humanities
Benin (2015)	60.5	54.6	63.7	54.9	55.1	61.5	61.4	56.8
Congo, Dem. Rep. (2016)	25.9	9.8	45.8	32.6	36.7	35.4	38.3	31.8
Ghana	26.8	16.4	60.9	26.8	19.9	40.1	44.8	43.5
Madagascar	41.2	18.5	67.9	37.3	33.6	46.0	53.8	52.3
Morocco (2017)	44.2	42.2	72.3	48.7	41.3	55.8	48.7	47.9
Mozambique	35.4	28.6	75.2	45.3	21.0	57.0	55.1	41.6
South Africa (2017)	52.2	32.2	74.9	56.4	38.4	68.3	57.3	73.2
Tunisia	73.9	44.2	75.3	77.2	55.6	77.3	71.3	74.4

Note: Data are unavailable for Djibouti and Senegal.

Source: adapted from UNESCO (2021); data from UNESCO Institute for Statistics

(or non-ambiguous responses) to a given question, unless otherwise specified. The full dataset is freely available from the *UNESCO Science Report* web portal at https://www.unesco.org/reports/science/2021/en.

The use of free-reply questions, rather than a scaled (Likert-type) ranking or multiple-choice question, had the advantage of allowing nuanced or unforeseen responses. This approach also helped the authors of the present study to identify (accidental) duplication among surveys during the final analysis. The points made were spontaneous and reflect the priorities, concepts and vocabulary evoked by respondents. However, this method may have contributed to the complaint from both the investigators and respondents that the survey took too long to conduct. As a result, some investigators may have taken shortcuts in transcribing the interview to compensate for the time spent on each interview. For researchers seeking to quantify the presence of particular challenges or opportunities, the use of a multiple-choice approach would be beneficial.

The surveys were often conducted using hard copies of the questionnaire, with the answers being transcribed later by the investigators or their assistants then submitted to UNESCO. Simplification and codification may have occurred at this stage in the process, as some responses show artificial similarities. When UNESCO conducted an additional codification at a later stage using a standard approach for the responses from all countries, it discarded some survey replies for this reason. For future surveys, it is recommended that the investigator submit the original, complete responses in the original language, along with their transcription of the interview.

SURVEY FINDINGS

Most respondents report using science and technology

Four out of five (79.6%) respondents said they used science or technology in their business (Table 4 and Appendix 2). This was the case for 66.7% of respondents over 55 years of age and 85.2% of those under the age of 25 years. Nearly half of the respondents were between the ages of 26 and 40 years (Figure 1).

More than one-quarter of the women interviewed had started a business in the food sector (26.9%) and one in six in textiles (15.7%). These were followed by beauty and personal care (7.6%), web platforms (6.9%) and digital marketing and services (5.7%), which included website design and blogging.

Some respondents underestimated the extent of their use of science and technology. For instance, one respondent sold medicines at her small pharmacy but denied using science and technology in her business. Among those who claimed not to use technology, the answers of 6.8% made it obvious that they did use digital technologies for at least part of their business. For example, one respondent who claimed not to use technology in her business added 'but I use WhatsApp'. Another said that 'I only fill in the data' for her business based on administrative services. One painter sold her work via the Internet but reported no use of technology.

Among those who reported using science and technology, the majority mentioned websites and online social networks such as Facebook and WhatsApp (Table 4). A smaller number mentioned specific production technologies, such as sewing machines, artisanal harvesting equipment, ovens or solar energy systems. Most of the products and services offered by the entrepreneurs in this study are small-scale with links to

Table 3: **Personal characteristics of the respondents based on self-reporting in structured questionnaires, total and by country, 2019**

		Share of respondents (%)						
	Number of respondents	Urban	Peri-urban	Rural	Post-secondary diploma	Bachelor's degree	Master's degree	PhD
Benin	38	89.5	5.3	5.3	18.4	34.2	36.8	0.0
Congo, Dem. Rep.	32	100.0	0.0	0.0	37.5	37.5	25.0	0.0
Djibouti	29	82.8	3.4	6.9	6.9	31.0	27.6	3.4
Ghana	55	65.5	32.7	1.8	0.0	49.1	5.5	0.0
Madagascar	39	46.2	53.8	0.0	38.5	15.4	2.6	0.0
Morocco	54	85.2	5.6	5.6	5.6	14.8	31.5	5.6
Mozambique	30	90.0	10.0	0.0	16.7	20.0	33.3	3.3
Senegal	51	92.2	5.9	0.0	13.7	23.5	19.6	5.9
South Africa	55	81.8	18.2	0.0	9.1	25.5	30.9	7.3
Tunisia	44	84.1	9.1	4.5	2.3	11.4	54.5	6.8
All countries	**427**	**81.0**	**15.2**	**2.3**	**13.3**	**26.2**	**26.2**	**3.5**

Note: The responses 'university' and 'degree' were classified as ISCED 6 (bachelor's degree or equivalent). The response 'diploma' was classified as ISCED 4 (high school completion). ISCED refers to the International Standard Classification of Education.

traditional cottage industries such as juice production, catering of local cuisine, tailoring or leather goods (Appendix 2).

Among the respondents who reported using science and technology, the largest share worked in the food sector (26.4%), followed by textiles (13.8%), services (such as accounting) [11.5%], web platforms (8.3%), beauty and personal care (6.9%) and digital marketing and services (6.6%) [Figure 2]. The respondents considered the use of machines to be an application of science. For instance, a respondent reported using 'dryers to dry the pepper and mills to grind the pepper, processing red hot pepper into well-packaged powdered pepper'. Another described her use of burners to melt aluminum to pour into molds to create cooking pots and utensils.

Usage of mechanical equipment and packaged technologies was common. Several entrepreneurs were involved in the bulk of the life-cycle of their product. For instance, one entrepreneur used cullers to harvest straw then a solar dryer and a sewing machine to join the edges into floor mats. Another described the equipment she used to grow, harvest, process, cook and package millet food products. One woman used machines to harvest, split and process bamboo into drinking cups.

Entrepreneurs drawn to lower cost of digital business

The women interviewed valued the low costs associated with a digital business. A 42-year-old entrepreneur from Tunisia wished people would 'communicate better on the advantages of the Internet to create a job without advancing a lot of money, which many women lack'. Korchi observes that 'young people, in particular, have understood the advantages in terms of lower start-up costs of launching online services such as bill payment platforms, catering, coaching or retail':

- 'As everything is done by Internet, there is no need for a lot of money at the moment' (24 years, Tunisia);
- 'Through my training and the Internet, it is possible to get started at a lower cost' (26 years, Benin); the same woman said that it is 'difficult for young people [in my country] to find work, therefore the Internet helps but clients do not always trust young people';
- '[My business growth has been] slow but at least the Internet allows me to sell without spending money by opening a store' (35 years, Djibouti);
- 'With the Internet, it's easy: you don't need a lot of money and you can reach a lot of people' (23 years, Tunisia);
- 'With the Internet, it seems less risky because one's costs are less' (32 years, Tunisia).

Internet is not a panacea, however. One 36-year-old entrepreneur who runs her own tourism agency in Djibouti said, 'I was a guide for an agency then I decided to create my own on the Internet because I cannot afford to rent a room and recruit a lot of people', but she planned to develop her business by recruiting to set up a traditional agency because 'some people do not trust the Internet'.

Nearly one-third of the women specified that they used the Internet (30.8%) and one in four (25.4%) reached out to customers via social media. Fourteen women noted that they used a computer directly in their work for tasks such as website creation, to adjust the drying time of their products or create clothing patterns. The majority of the entrepreneurs who mentioned social media and the Internet referenced

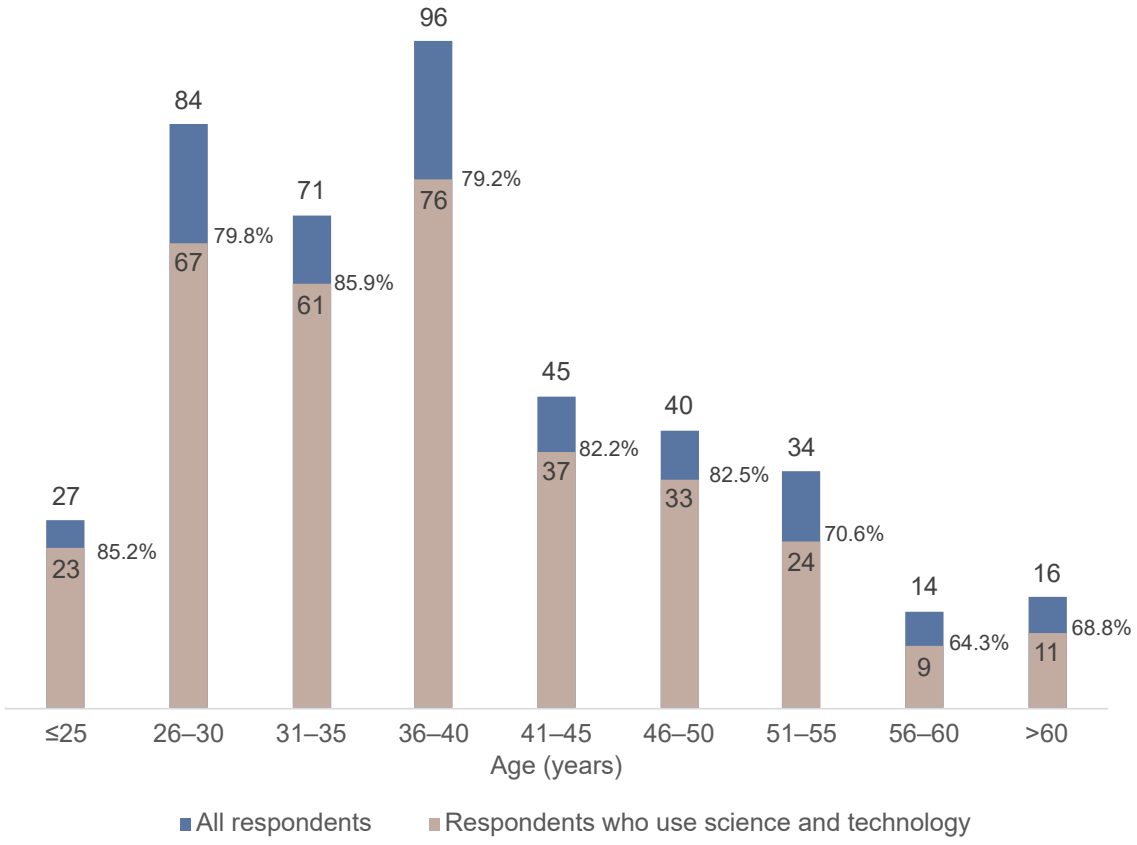
Table 4: **Extent of use of science and technology by respondents, based on self-reporting in structured questionnaires, total and by country, 2019**

	Share of respondents who specified (%)						
	using science & technology*	reporting innovation	holding a registered patent	having heard of an incubation hub	having been assisted by an incubation hub	using Internet	using social media
Benin	78.9	15.8	2.6	34.2	18.4	71.1	31.6
Congo, Dem. Rep.	81.3	53.1	0.0	90.6	68.8	15.6	46.9
Djibouti	100.0	0.0	0.0	20.7	13.8	100.0	44.8
Ghana	87.3	60.0	18.2	52.7	21.8	36.4	20.0
Madagascar	43.6	30.8	12.8	15.4	10.3	2.6	35.9
Morocco	88.9	3.7	0.0	50.0	20.4	74.1	68.5
Mozambique	56.7	10.0	26.7	43.3	36.7	33.3	20.0
Senegal	78.4	9.8	0.0	2.0	2.0	9.8	25.5
South Africa	83.6	38.2	7.3	52.7	40.0	27.3	29.1
Tunisia	88.6	4.5	9.1	27.3	20.5	52.3	43.2
All countries	**79.6**	**23.9**	**7.7**	**38.6**	**24.1**	**41.0**	**36.5**

* For a breakdown of science and technology usage, see Appendix 2. Usage of science and technology here includes coverage of social media and Internet.

Note: The shares of respondents in this table represent the share of the total number of respondents per country. Not all respondents answered each question.

Figure 1: **Number of respondents and share reporting the use of science and technology, by age group**



it when describing how they connect with their clients or suppliers, while only seven specified that they created websites for their clients.

One respondent said, 'the Internet allows women, even those almost illiterate, to make themselves known; [this gave me] a big chance, I could never have had so many customers in my village without its help'. According to Korchi, 'mobile Internet opens up new possibilities in the professional context. Street vendors working in the informal sector mobilize it for two main reasons: to stay in constant contact with their customers despite their mobility and to advertise their products cheaply by sharing photos and videos via WhatsApp and Snapchat.' The small sample size of rural respondents precludes further analysis of this group in the present study.

Entrepreneurs hesitant to claim or patent their innovation

In total, 102 women (23.9% of all 427 respondents) stated that they had innovated by developing a new process or product (Table 4). A further 24 (5.6%) expressed uncertainty as to whether they had innovated or not. 'I do not know if it is new' was a common response. Eight women stated that they had created an application for a mobile phone alone or in partnership.

Thirty-three of the 427 entrepreneurs (7.5%) reported holding a patent although the question may have been misunderstood, at times. When asked what difficulties they had encountered in registering their intellectual property with the patent office, 16 women mentioned investment groups like African Women Co-ordinated Investments in South Africa or regulatory authorities like the Food and Drugs Board in Ghana. The real figure for the number of women who had patented their invention may, thus, be closer to 17.

Among the problems encountered in registering their intellectual property, 17 women described the process as expensive and another five as lengthy and/or bureaucratic. One woman complained of a 'lack of information and guidance, especially on funding'. Another regretted being unable to 'find documentation on the Internet and a specialist lawyer to help me with the process'.

UNESCO (2021) confirms that 'the process for registering intellectual property remains costly and difficult to navigate for local inventors'. A 2017 study by de Andrade and Viswanath cited in UNESCO (2021, see Box 19.3) found that it cost over US$ 37 000 at the African Regional Intellectual Property Organization (ARIPO) and over US$ 30 000 at the Organisation africaine de la propriété intellectuelle (OAPI) to register and maintain a 30-page patent for the first ten years. This compares with US$ 5 216 in South Africa (which is

a member neither of ARIPO nor OAPI) and just US$ 2 500 in the UK. To compound matters, renewal fees (annuities) can be high. As a result, only 17 000 patent applications were registered in Africa in 2018, equivalent to 0.5% of the global total. Of these patent applications, only 18.4% originated from local residents, according to the World Intellectual Property Organization's statistics database. In the same year, the UK alone registered more applications for patent registration than Africa as a whole (20 941), of which 61.4% originated from local residents. UNESCO (2021) recommends that ARIPO and OAPI 'join forces to simplify online procedures for patent applications and significantly reduce the cost of pre-examination fees and services for young African innovators, university students and early-stage start-ups'.

Almost one in four respondents aware of local tech incubator

Of the 165 respondents (38.6%) who were aware of a local technology incubator (hereafter, 'incubator') or similar structure, 103 (24.1%) said they had received support from one (Figure 3). The type of support ranged from training (45 responses) to financial support (21 responses), equipment and co-working opportunities (Figure 4). Several respondents knew of women's associations or 'foreign aid agencies that provide training, especially for women', placing these in the same category as incubators. One respondent replied, 'No, they don't give money but training and [I had] no need', when asked if she had been supported by an incubator.

Women from the Democratic Republic of Congo were most likely (29 out of 32 women, 90.6%) to have heard of a local incubator and to have been assisted by one (22 out of 32 women, 68.8%). They were followed by South Africans at 52.7% and 40.0%, respectively (Figure 3).

Although more than one-third of women (38.6%) were aware of an incubator, only 24.1% had received assistance from one. Ghana and Morocco showed the largest 'assistance gap', with fewer than half of the entrepreneurs who had heard of an incubator having received assistance from one. One entrepreneur explained that, 'through these NGOs, in particular [I learned] how to use the Internet and they installed accounting software for me whereas, before, I did everything by hand'. Another said, 'There are associations that help women; they helped me to respect the rules of hygiene, packaging and conservation'.

Thirty women had not looked for an incubator or similar structure. One said, 'No, but now I'm going to look for one', when asked if she was aware of a local incubator. Another said, 'Yes, [I am aware]. A lot [of them are] owned by men.'

Figure 2: **Respondents by sector of activity (%)**

Among the 349 entrepreneurs who reported using science and technology, for sectoral categories accounting for at least 1% of respondents
Number of respondents given within brackets

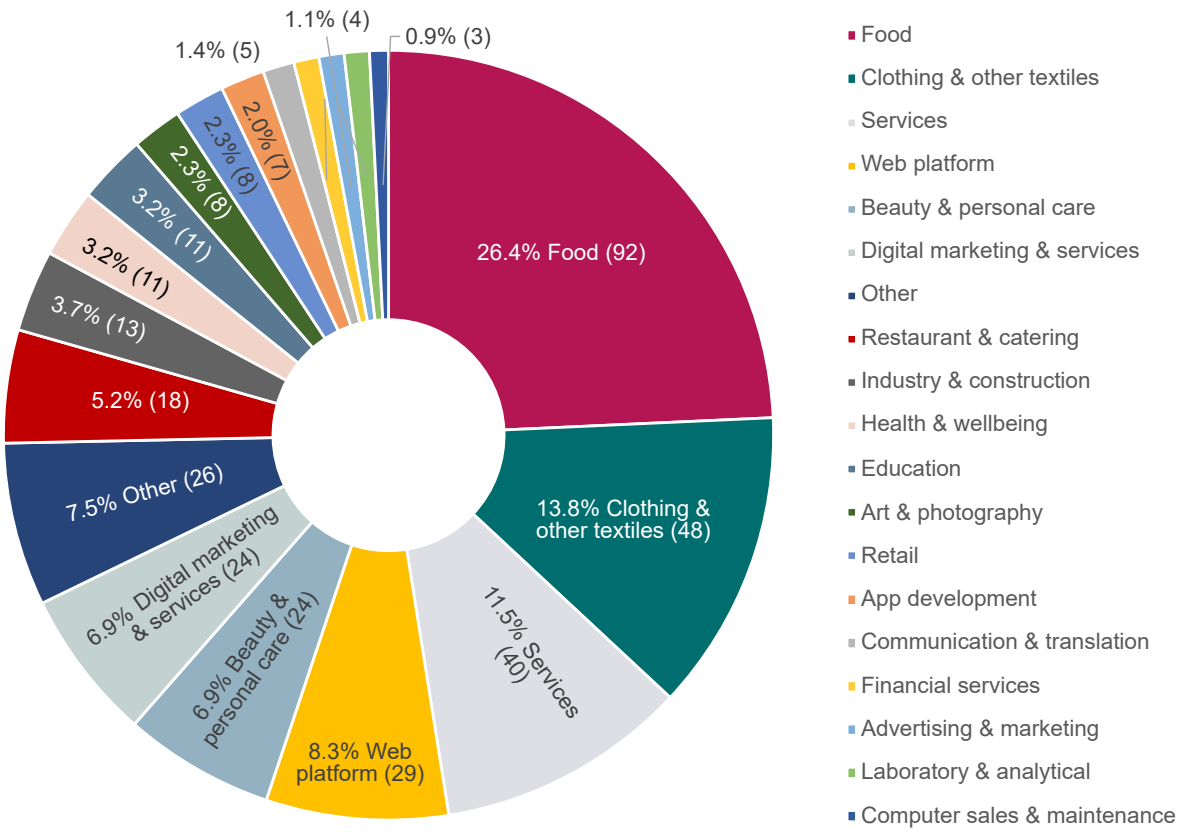
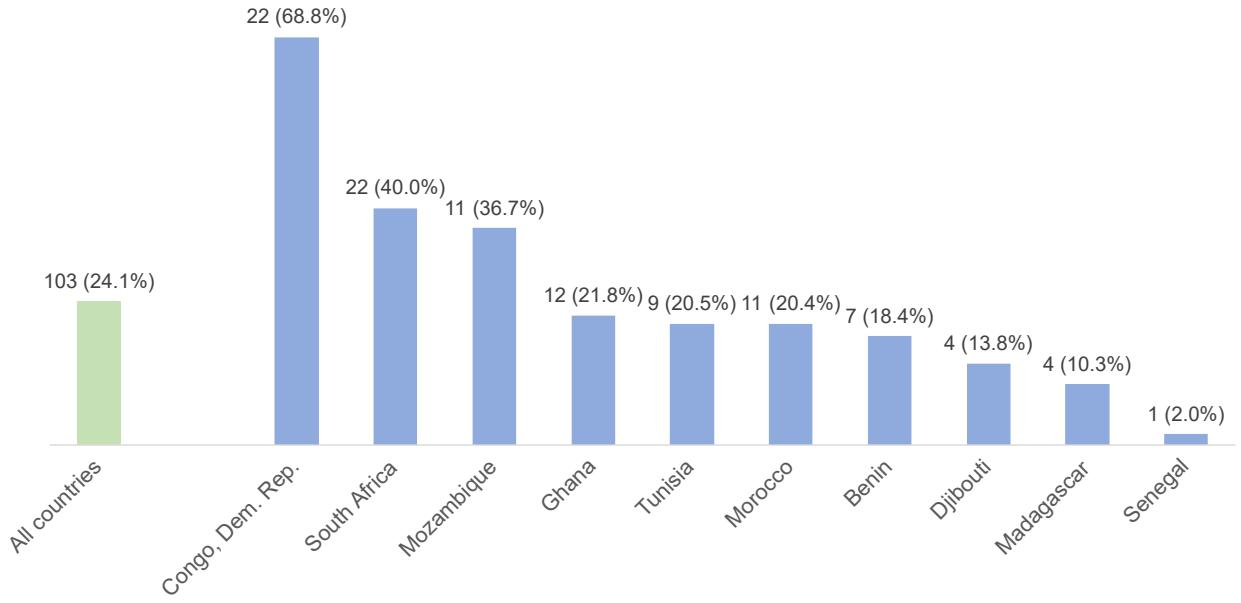


Figure 3: **Number of respondents assisted by an incubator, by country**

The percentage share is given within brackets



Incubators are often located in large cities, far from the homes of rural women. If a woman is her family's primary caregiver, she may find it especially difficult to be away from her family for a long period of time.

One in ten women motivated by lack of jobs or negative work experience

Fewer than 11% of respondents (46 out of 427) attributed their decision to launch their own business to a lack of employment opportunities or poor treatment at the hands of their previous employer. This was slightly higher than the share of respondents who took up entrepreneurship out of direct financial need (35 women).

The present study did not select for the year of establishment of respondents' businesses. The most long-standing business dated back to 1983 but the bulk had been established since 2009 (80.5%) [Figure 5]. Gender-disaggregated data on business survival in Africa are difficult to come by, although female-owned businesses in Ghana are known to close at a higher rate than male-owned businesses (Langevang *et al.*, 2015). As one of the survey respondents from Morocco noted, 'Legally, it is easy to be an entrepreneur but that does not mean it is easy to succeed, especially for women.'

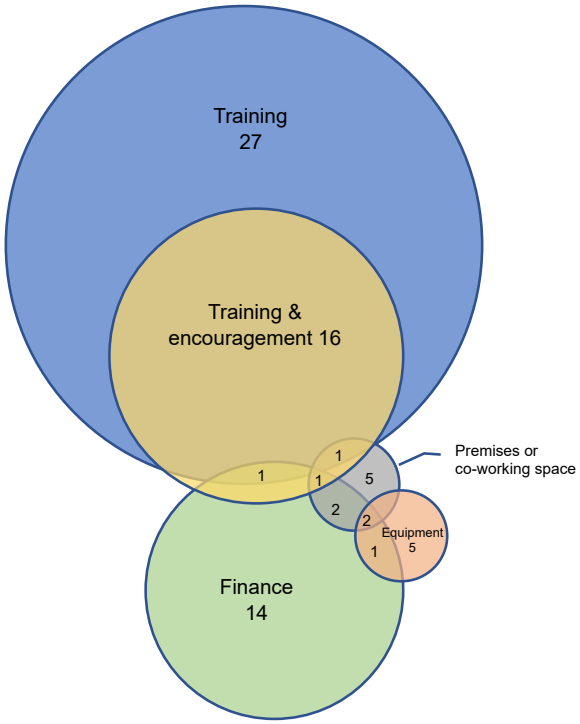
Access to finance greatest challenge for start-ups

The entrepreneurs were asked to identify the challenges they had experienced when starting their own business. Some 399 women answered this question (see Figure 6 overleaf).

Access to finance was the most commonly identified barrier (280 of 399 women, 70.2%) faced by the entrepreneurs when starting their own business. Of the 125 women who received start-up finance from a source other than a start-up incubator, one-third (42 respondents, 33.6%) had used their own funds or those of their family or close friends (Table 5). Sixty-two (49.6%) reported obtaining a bank loan. Another eight interviewees (6.4%) mentioned having accessed microfinance. None of the respondents mentioned online crowdfunding or peer-to-peer lending as the source of their start-up finance. Some expressed concern that instability in their country might restrict investment.

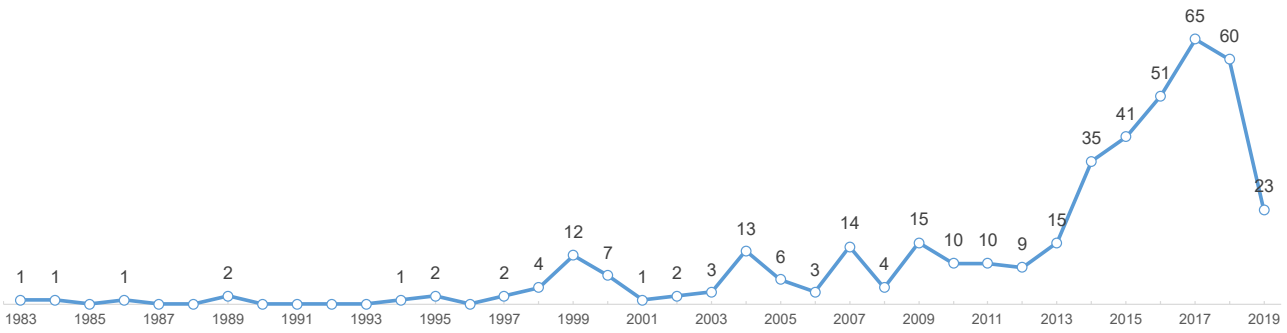
Figure 4: **Type of assistance received by respondents from tech incubators**

The number of respondents is given in each circle



Note: Of the 99 women who said they had received assistance from an incubator, 75 specified what kind. Some had received more than one form of assistance. Software (specified once) was categorized as equipment. One of the women trained also received equipment.

Figure 5: **Number of surveyed businesses by year of establishment**



The ease with which a business accesses finance may affect its development. According to Korchi, 'the funding problem prevents [women] from recruiting qualified staff, thus forcing them to do everything alone or to hire relatives, which ultimately makes their business local in nature for the most part.'

The lack of a bank account and credit card penalizes both entrepreneurs and their customers, as they are a precondition for making or receiving digital payments. The share of the total population with a bank account varies strongly among the countries under study (Table 6). Female entrepreneurs may find it harder to access financial services than their male counterparts, judging from the World Bank's 2017 *Global Findex Report*, which found that 37% of women in sub-Saharan Africa held a bank account, compared to 48% of men, this gap having widened over time.

Access to financial instruments may be limited for start-ups, particularly those operating on a small scale and in common sectors such as food and catering. Women may also be more likely than men to lack sufficient guarantees or personal equity (World Bank, 2018; Ojong *et al.*, 2021). There is a general perception that women pursue the same types of business as each other, leading to competition for finance and markets, a perception that is supported by data for the sectors of agriculture, food processing, retail and other services (Ojong *et al.*, 2021 and references therein). This problem was mentioned by two respondents. One said that 'we hope to spread to other cities but the problem is that there is a lot of copying as soon as an idea works, so there are others in the same sector'. The second observed that, 'in the beginning, [business went] well but already three people [have started to] do the same'.

That said, the perception of reduced access to start-up credit may outweigh the actual limitations. According to Morsy *et al.* (2019), the probability of a female manager in an African country self-selecting against applying for a loan because she assumed it would not be approved is more than four times greater than the corresponding probability for a male manager, despite a lack of gender-based discrimination by financial institutions and no difference in objective creditworthiness between male- and female-managed firms. When Morsy *et al.* (2019) studied manager behaviour

Table 5: **Number of respondents who received start-up finance from a source other than a start-up incubator**

	Number
Bank	62
Personal funds (incl. family)	42
Microfinance	6
Philanthropic organization	5
International aid	3
Non-governmental organization	3
Private loan	2
Women's co-operative	2
Total	**125**

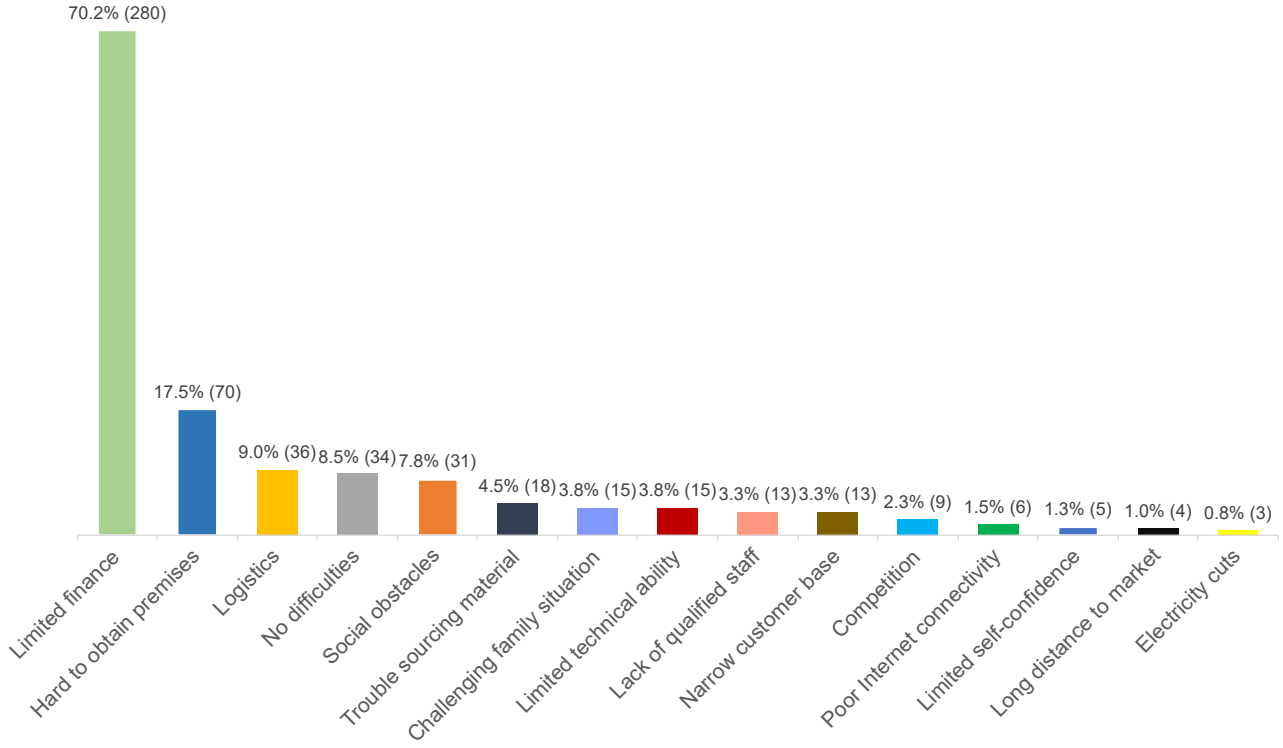
Table 6: **Share of population aged 15 years or above holding an account at a financial institution or with a mobile money service provider, by country, 2017 (%)**

	Share of population (%)
Benin	38.5
Congo, Dem. Rep.	25.8
Djibouti (2011)	12.3
Ghana	57.5
Madagascar	17.9
Morocco	28.6
Mozambique	41.7
Senegal	42.3
South Africa	69.2
Tunisia	36.9

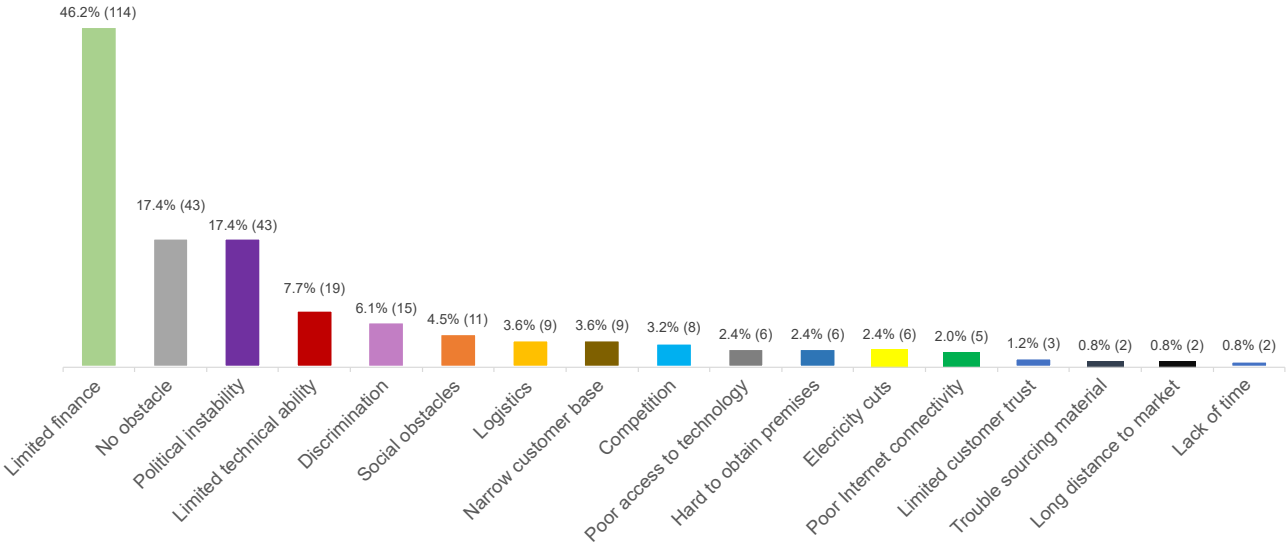
Source: Demirguc-Kunt *et al.* (2018)

Figure 6: **(A) Difficulties experienced by the respondents in creating or developing their business and (B) obstacles they identified for those starting a similar business today**

(A) What are the main difficulties you have encountered in creating and/or developing your business?
(399 total responses)



(B) What obstacles are there in the current climate for developing a business like yours?
(247 total responses)



Note: A single entrepreneur could report multiple obstacles. 'Social obstacles' includes challenges related to social attitudes and language barriers. The grouping 'technology' includes responses that refer to access to technologies or use of technologies; by contrast, 'lack of technical ability' includes responses that suggest a lack of training or technical problems. 'Electricity cuts' encompasses responses indicating an insufficient electricity supply, frequent power outages or cuts.

in 47 African countries over 2006–2016, they found that 'women entrepreneurs in Africa, in general, and in North Africa, in particular, are more likely to self-select themselves out of the credit market due to low [self-]perceived creditworthiness compared to their men counterparts' (Morsy *et al.*, 2019).

There are signs of positive change in the tech industry at large: the number of African tech start-ups obtaining venture capital grew exponentially between 2015 and 2020 from 55 to 359 (BCG, 2021). However, the gender gap remains strong in start-up funding for the tech industry: over the period from January 2019 to April 2020, 13.4% of African tech start-ups and small or medium-sized enterprises receiving venture capital were (co-)founded by women, yet female (co-)founded companies were allocated 5.7% of venture capital in 2019, a share that even dropped to 3.2% in the first four months of 2020 (Briter Bridges, 2021).

Digital transition a challenge for informal sector

In several of the countries analysed, there is a large informal sector (Figure 7). In many cases, this is due to financial, administrative and other barriers to establishing a formal business. Previous studies have demonstrated a tendency for entrepreneurs with higher levels of education to register their business formally, including in Ghana and Morocco (see Ojong *et al.*, 2021).

The interviewers reported difficulties in filling out the requested surveys because many entrepreneurs had not registered their businesses and were reluctant to share their personal details. Korchi describes how, 'in the Democratic Republic of Congo, it was difficult for our team to interview women. Many mistook the interviewer for a representative of the state conducting a census to ask for taxes. Other potential interviewees asked to be paid or for police authorization or expressed distrust of strangers 'stealing' their ideas. Many interviewees also identified instability in their country as a key factor discouraging them from launching or developing their own business, despite business opportunities.' Of the 32 women in the Democratic Republic of Congo who agreed to be interviewed, 29 worked in the informal sector, primarily because they lacked the financial means to set up a formal business.

Numerous African countries have adopted strategies to accelerate the use of digital technologies in public administration as a means of improving public service delivery, including by making it easier to register a new business. By limiting the informal economy, governments also hope to increase tax revenue and combat corruption and tax evasion. Achieving this will entail broadening access to Internet. For instance (UNESCO, 2021):

- In 2018, Djibouti initiated a four-year Public Administration Modernization Project. Supported by the World Bank, it envisages the roll-out of digital systems to improve citizens' access to services and boost government revenue by making tax and customs administrations more efficient.
- Tunisia's government proposed a digital payment system in 2018, in part to help limit tax evasion in a country where the share of the labour force working in the informal sector is estimated at 42%.
- The *Digital Morocco 2020* strategy (2016) aims to place half of all government administrative procedures online and ensure that one-fifth of SMEs have Internet access.
- Since the *Ghana Digital Agenda* was adopted in 2017, a range of public institutions have migrated to digital platforms. Moreover, regional community information centres have been built across the country since 2013 to bring e-government services directly to communities.
- Madagascar is exploring e-governance to improve the delivery of public services. Currently, nearly all public services are carried out in person. A law passed in 2018 (#027) called for the establishment of a national civil registry and identification centre. The same year, the government created a Digital Governance Unit to implement Madagascar's *Digital Governance Strategy* (2019). Within this framework, a project is being implemented to establish an interoperable civil registry and introduce streamlined digital services for both citizens and businesses that adhere to the 'once-only' principle, within the Digital Governance and Identification Management System Project financed by the World Bank.

The digital transition creates uncertainty for informal businesses which may not be in a position to adopt digital payment systems in a timely manner, such as if they or their customers lack bank accounts and credit cards.

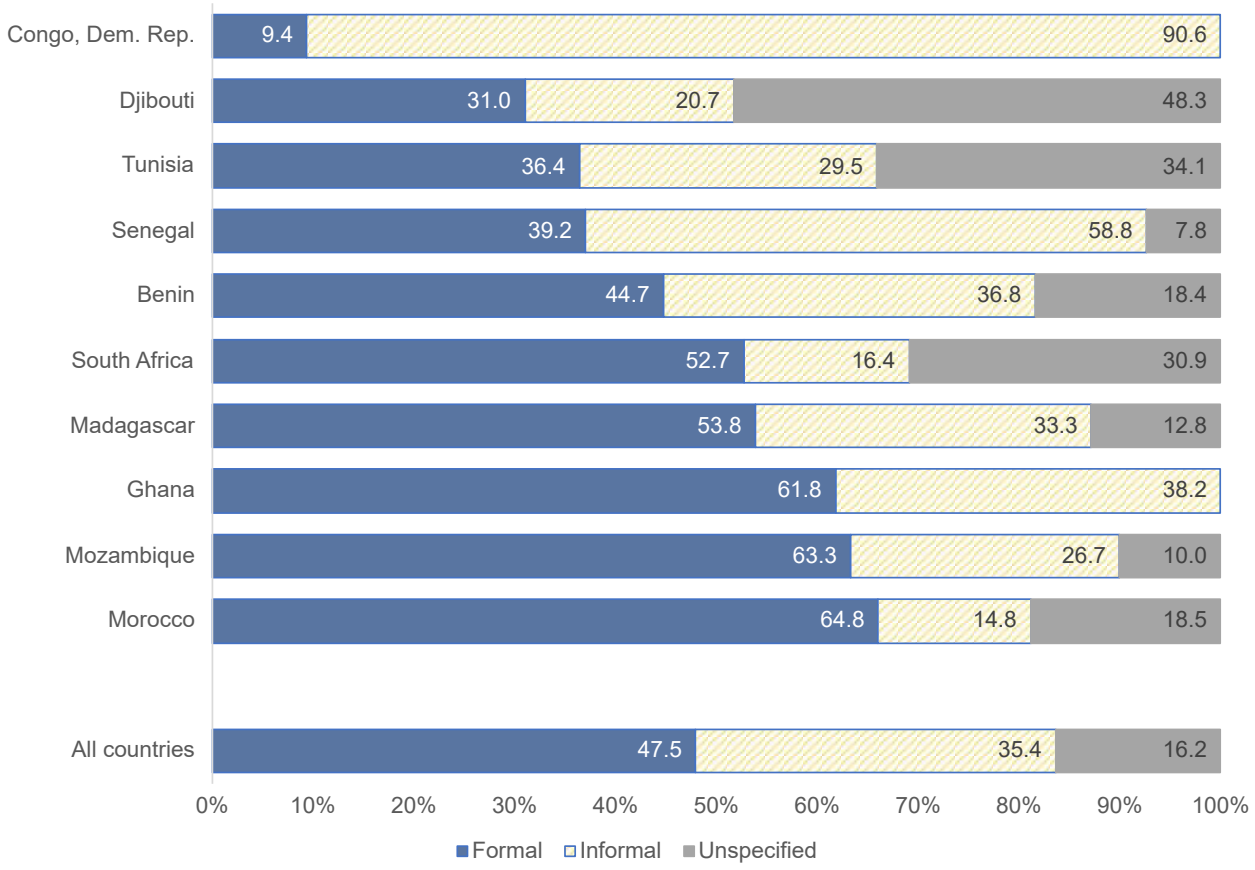
Most women backed by their immediate family

Female entrepreneurs consistently mentioned the importance of support from their family and partner when it came to obtaining finance, technical assistance and labour. In many cases, entrepreneurs' own children and immediate family worked in their business. Some women had started their business after their husband died or after a divorce.

Women prized support from their partner. It is noteworthy that 85.1% of the interviewees who responded to the question about their partner's opinion said that they were either supportive or very supportive of their business. Five entrepreneurs specified that their partner had initially been opposed to the idea before eventually accepting it. One said that her partner had been 'against at first, and [when] I started to earn money, he changed his mind'. Another entrepreneur said that 'he didn't want [me to start a business] at first because of the harassment'.

Only 11.6% of respondents cited social or family challenges, although several entrepreneurs alluded to social pressures that often carried a financial cost. Almost one in five (18%) of the women mentioned having encountered difficulties in finding premises or land for their business (Figure 6).

Figure 7: **Share of respondents with a formally registered business, by country (%)**



One respondent explained the need for additional funds to rent office space by the fact that 'people are sensitive to appearances and therefore [if we] make an appointment [with a client] in a cafe, they do not take us seriously'. Another 1.3% (five respondents) noted the psychological challenge of starting a new business as a woman, requiring effort to overcome 'being female in the head'.

Entrepreneurship was seen as an activity for the young. One 26-year-old Tunisian entrepreneur remarked, 'As I am young, [my husband] lets me try and, if it doesn't work, I can look for another job'. By contrast, a 45-year-old entrepreneur, also from Tunisia, said her family's reaction was 'good but with some fears because of my age and little experience of entrepreneurship'.

Although there are examples of successful women entrepreneurs in small business and in new technologies, such women lack visibility, especially in Africa. Their lack of visibility limits the extent to which they can serve as positive role models for other women. In responding to the question 'Why did you become an entrepreneur?' several respondents stated that they had been inspired by examples they had seen of other women (Box 1).

Women see fewer obstacles for next generation of start-ups

Some 245 entrepreneurs replied to the question, 'What opportunities and obstacles are there in the current climate (social, economic, etc.) for developing a business?'

The entrepreneurs were more optimistic about the present situation, with 17.6% (43) believing there were no specific obstacles today, compared to 8.8% (35 out of 280) who did not recall having experienced any obstacles when starting their own business years earlier (Figure 6).

Finance remained the greatest concern, with 46.5% (114) of respondents identifying access to finance as an obstacle for new start-ups in their country. Many of the suggestions or requests for training specified financial training, in particular, including support to understand how to access finance and navigate the logistical hurdles associated with applying for grants and loans or accessing financial mechanisms such as tax incentives.

When asked to cite obstacles to setting up a new business, 3.6% (9) of interviewees cited logistical problems as a challenge for businesses today, such as lengthy forms and bureaucratic procedures ('red tape') that were either hard to understand, expensive or time-consuming.

This is lower than the share who had actually experienced logistical problems when establishing their own business (8.8%, 35 out of 398). Although the entrepreneurs felt they had strong customer support and local interest, some expressed concern (3.7%, 9 of 245) about the sustainability of the purchasing power of their local customer base (100 respondents referred to financial challenges but it was not clear whether these were experienced by the entrepreneurs themselves or their customers). A further 6.5% (16) of respondents identified a need for training and 6.1% (15)

noted that they had experienced gender discrimination. Corruption was only specified by one interviewee, who said that 'women are not helped much in my community. The mayor supports women who help his election campaign but my friends and I have not received any help.' However, concern about corruption was one factor limiting the number of entrepreneurs who agreed to respond to the survey (see Introduction).

Although technologies can provide opportunities, the cost of Internet connections and of smartphones is still high in most of the countries under study (Table 2). Despite this being a familiar issue, few respondents mentioned electricity cuts (6 respondents, 2.4%) or Internet connectivity problems (5 respondents, 2.0%).

Interviewees recommend more access to finance and training

Through two questions,[3] the interviewees were asked to recommend means of support for entrepreneurs like themselves (Table 7 and Figure 8). One-third of respondents called for gender-specific support, across a range of support types.

There were strong calls for policies to facilitate access to finance, such as loans or grants, tax incentives or credit repayment schemes tailored to women's needs. The desire for clarity about eligibility for finance was a common request.

In the countries under study, one innovative financial mechanism deserves special attention: Tunisia's Start-up Act (2018) provides a number of legal and financial incentives for qualifying early-stage enterprises, such as corporate tax exemptions and mechanisms for financial support. About 250 start-ups have received support, financial or otherwise, within the framework of this act. The Start-up Act is also purportedly the world's first legal framework to grant aspiring entrepreneurs year-long leave, extendable to two years, to set up a new business with a state-funded salary during the first year of operation (UNESCO, 2021). This initiative could be particularly helpful to female entrepreneurs.

Another good practice is Senegal's Sovereign Fund for Strategic Investments (est. 2012); it uses state revenue from oil and gas to invest in capital funds targeting SMEs in sectors prioritized by the *Senegal Emerging Plan* (2014), such as solar energy, agriculture and health (see Box 18.4 in UNESCO, 2021).

According to UNESCO (2021), the French-speaking countries of West Africa are currently enjoying financial support from France, Senegal and the African Development Bank to boost SMEs and the subregion's digital ecosystem. These countries also have some of the fastest-growing ecosystems for tech hubs, due in part to the efforts of business angels to bridge the investment gap with their English-speaking neighbours.

Training was the next priority identified by the respondents. They often recommended specific training in how to access or manage finance, alongside training in how to navigate logistical hurdles to ensure the successful launch and day-to-day operation of an independent business. Given the hesitation to use incubators shown by the respondents to the present survey, the creation of an incubator will need to be accompanied by shifts in social understanding and willingness to use inclusive, accessible start-up incubators.

Following finance and training, the entrepreneurs prioritized policies in support of equity and inclusion (23 respondents, 8.9%) and fair governance (23 respondents, 8.9%).

The ten rural women surveyed spoke positively about their businesses but regretted the distance they needed to travel to reach incubators and training. One mechanism designed to overcome this challenge is South Africa's Grassroots Innovation Programme (2019), which provides social entrepreneurs and innovators in townships and rural areas with technical and financial support (UNESCO, 2021).

Box 1: 'Why did you become an entrepreneur?'

- 'With the Internet it's easy, you don't need a lot of money and you can reach a lot of people.'
- '[I wanted] to be able to do everything, touch everything and develop multiple skills and get started and have no regrets.'
- '[I wanted] to contribute to society by creating jobs and innovating.'
- 'I want to take advantage of the country's digital policy; wages are very low in other sectors.'
- 'I am from the start-up generation.'
- '[I did it] because I would like to create a solution that has a social impact and be financially independent.'
- 'I want to develop and contribute to the prosperity and progress of my country.'
- '[I did it out of] necessity and I saw on TV that it worked well in France, so I wanted to try'.
- '[I was] motivated by the success of others in the same sector'.
- 'I saw a lot of success and I wanted to try; my husband's salary allows us to maintain our home so it motivated me more'.
- 'I saw on social networks that it works super well'.
- 'I have seen many people succeed with simple ideas'.
- 'Many around me are entrepreneurs'.
- 'I want to regain control over my life.'
- 'I love being independent.'
- '[I did it] for my daughter.'

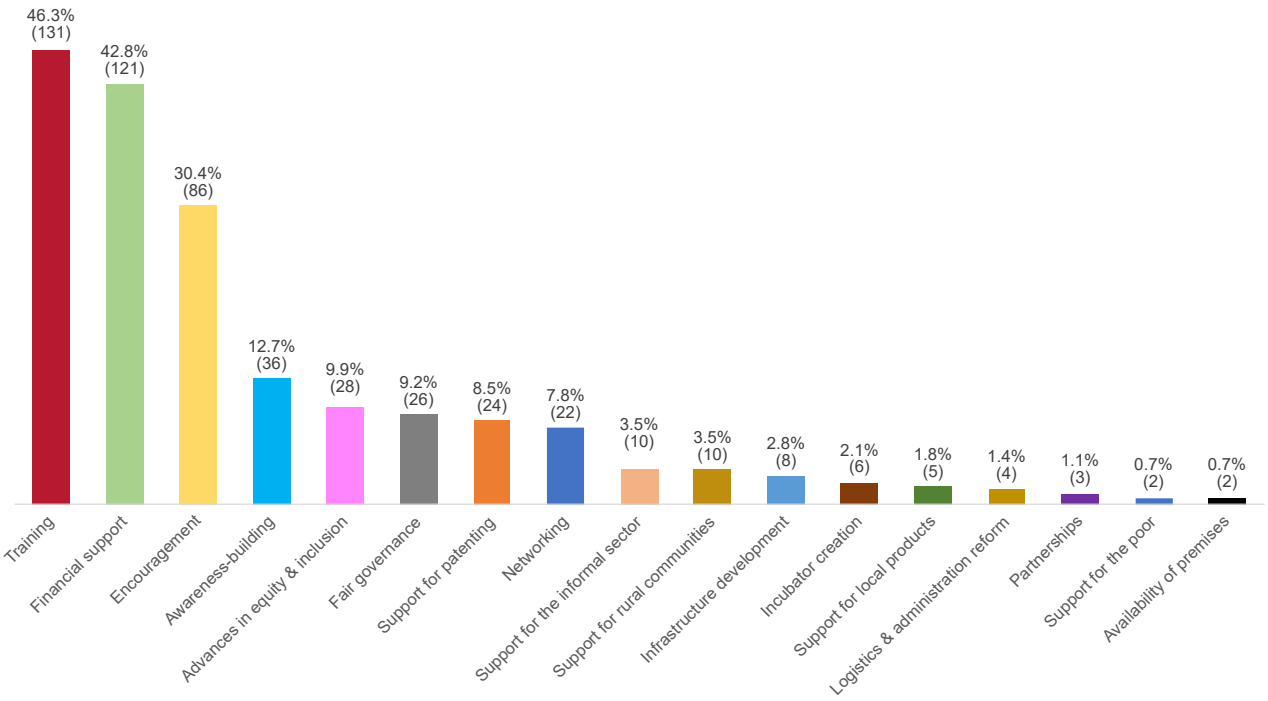
Selected quotes from UNESCO survey respondents, 2019

Table 7: **Measures proposed by respondents to bolster support for women entrepreneurs**

Financial support and taxation practices
There should be more financial support for women without capital of their own.
More resources should be provided for women entrepreneurs, especially in the new technology and science sectors.
The government should provide women-led businesses with tax exemptions to help them grow.
Women who employ personnel should pay lower taxes.
The government should help women to acquire premises.
Women entrepreneurs should receive both financial and psychological support.
Finance should be provided for informal businesses.
Women entrepreneurs should receive sufficient credit at a reduced rate compared to what is currently applied on the market, with the start of repayment deferred by six months or one year.
Provide women entrepreneurs with loans at a lower interest rate.
Provide women entrepreneurs with flexible loans.
Create special funds for women entrepreneurs, particularly young women, and otherwise give them priority for financial support.
Introduce a policy of subsidies to support women entrepreneurs.
Introduce financial measures to support women entrepreneurs who fall sick and have no-one to replace them during their illness.
Intellectual property
Reduce the cost of registering a patent.
Provide guidance on the availability of financial support to reduce the cost of registering a patent.
Shorten the process for registering a patent and make it less bureaucratic.
Provide guidance on how to register one's intellectual property, including access to specialist lawyers.
Trade
There should be a reduction in imports [that compete with local products].
Measures should be put in place to counter unfair competition.
Local products should be popularized.
Women entrepreneurs should receive financial aid to facilitate their importation [of raw materials] and exports of their products.
There should be stronger collaboration between women entrepreneurs and the Ministry of Commerce and Industry, or its equivalent.
The circulation of goods within Africa should be facilitated.
Training
Women entrepreneurs, particularly young women, should be given priority in training programmes.
Workshops should be created for young leaders.
A policy should be adopted to develop professions linked to new technologies.
Women should be provided with more training in formal entrepreneurship to help them leave the informal sector.
A learning establishment should be created specifically for women entrepreneurs.
Women should receive support in business management.
Connectivity
Better connectivity should be provided in rural areas.
Faster bandwidth should be provided across the country.
Foster universal access to Internet and encourage businesses and administrations to use new digital technologies.
Miscellaneous
Administrative procedures should be made easier to support young women entrepreneurs.
There should be more incubators outside big cities to support young women entrepreneurs.
Women artisans should be encouraged to form collectives to foster mutual support and networking.
Women entrepreneurs should be encouraged to group themselves in an institutional structure to subsidize their costs.
Scientific research should be encouraged.
Provide more spaces for women who want to start their own business.
Provide access to experts on technical subjects like data confidentiality.

Figure 8: **Respondents' priorities for bolstering support for women entrepreneurs, by category**

(258 total responses)



Some 100 innovators were enrolled in the programme in 2019 to help them develop their concept and commercialize their ideas (UNESCO, 2021).

Low tech can make a social impact too

At least eight of the women interviewed had created an application for mobile phones or were in the process of doing so. All were focusing on providing services to underserved populations, including other women. Such applications included safe ride-hailing services for women, home-help services and information for university students.

There is growing interest in Africa in creating local opportunities to innovate while shrinking the digital gender gap. For instance, in Tunisia, the World Bank launched the Empower Her initiative in 2016 with a series of workshops and hackathons for 87 unemployed youth selected from a pool of over 300 applicants (Haddad, 2018). All of the hackathons were held in the poorest interior regions of Tunisia. In December 2019, the Ministry of Communications announced the three winners of its first Miss Geek Ghana competition for budding software app developers aged 13–25 years. In addition to cash prizes, the young women received business training and financial support to develop their socially innovative project (see chapter 18 in UNESCO, 2021).

Regional efforts may also support some entrepreneurs in the countries under study. Google's Launchpad Accelerator Africa provides African start-ups specializing in artificial intelligence with equity-free support, access to Google engineers and intensive mentoring, as well as training in public relations. It accepts applications from top seed-stage African start-ups located in Ghana, Morocco, Senegal, South Africa and Tunisia, among other countries (see Box 18.2 in UNESCO, 2021). The digital platform Engage, launched by the Islamic Development Bank in February 2018, has been designed to serve innovators and small and medium-sized enterprises, among others, with technology transfer and calls for proposals in the field of innovation (see Box 17.2 in UNESCO, 2021). The aim is to promote ways to use science and engineering to achieve the Sustainable Development Goals.

These initiatives all have in common a declared focus on advanced or high-tech digital solutions, including 'prestige' technologies such as machine learning. In practice, high-tech projects and applications involve a minority of the population in their creation and use, particularly when the consumption of a product or service itself relies on the mastery and possession of advanced technologies. A product or service that meets the needs of a large segment of society may be worth the investment, even if the underlying tech is simple.

For example, traditional sun-drying is a common method of food preservation in Burkina Faso but can lead to post-harvest losses of 50% for fruits. As a result, gas-powered dryers have begun to dominate for industrial purposes, imported solar-dryer systems being too costly for local farmers (Udomkun *et al.*, 2020). Burkina Faso is a lead supplier of dried fruits, such as mangoes, to Europe. Drying fruit extends its shelf life and market potential, an important step towards food security during weather or seasons inclement to local food production. Dried fruit provide a reliable source of essential vitamins, which can be stored on a long-term basis without the need for electricity (Udomkun *et al.*, 2020). A local

innovation to reduce the post-harvest loss of fruits could have a significant, far-reaching impact for local food security and the established export trade in dried fruit.

These factors are present in the minds of entrepreneurs. For instance, an entrepreneur in South Africa who crushes sugarcane and ferments it to produce alcohol at her own distillery said that 'climate variability has benefited me due to a recent great yield of sugarcane due to continual heavy downpours'. A respondent from Ghana set up a solar oven with the help of a friend and now sells solar-baked pastries as well as local beverages treated to have a longer shelf life. The use of a centrifuge facilitates the production of fruit and vegetable concentrates for an entrepreneur in Madagascar, where another prepares a stable dried powder of moringa leaves.

Given both the societal expectation and the tendency for women to focus on their family's and communities' needs, female entrepreneurs may be more likely to focus on practical applications of low-cost technologies or large-scale service delivery, such as in the agricultural or food sectors.

CONCLUSION

Maximizing entrepreneurship opportunities for women may require a change in mindset

The majority (80%) of the 427 women interviewed in the course of the current survey identified themselves as users of science and technology. Women used a range of technologies in their business, from traditional and solar ovens to sewing machines, digital design software and social media networks. Some of the women may have underestimated the extent of their own use of science and technology, judging from responses such as 'I don't use technology but I do use WhatsApp'.

Respondents reported using technology to create products but also to reach their customers and expand their business, such as via social media. The lower cost of launching a business with online marketing held strong appeal.

The respondents were highly sensitive to others' perception of their business' potential, their status in society as a female entrepreneur and the type of opportunity available to women like themselves. Given this sensitivity, it is noteworthy that 85% of the women said that their partner had been supportive of their project. Knowledge of other female entrepreneurs was also a common factor in persuading women to launch their own business.

Seven out of ten respondents identified difficulties in accessing finance as the most common barrier to entrepreneurship. This was followed by logistical difficulties, such as bureaucratic processes and in the obtention of office premises. There were strong calls for policies to facilitate access to finance, such as loans or grants, tax incentives or credit repayment schemes tailored to women's needs. One common request formulated by the entrepreneurs was for greater clarity about their eligibility for finance.

One factor preventing some entrepreneurs from applying for finance was the informal nature of their business. A growing number of African governments are introducing electronic payment services and digitalizing other government platforms in order to make it easier to register a new business, reduce the size of the informal sector and combat tax evasion and corruption. In countries where the traditional informal business culture persists and cash payments are the norm, entrepreneurs may need support to help them transition to a more digital business model.

Although 39% of the respondents were aware of the existence of a local technology incubator, only one-quarter of these women had received support from one. It was common for the entrepreneurs to assume that they did not qualify for this form of support. This suggests that technology hubs need to do more to advertise their services to start-ups led by women, including those living in rural areas.

After finance, the next priority identified by the respondents was training. The women were particularly keen to learn how to access or manage finance and navigate logistical hurdles to ensure the successful launch and day-to-day running of their business. For more than half of the women who had received support from a tech incubator, this assistance had taken the form of training. Among women who had innovated, there was a strong demand for guidance on how to register their intellectual property. One reason why some women refused to be interviewed for the present survey was the fear of their idea being copied by others.

The third priority for reform advocated by the respondents concerned policies in support of equity, inclusion and fair governance. This priority overlaps with the aforementioned priorities related to finance and training.

The present survey has underscored another prerequisite for a successful business: self-confidence. Although the primary impediment to entrepreneurship identified by the interviewees was a lack of finance, an even bigger hurdle seems to be the women's own inhibitions about their capacity to convince potential funders to support their start-up.

According to Korchi, 'this self-limitation can be demonstrated by women's low participation in start-up competitions: as an example, while adjudicating at EDF Pulse, a large event in 2019 supporting African start-ups held in Casablanca for Moroccan entrepreneurs, I asked about the problematic absence of female candidates. I was told that none had applied. This trend is confirmed by a young entrepreneur in technology, Doha Margulies, who regularly participates in this type of competition. Sometimes she is the only woman; at best, the number of women does not exceed 10 candidates'. She goes on to say that 'two other women justified this se0lf-censorship by society's perception that everything related to new technologies is the domain of men. Instead of facing other men or losing to them, they refrain from participating.'

Her words echo the findings by Hattab (2012), who assessed survey responses from ten Arab countries, including Morocco, which participated in the 2009 cycle of the Global Entrepreneurship Monitor. Hattab noted the low economic participation of women (28% of adult women in

the Middle East being economically active in 2010), despite their declared interest in entrepreneurship: 75% of Moroccan women considered starting their own business to be a desirable career choice and 67% felt they had the requisite knowledge and skills to start a business but 29% said that fear of failure would prevent them from doing so. This suggests that policies designed to foster entrepreneurship should find ways to reach out to women who may wrongly assume that they do not qualify for such incentive measures.

What makes a person decide to start their own business? It can be difficult to gauge from data on business creation whether a given entrepreneur saw starting their own business as an opportunity or a last resort, such as in the absence of salaried job opportunities. Only one in ten respondents to the present survey attributed their decision to launch their own business to a lack of employment opportunities or poor treatment at the hands of their previous employer. This finding contradicts the preconception that women launch their own business for lack of other career options. When Anambane and Adom (2018) surveyed 20 female entrepreneurs in the Nabadam district of Ghana, they found that educated women were expected to seek formal employment, since entrepreneurship was perceived as a field for uneducated women who had trouble finding a salaried position. The evidence suggests the contrary. Abor and Biekpe (2006) found that the level of education was higher among female Ghanaian entrepreneurs than their male counterparts.

Indeed, it would be a mistake to assume that the respondents to the present survey were uneducated. More than half held a bachelor's degree or higher in all but Madagascar (18%) and Senegal (49%) [Table 3].

The survey responses indicate that social attitudes towards women entrepreneurs, including women's own self-perception, are as much of a barrier to success as the practical availability of funding, training and licensing. National efforts to spur tech-driven start-ups face a disproportionate gender gap in access to modern technologies and a reluctance among women to delve into a space still dominated by men. For instance, one 35-year-old entrepreneur operating a legal aid platform with five employees said that female entrepreneurs in her country faced obstacles in obtaining financial, material and cultural resources. She concluded from this that 'the world of new technologies is still dominated by men.' Another respondent had some advice for her: 'Women should believe in themselves and their abilities'.

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ENDNOTES

1 The gender parity score is calculated as the proportion of women who use the Internet divided by the proportion of men. A value smaller than one indicates that men are more likely to use the Internet than women, whereas a value greater than one indicates the opposite. Values between 0.98 and 1.02 indicate gender parity. See: ITU (2020).

2 A further 11 countries have signed the Malabo Convention: Benin, Chad, Comoros, Republic of Congo, Guinea-Bissau, Mauritania, São Tomé and Príncipe, Sierra Leone, Togo, Tunisia and Zambia.

3 The two questions were: 'What policies would you like to see implemented in your country to promote the development of businesses like yours and to support female entrepreneurs?' and 'What else should be done to encourage more women to become entrepreneurs and invest in new technologies?

APPENDIX 1

Questionnaire: How are women entrepreneurs in Africa using science and technology?

	Question	Notes
1	What is your name and surname?	
2	How old are you?	
3	What is your marital status? Select from: · Married · Single · Widowed · Divorced or separated	
4	Do you live in the city or suburbs?	
5	What is the highest level of education you have achieved (if relevant, title of diploma, degree)?	
6	If you are a graduate, what is your area of specialization?	
7	When did you start your business?	
8	Why did you decide to become an entrepreneur?	
9	How did your spouse or partner react to your decision (if not single)?	
10	How did your family (parents, children, siblings, etc.) react to your decision?	
11	How did your community react to your decision?	
12	How many employees do you have? (number of men, number of women)	
13	Do you intend to hire new personnel in the next six months? If so, how many people?	
14	What are the main difficulties you have encountered in creating and/or developing your business (obtaining funds, finding premises, etc.)?	
15	How long after the launch of your business did these difficulties arise?	
16	What is the legal status of your business? Is it: · formally registered with the relevant bureau of commerce? · an informal enterprise?	
17	What do you sell?	
18	Do you make use of science and/or technology in developing your product, using already existing techniques, means or practices? for example: the manufacture of soap, production of textiles, dried fruit or cooked food These utilise science and/or technology: ovens, sewing machines, etc.	
19	Have you created a unique product or process that did not previously exist, and therefore innovated? (product and process innovation)	If her response to questions 18 and/or 19 is 'yes', please go to question 20. If her answer to questions 18 and 19 is 'no', the interview ends here.
If your product reaches the market without going through some process of transformation, as in the sale of fresh fruit, the interview ends here.		
20	If your product is in some way processed, what kind of processing takes place? What technologies/techniques do you use?	Examples: soap-making, spinning cloth out of cotton, sewing clothes, cooking food If the woman cooks food, ask is she uses an oven or charcoal, or some other method
21	If you have innovated by improving or creating a product or process through the use of science and/or technology, how did you achieve this innovation?	
22	Have you adapted an existing technology or technique to transform or create your product/process? If so, how?	
23	Do you share the technology/technique you have developed with anyone for free?	
24	Do you sell the technology/technique you have developed to people who want to use it?	
25	Do you know what steps to take to patent your technical innovation	
26	Have you patented your original technology/technique? (If so, with which patent office(s)?)	
27	If you answered 'yes' to question 26, what problems have you encountered in registering your intellectual property with the patent office(s)?	
28	How did you come to know your line of business? For example: through training, or emulating women in the same sector, etc.	
29	How did you launch your product?	For example: utilising market research, assistants, a website, etc.
30	Do you know of a nearby technology incubator, or similar structure?	**Definitions:** **Technology hub:** organization with physical address, providing office facilities, financial and/or in-kind support to tech entrepreneurs; **Incubator:** office facilities provided, plus in-kind support at an early stage/idea stage; **Accelerator:** office facilities provided, plus short-term funding and support programme; **Co-working:** office facilities provided but no specific support programme.
31	Did you receive assistance from such a structure (public or private) when you started your project, and if so, what kind of assistance? · financial support · in-kind support, such as shared office facilities, free access to electricity, internet, etc.	
32	If you have received financial support from a source other than a technology hub or incubator, from which entity and at what stage(s) of development of your project?	For example: the state, a public or private bank, a private company (for profit or otherwise), international aid institutions (UN, cooperation agencies), a foundation or other philanthropic organization (national or international)
33	What other support did you receive at the beginning of your project, and what support are you receiving now? · personal: family, friends, etc. · professional: state or private (specify)	
34	Do you have shareholders and, if so, who are they and how much of the company do they own?	
35	What steps have you taken to help make your product known to potential customers? What problems have hampered your efforts and how have you overcome them?	for example: setting up a website. (N.B. marketing innovation). Problems may include electricity cuts, internet connectivity problems…
36	How has your company developed/progressed in comparison to projections?	
37	Have you developed your own project management system, or replicated an existing system?	N.B. organizational innovation
38	Does your company provide sufficient revenue for you and your employees?	
39	What plans do you have to develop your business?	
40	What opportunities and obstacles are there in the current climate (social, economic, etc.) for developing a business like yours?	
41	What policies would you like to see implemented in your country to promote the development of businesses like yours and to support female entrepreneurs?	
42	What else should be done to encourage more women to become entrepreneurs and invest in new technologies?	

APPENDIX 2

Breakdown by type of science and technology specified by respondents

Excluding Internet and social media (153 responses)

Science/technology used	Number of respondents per country
Chemicals (e.g. laboratory, paint production, insecticides production)	Dem. Rep. of Congo (5), Madagascar (1), Mozambique (2), South Africa (1), Tunisia (1)
Beekeeping equipment	Ghana (1), Mozambique (1)
Bottler	Mozambique (2)
Brewing and distilling	Ghana (2), South Africa (1)
Camera	South Africa (1)
Canning equipment for food preservation	Ghana (2), Madagascar (1), Senegal (1)
Centrifuge	Madagascar (1)
Clothes steamer, dry cleaning machine, ironing machine	Mozambique (1)
Crushing machinery	South Africa (4)
Fermentation and culturing (e.g. cheese, gari, yogurt, etc.)	Benin (1), Dem. Rep. of Congo (3), Ghana (3), Madagascar (1), Mozambique (1), Senegal (1), South Africa (3), Tunisia (1)
Egg incubator	Ghana (2)
Facial steamer and ultraviolet (UV) sterilizer	South Africa (2)
Farm and agricultural machinery	Ghana (12), South Africa (7)
Filter and water purifier	Ghana (2)
Food dryer	Ghana (3), Mozambique (1)
Freezer	Ghana (2)
Kiln (pottery production) and sander	Madagascar (1)
Kitchen mixer or kneading machine	Ghana (2), Madagascar (1), Mozambique (2), Senegal (1), South Africa (1)
Laser	Madagascar (1)
Miller or grinder (to process food products, glass for beads or stones and shells for terrazzo tiles)	Ghana (7), Madagascar (2), Mozambique (4), Senegal (2), South Africa (1)
Molds	Ghana (3), South Africa (2)
Mortar	Senegal (1)
Oil extractor	Ghana (2), Mozambique (1)
Overhead projector	South Africa (1)
Packaging machine	Mozambique (1), Tunisia (1)
Paper production	Madagascar (2)
Polishing machine	Ghana (1), Madagascar (1)
Saponification (soap production)	Benin (2), Mozambique (1), Senegal (1)
Sealer	South Africa (3)
Sewing machine	Ghana (3), Madagascar (1), Mozambique (1), Tunisia (1)
Shoe-making equipment	South Africa (2)
Slicer (food processing)	Ghana (1)
Software for professional purposes (photography, property management, design, education, etc.)	Ghana (1), Morocco (1), Senegal (2), South Africa (6), Tunisia (2)
Solar energy system	Ghana (1)
Spinning and weaving gear	Ghana (2), Madagascar (1)
Sports/medical equipment	Mozambique (3), South Africa (1)
Leather tanning	Madagascar (2)
Washing machine	Madagascar (1)
Welding equipment	Madagascar (1)

Note: Not all respondents described how they used science and/or technology. For details of the respondents' usage of Internet and social media, see Table 4

Science/technology used	Number of respondents per country
Oven or stove, by type:	
Biomass oven	Madagascar (1)
Charcoal oven	Benin (1), Dem. Rep. of Congo (3), Madagascar (2), Mozambique (2), Tunisia (1)
Charcoal oven and electric stove/oven	Benin (1), Dem. Rep. of Congo (9)
Charcoal oven and gas stove/oven	Mozambique (1)
Oven (unspecified)	Benin (1), Ghana (7), Madagascar (2), Senegal (2), South Africa (4), Tunisia (2)
Electric stove/oven	Dem. Rep. of Congo (1), Mozambique (1)
Gas stove/oven	Dem. Rep. of Congo (1), Ghana (3), Morocco (2), Senegal (1)
Microwave oven	Tunisia (1)
Solar oven	Ghana (2)


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