

The **KENYA INSTITUTE** for **PUBLIC**
POLICY RESEARCH and **ANALYSIS**

Revolutionizing Informal Labour Market through Fourth Industrial Revolution: A Case of Jua Kali Sector

Don Okello and Winnie Momanyi

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**THE KENYA INSTITUTE FOR PUBLIC POLICY
RESEARCH AND ANALYSIS (KIPPRA)**

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Revolutionizing Informal Labour Market through Fourth Industrial Revolution: A Case of Jua Kali Sector

Don Okello and Winnie Momanyi

Kenya Institute for Public Policy
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Abstract

Across the world, countries are investing in the 4IR technologies by recognizing new niches for different industries and leveraging them to achieve sustainable growth and development. The Jua Kali sector in Kenya is a significant driver in economic growth and development, the government recognizes the need for its revolutionization by tapping into the 4IR technologies to achieve the sector's full potential. There have been efforts to embrace the emerging technologies presented by 4IR, but the question of durability and sustainability persists. The study findings indicated a most probable future that leverages 4IR technologies to facilitate an increased rate of invention and innovation, increased access to finance, increased 4IR technology adoption, growth in digital literacy, and financial inclusion in the Jua Kali sector. However, a major impediment to achieving this future would be inadequate infrastructure. To revolutionize the informal Jua Kali sector through 4IR technologies, the government needs to support innovation and technological advancement among Jua Kali firms through training and capacity-building programmes. To enhance financial inclusion with increased access to financial capital the government can support and promote microfinance institutions that provide small loans and financial services tailored to the needs of Jua Kali entrepreneurs. In addition, the adoption of 4IR technology can be increased by the government offering subsidies, grants, and tax incentives to Jua Kali firms for investing in 4IR technologies. Further, there is a need to enhance digital literacy by deploying mobile training units equipped with computers and Internet access to reach Jua Kali workers in remote or underserved areas.

Abbreviations and Acronyms

EMDEs	Emerging Market and Developing Economies
GDP	Gross Domestic Product
ILO	International Labour Organization
ISAs	Informal Sector Activities
JKDF	Jua Kali Development Fund
SDG	Sustainable Development Goal
SFA	Stochastic Frontier Analysis
ST&I	Science, Technology, and Innovations
SSA	Sub-Saharan Africa
KNIS	Kenya's National Innovation System
KIRDI	Kenya Industrial Research and Development Institute
KIPI	Kenya Industrial Property Institute
USA	United States of America
4IR	Fourth Industrial Revolution

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1. Introduction

The concept of the informal labour market is highly complex and multidimensional. Different scholars have defined the informal labour market from their contextual meaning. It has been defined as a sector characterized by non-standard employment relationships whereby standards lack legal protections and the absence of formal contracts (Chen and Carr, 2001; Fields, 2005). On the other hand, the informal labour market refers to work arrangements characterized by economic activity by workers taking place outside normal regulatory channels usually having the informal labour working in irregular and insecure work arrangements (Portes and Schauffler, 1993; Williams, 2008).

The informal labour market in Kenya has long been seen as an integral part of economic development. One of the informal sectors in Kenya is the informal Jua Kali sector. The informal Jua Kali sector in Kenya is called “work under the hot sun”—alluding to the many employment opportunities that operate outdoors, without fixed location, in the street, and so on. In a nutshell, the Jua Kali sector is a collection of traders and artisans in possession of a wide array of skills, among them metalwork, carpentry, plumbing, fabrication, tailoring, shoe repair, automobile repair, and many other skills. The informal Jua Kali sector is therefore not regulated or protected by the government and often operates outside the formal economy. The ILO’s (1972) report suggests that Informal Sector Activities (ISAs) are characterized by the following criteria: ease of entry, reliance on indigenous resources, small-scale operations, labour-intensive and adaptive technology, skills acquired outside of formal school system, and operate on unregistered and competitive markets.

The workers in the Jua Kali sector have low skills and earn lower wages, they lack access to finance and the safety of social networks that workers in the formal sector have access to (Ohnsorge and Shu, 2022). Informality in the Jua Kali sector relates to low productivity, and poor remuneration of workers because of their low skills (Loayza, 2018). Subsistence informality is prevalent in low-income countries and is associated with low-skilled technology and the remuneration of workers below subsistence levels (Elgin et al., 2021). Informality in the Jua Kali sector is often the cause of development challenges, especially in Emerging Markets and Developing Economies (EMDEs). This is because of relying on labour-intensive activities that employ unskilled workers who are poorly remunerated and do not have fiscal resources (Chen, 2023; Ohnsorge and Shu, 2022).

As the Fourth Industrial Revolution unfolds, the Jua Kali sector is seeking to harness new and emerging technologies to reach higher levels of efficiency in production and consumption, expand into new markets, and compete on new products for a global consumer base composed increasingly of digital natives (Fox et. al, 2020). More and more, employers are therefore also seeking workers with new skills from further afield to retain a competitive edge for their enterprises and expand their workforce productivity. Some workers are experiencing rapidly expanding opportunities in a variety of new and emerging job roles such as e-commerce entrepreneurs, digital marketing specialists, and recycling specialists,

while others are experiencing a rapidly declining outlook in a range of job roles traditionally considered 'safe bets' and gateways to a lifetime career.

Although the Jua Kali concept has been practiced globally and even in Kenya since time immemorial including policies and constitutional realignments to boost the Jua Kali sector, the question of durability and sustainability of the informal Jua Kali sector has remained a challenge. The Jua Kali sector in Kenya encompasses a substantial portion of the nation's workforce. It remains to date faced with challenges that present serious obstacles likely to bring about its revolutionization into, and integration within the modern or mainstream working economy.

Several studies have investigated what determines the rate of adoption of 4IR in terms of technology and innovation and technology use in industries, whereas very few focus on Kenya's informal Jua Kali sector – the acquisition of technology, types of innovations, and the factors influencing innovation in the informal sector. These factors are; access to finance (Ayyagari, et al., 2007), human skills, managerial experience age, size, and external linkages (Robson, et al., 2009; Dutz and O'Connell, 2013; Hossain, 2015). This study will solely focus on the Jua Kali sector because it is a major employer of Kenya's working population (employs 15.96 million roughly 83 per cent of Kenya's labour force, Kenya Economic Survey 2023) and a contributor to the GDP. In 2015, 34 per cent of Kenya's GDP was contributed by MSMEs, most of which are in Jua Kali (KNBS, 2016: MSME Survey). Given this background, research on the acquisition of 4IR technology in the Jua Kali sector is important.

Therefore, it is imperative that the policy formulators, researchers, and the government of Kenya in general move with speed to align the Jua Kali sector to its policies if it must be sustained in the country. This study sought out how digital literacy, financial inclusion, and 4IR technology adoption can be used to revolutionize the Jua Kali sector in Kenya.

The overall objective of this paper is to assess the effect of revolutionizing informal Jua Kali through the Fourth industrial revolution, a case of the Jua Kali sector in Kenya. The specific objectives include to examine the future of Kenya's Informal Jua Kali sector through the lens of the 4IR by 2063 and recommending a policy framework for integrating the informal Jua Kali sector with 4IR technologies through 2063.

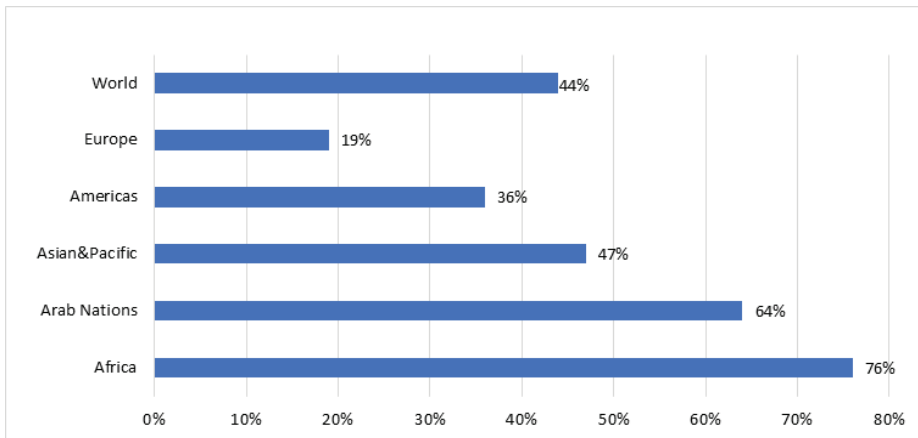
2. Overview of the Informal Jua Kali Sector

2.1 Global Context

The International Labor Organization estimates that about 2 billion workers, or over 44 per cent of the world's adult labor force, operate in the informal sector. The total workforce in the informal sector differs in various regions across the globe. For example, 19 per cent in Europe, 76 per cent in Africa, 47 per cent Asian and Pacific (China excluded), and 64 in Arab nations (ILO, 2018). The informal sector also contributes massively to the Gross Domestic Product (GDP) of many countries. In the United States of America (USA) the informal labour market contributes to approximately 29 per cent of the country's GDP. In Sub-Saharan Africa (SSA) countries, the informal sector contributes about 41 per cent of the total Gross Domestic Product (GDP)(ILO,2018).

The informal labour market is a greater source of employment for men (63.0 per cent) than for women (58.1 per cent). Out of the two billion workers in informal employment worldwide, just over 740 million are women. Women are more exposed to informal employment in most low- and lower-middle-income countries and are more often found in the most vulnerable situations (ILO, 2018).

Figure 1.1: Distribution of employment in the informal labour market globally



Source: (ILO, 2018)

The informal economy is a global phenomenon, but there is great variation within and across countries. On average, it represents 35 per cent of GDP in low- and middle-income countries versus 15 per cent in advanced economies. As the informal labour market continues to grow globally, there is a need to incorporate 4IR technologies as the role of 4IR has been, and is, key in spurring economic growth and development in countries worldwide. This was evident in the first industrial revolution (mid-18th century to about 1830) and the second industrial

revolution (mid-19th century until the early 20th century) across Europe and in the United States of America.

The level of education is a key factor affecting the level of informality. Globally, when the level of education increases, the level of informality decreases (ILO, 2018). People who have completed secondary and tertiary education are less likely to be in informal employment compared to workers who have either no education or completed primary education. According to (ILO, 2018) People living in rural areas are almost twice as likely to be in informal employment as those in urban areas. Agriculture is the sector with the highest level of informal employment – estimated at more than 90 per cent.

2.2 Regional Context

In the bustling streets and vibrant markets of African cities, the informal labor market thrives as a dynamic and resilient ecosystem, where millions of individuals engage in a myriad of economic activities. African cities have a higher prevalence of informal employment, as seen in the cases of Kampala (Uganda) at 86 per cent, Lome (Togo) at 83 per cent, Bomako (Mali) 82 per cent, and Cotonou (Benin) at 81 per cent their employed population (ILO, 2022). This shows that informal employment in African cities is the norm rather than the exception. In the past, policy narratives in Africa often overlooked or even perceived informal economies as detrimental to formal economies, viewing them as a threat that needed to be eliminated or tightly regulated rather than supported and invested in for inclusive structural economic transformation. In recent times, particularly amidst the evolving COVID-19 era, there has been a growing acknowledgment of the importance of the informal economy in Africa. This shift in perspective stems from a heightened awareness of the vulnerability faced by workers and enterprises operating within the informal sector. Moreover, there is now a deeper understanding of the substantial contribution that the informal economy makes to Africa's GDP, income levels, and employment rates. Additionally, there's recognition of the interconnectedness between the informal and formal economies, highlighting the significant impact that developments in the informal sector have on the formal economy.

This realm is often characterized by flexibility and informality, especially in the Jua Kali sector, which serves as a vital source of livelihood for a significant portion of the continent's population. The African informal labor market encompasses a diverse array of occupations, ranging from street vending and artisanal craftsmanship to domestic work and service provision. According to the International Labour Organization (ILO) 2022, over 76% of total employment in Sub-Saharan Africa is informal, making it a cornerstone of the region's economy (ILO, 2018). As Sub-Saharan Africa ushers in the 4IR technologies, Jua Kali businesses' tendency for growth, is still limited by access to physical infrastructure and government services that are likely to be resolved by full adoption of 4IR technologies (Henning and Akoob, 2020).

2.3 Local Context

In Kenya, the Jua Kali as an informal sector was traditionally run in the form of small industries in a few African homes which mainly dealt with blacksmithing activities (Maundu 2012). The advent of the Asian community to Kenya at the turn of the current century marked the gradual shift of 'home-based' Jua Kali activity to urbanized enterprises. Among the initial urban Jua Kali enterprises introduced were motor mechanics, carpentry, masonry, tin smithery, and black smithery (Maundu 2012). With time, the Indigenous Kenyans soon entered the market and gradually expanded the industry by producing a wide range of such items as Jikos (braziers), cooking and frying pans, steel windows, tin lamps, motor spares, and leather artifacts (Maundu 2012). Today the Jua Kali industry represents an enormous conglomeration of products in many towns and villages across the Republic of Kenya.

Sustainable Development Goal 9 (SDG 9) aims at promoting innovations and technology in developing countries, which in turn could help in achieving the other SDGs, such as SDG 1 and 8 that target poverty reduction and Economic growth. The adoption of 4IR technologies, which is also an aim for SDG 9 in the informal Jua Kali sector will improve efficiency and quality, and reduce work time, and increase production (Mendi, 2007).

Kenya, for so long has been struggling to ignite and accelerate the use of 4IR technologies through the promotion of Science, Technology, and Innovations (ST&I). This is being done through the adoption and implementation of various policies and giving it a more concern as a key aspect of growth and development. Science, Technology, and Innovations (ST&I) have led to several changes in the Jua Kali sector. The implementation of some policies such as Kenya's National Innovation System (KNIS) has helped in the establishment of key institutions to improve the Jua Kali sector.

Revolutionizing the Jua Kali sector include addressing challenges of financial access, digital literacy, technology adoption, marketing, and productivity at the same time using opportunities that are present through innovation (Ayentimi and Burgess, 2019). The Vision 2030 (Government of Kenya, 2007) aims to have Kenya become an industrialized and middle-income country. The use of technology and innovations in different economic sectors, including the Jua Kali, is key to enhancing productivity and spurring industrialization. The importance of the Jua Kali sector in Kenya is such that most of the population of the country relies on this workforce for employment, and a change for better conditions within this sector will inevitably spill over socioeconomic waves accordingly. Formal sector workers in Kenya have higher education levels and earn more even at similar levels of education as compared to those in the Jua Kali sector hence they are significantly less poor.

Kenya Industrial Research and Development Institute (KIRDI) had the role of modifying foreign technologies to suit local MSEs. The Industrial Property Act 2001 (Government of Kenya, 2001) established the Kenya Industrial Property

Institute (KIPI) whose core function is to administer property rights. Sessional Paper No. 2 of 2005 on the Development of Micro and Small Enterprises for Employment Creation for Poverty Reduction (Government of Kenya, 2005) gave a clearer policy direction about MSEs and technology, focusing on easing access to information on technology, technology adoption and adaptation, technological institutional support, and skills development.

2.4 The Importance of the Informal Jua Kali Sector in Kenya

The Jua Kali sector plays a key function in Kenya's economy, in terms of employment, it constitutes up to 80 per cent of the overall employment in Kenya (Kenya National Bureau of Statistics (KNBS, 2023). A study by the Mercy Corps, estimates that the informal sector makes up 83.6 per cent of the Kenyan economy and employs 14.9 million people out of the total working population (Mercy Corps, 2019). The government of Kenya estimates the Jua Kali sector's employment opportunities to be approximately 77 per cent of the total manpower in Kenya. Most of the people working in the informal Jua Kali Sector are young people, data from recent (KNBS, 2018) surveys show that 60 per cent are within the age bracket of 18 and 35 years, women constitute 50 per cent of the total number of people working in the informal sector. Estimates indicate that there are more than one (1) million Jua Kali artisans, the majority of whom work and sell their wares on the roadsides (Republic of Kenya, 2019; United Nations Development Programme (UNDP, 2018).

Kenya Economic Survey Report 2022 opines that the Jua Kali sector contributes to 25 per cent of the GDP. The role of the Jua Kali sector in the economy cannot be underestimated; apart from creating jobs, Jua Kali products are exported to the neighboring counties thereby fetching foreign exchange for the economy. The adoption of 4IR technologies, especially on the use of mobile platforms, can ease access to the market for informal Jua Kali workers in Kenya. In this regard, digital marketplaces and mobile app development among the very few informal workers have increased the connectivity to the market removing middlemen between them and the final consumer, increasing their outreach, and enhancing their income opportunities (Beyene, 2018). This is in line with the current global trend where such digital platforms are being embedded into informal economies for the formalization and modernization of the informal economy.

Financial inclusion in the Jua Kali Sector is a necessity for effectiveness and efficiency in the sector. Greater financial inclusion is one way that the Jua Kali sector can be revolutionized (Murein, 2020). The financial services to informal workers in the likes of banking or credit facilities enable those people and enterprises in the informal sector to indulge in strengthening themselves financially as well as furthering their investments (Jack and Suri, 2014). Such efforts could be indispensable and mobile banking stands to be useful in offering digital financial solutions in the Jua Kali sector.

3. Literature Review

This section discusses the theories that exist on the concept of 4IR and the informal Jua Kali sector and provides the empirical literature.

3.1 Theoretical Literature

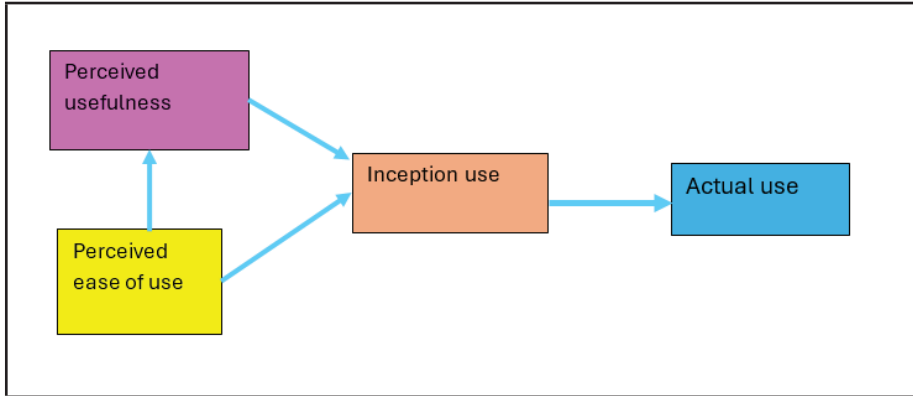
3.1.1 Diffusion of Innovation Theory

The Diffusion of Innovation Theory was developed by Everett Rogers in 1962. Everett postulated in this theory how, why, and at what rate new ideas and technology spread. This theory's main objective is to offer explanations on how, why, and the rate at which ideas and technology diffuse. The successful adoption and integration of Fourth Industrial Revolution (4IR) technologies in the informal labour market are influenced by various factors according to the process of innovation diffusion within a social system developed by Rodgers a long time ago. This theory is premised on the position that innovations, in this case, 4IR technologies, follow a certain predictable adoption path across individual and group adopters. According to the theory, five crucial elements determine the rate at which adoption should occur: relative advantage, compatibility, complexity, trialability, and observability. These elements are crucial in revolutionizing the Jua Kali sector in Kenya through 4IR. The integration of innovation in the Jua Kali sector should be seamless in that the degree of compatibility must have a greater magnitude. Innovations in which informal workers can easily fit their existing workflow processes and compatibility with values are more compatible hence facilitating the adoption (Rogers, 1962). Diffusion theory structurally creates a given framework on how innovations flow through the social system. With 4IR, better job opportunities in the Jua Kali sector are assured because of technological advancement. The theory assumes a linear and uniform progression of adoption thus disregarding complexities intrinsic to different social sets around which the needed diffusion happens (Hovick, 2018).

3.1.2 Technology Acceptance Model

The Technology Acceptance Model (TAM) was introduced by Fred Davis in 1986. It is an information systems theory that models how users come to accept and use a technology. The impact of the Fourth Industrial Revolution (4IR) on fostering entrepreneurship and innovation within the Jua Kali sector can be linked to the Technology Acceptance Model (TAM), which explains how users come to accept and use new technologies (Davis, 1989). TAM posits that perceived ease of use and perceived usefulness are crucial determinants of individuals' intentions to adopt and use technology. Applying TAM to the 4IR context provides insights into how informal entrepreneurs perceive and embrace advanced technologies. Figure 3 below shows a path for TAM.

Figure 3.1: Technology Acceptance Model



Source: *Theory Hub Book, 1996*

However, challenges exist, particularly related to the digital divide. In Kenya, not all artisans and other entrepreneurs especially in the Jua Kali sector may perceive these technologies as accessible or relevant to their businesses. Factors such as limited access to technology, digital illiteracy, and security concerns may impact the perceived ease of use and usefulness, hindering the widespread adoption of 4IR technologies in the Jua Kali sector (Ngulube, 2020).

3.2 Empirical Literature

The Fourth Industrial Revolution (4IR) has brought about unprecedented technological advancement, reshaping the global economic landscape and influencing entrepreneurship and innovation, particularly within the informal sector.

According to Brynjolfsson and McAfee (2014) in their study on human work in the robotic future: Policy for the age of automation, using trend analysis they asserted that the Fourth Industrial Revolution will shift the balance of the skills needed for the labour market by creating new kinds of uniquely human skills which are less automatable. The literature argues that the shift may empower workers in the informal sector as greater worth will be placed on characteristics such as creativity, emotive classic discernment, and adaptability. In Kenya, 4IR may provide an opportunity for recognition and formalization of skills in the Jua Kali sector that may generate better opportunities for a wide range of workers.

Chakravorty et al. (2021) used a case study design to assess specific cases whereby the 4IR-led transformations had positively impacted job opportunities in the informal sectors. The study explored how digital platforms and technological tools were implemented in informal economies, and cases emerged from the data of the innovations expanding micro-entrepreneurship and creating new job categories.

Interestingly, the findings underscored the potential of 4IR not only to sustain but also to enhance employment prospects in traditionally informal settings.

In a study by Michael Danquah (2017), on Technology transfer, adoption of technology, and the efficiency of nations, using Empirical evidence from Sub-Saharan Africa, Danquah found that trade openness, machinery imports, human capital, relative R&D, human capital, and GDP positively affects technology transfers and absorption. Panel data from 78 countries and Stochastic Frontier Analysis (SFA) were used in this study. Lack of policies that focus on development of domestic capacity to absorb technology and manpower were some hindrances to technology absorption by informal firms. Amoah et al. (2018) also find skills gaps and cost implications as being bottlenecks to innovation absorption, thus affecting labour productivity.

In assessing the awareness and use of digital platforms by informal businesses through a surveys and interviews approach, (Khan et al. 2019) found that a substantive proportion of the informal entrepreneurs knew digital platforms. According to their study, there is an active use of the same to reach customers, hence a tenuous indication of positive 4IR impact in fostering not only economic development across various sectors but also entrepreneurship and innovation for any given industry.

A study on to what extent could new technologies known as the Fourth Industrial Revolution (4IR) accelerate the creation of new wage jobs in expanding higher-productivity sectors, leading to a decline in the share of people working informally, and to what extent would youth benefit, (Fox et al. 2021) used a selective literature review. They discussed primarily the most relevant recent academic and institutional publications that address the core research question with a focus on the recent major reports on 4IR and Africa, and the evidence therein regarding the possible benefits to production units, whether formal or informal. The findings highlighted that Africa cannot escape 4IR, as African states become increasingly integrated into the global economy. The balance between the positive and negative outcomes from 4IR will depend on initial country conditions and policy choices.

To explore the implications of the Fourth Industrial Revolution (4IR) on current public sector monitoring and evaluation (M&E) in Africa, (Nalubega et al 2019) used the documentary review method to collect data. This research answered the following guiding questions: (1) How has the 4IR been harnessed in Africa to improve public sector service delivery? (2) How can the 4IR be harnessed to improve M&E in the public sector in Africa? and (3) What are the implications of the 4IR technologies on public sector M&E in Africa? Findings revealed that various 4IR disruptive technologies have already been fully adopted in public service delivery in Africa. The 4IR disruptive technologies can capture, collect, and analyze multi-dimensional information or data from multiple contextual variables, with minimal costs and time in qualitative and quantitative formats. However, findings disclosed that the use of big data in evaluation requires extra new skills training and critical discussions among M&E specialists, technologists, economists, engineers, and tech companies as a whole to significantly enhance the quality, validity, and reliability of the data captured by the technologies.

Adoption of digital technologies can lead to changes in the skills demanded by the informal labor market. Christophe D. (2016) on the digitalization of the economy and its impact on labour markets, argues that there may be an increased demand for workers with digital literacy, technical skills, and abilities to work with data and information technologies. Job polarization, where there is growth in both high-skilled, high-paying jobs and low-skilled, low-paying jobs, but a decline in middle-skilled occupations.

Revolutionizing the informal Jua Kali sector through the Fourth Industrial Revolution (4IR) provides a comprehensive overview of technological advancements and their potential impacts, emphasizing opportunities for increased productivity, market access, and innovation. However, it often lacks detailed case studies and empirical data specific to the Jua Kali context, relying more on theoretical models than primary research. While it highlights both positive and negative impacts, such as job displacement and the digital divide, most of the analysis tends to remain theoretical with limited real-world evidence. This study focuses solely on the Jua Kali sector providing possible projections for the sector by 2063.

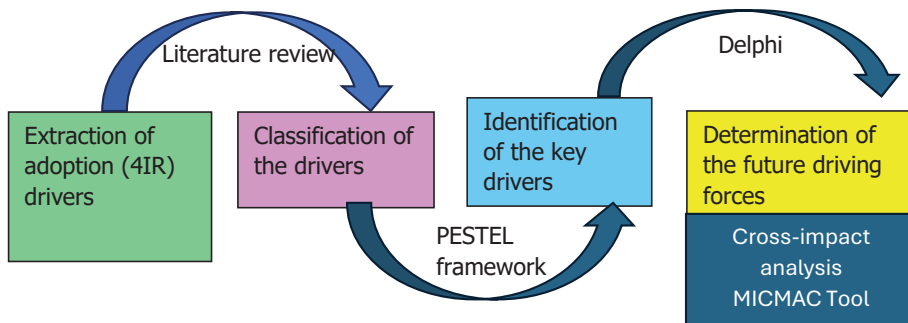
4. Methodology

This chapter presents the methodology that was used to conduct the study. In the existing literature, there exist various concerns on approaches to foresight practices and methods (Boucher and Amara 1977). In this study, revolutionizing the informal labor market through Fourth industrial revolution in the informal Jua Kali sector Kenya, the foresight futures approach was adopted.

4.1 Analytical Framework

Foresight can be categorized into three categories: qualitative, quantitative, and semiquantitative (Popper 2008a, b). Semiquantitative methods utilize mathematical concepts to measure the subjective nature, logical assessments, and perspectives of experts, such as cross-impact analysis and Delphi (Popper 2008a, b; Popper and Medina 2008). This study utilized semiquantitative techniques such as cross-impact analysis. PESTEL framework was adopted to group the levels of adoption of 4IR technologies in the Jua Kali sector into clusters for analysis, and the adopted drivers were categorized. An extensive literature review and environmental scanning were conducted to identify drivers and possible and plausible scenarios. The characteristics of the Jua Kali sector were discussed, and challenges and barriers were reviewed in relation to the future adoption of 4IR technologies. In the next step, the key driving factors of 4IR adoption into the informal labour market were extracted using the Delphi method through questionnaires and interviews with the key stakeholders. The future is categorized as probable future, plausible feature, and possible features. The last stage involved utilizing the scenario matrix to identify the driving forces towards revolutionizing the Jua Kali sector in Kenya through 4IR by use of cross-impact analysis with the aid of the MICMAC Tool. To arrive at the key drivers that will inform the future and strategies (four-step method) to reach the key driving forces can be illustrated as shown in Figure 4.1.

Figure 4.1: Illustration of four-step method to reach the 4IR in the Jua Kali sector



Source: Authors compilation, 2024

4.1.1 Identification of the informal Jua Kali sector factors

The heart of scenario building is to identify the right key factors around which to construct and influence the future environment (Bradfeld et al. 2005; Schwartz 2012; Amer et al. 2013). Key factors (drivers) were selected from research works and insights from the stakeholders in this study. The key factors were classified under the political, economic, social, technological, environmental, and legal categories.

4.1.2 Determination of the informal Jua Kali sector key driving forces

Driving forces are the key factors that have strong impacts on other key factors but are weakly affected by others. In other words, driving forces represent all variables that can form the future of Jua Kali individually or through interaction with other factors (Wack 1985; Pillkahn 2008).

Based on the methodology of future studies, driving forces are defined by cross-impact analysis. Cross-impact analysis was originally developed by Gordon and Helmer in 1966, and since then it has been widely used as a future research method (Gordon 1994; Bishop 2007). Cross-impact analysis is a method that contains a process of scanning possible futures to reduce uncertainties and investigates pairwise analysis of listed events (Bradfeld et al. 2005).

Cross-impact analysis is a scenario design methodological approach in which the mutual connection of a set of variables (descriptors) has been assessed by expert judgment (Culka and Society 2018). Cross-impact analysis is used to capture the inter-relationship between key influencing factors. The Delphi method is used to fill cross-impact matrix (CIM). The Delphi experts were asked about the conditional probability of occurrence of each cell, and an average of their answers was then placed in each cell after it was corrected by the experts' view. This method has been widely used recently, and many researchers have attempted to make it more applicable (Pillkahn 2008; Amer et al. 2013). Two rounds of Delphi were conducted and the one with the lower standard deviation was considered since it shows a consensus from the panel. Based on the Delphi panel's judgments, the impacts of key factors on each other were evaluated using cross-impact analysis which a later scenario matrix was created. The tool produces a graph that shows the extent to which the key factors are affected by each other at four (4) levels, that is, No Impact, Low Impact, Moderate Impact, and High Impact. The analysis is performed based on grading the direct relationship between parameters using questionnaires which consist of the importance and the probabilities of driving forces (events) for both the present and future perspective.

4.1.3 Scenario development

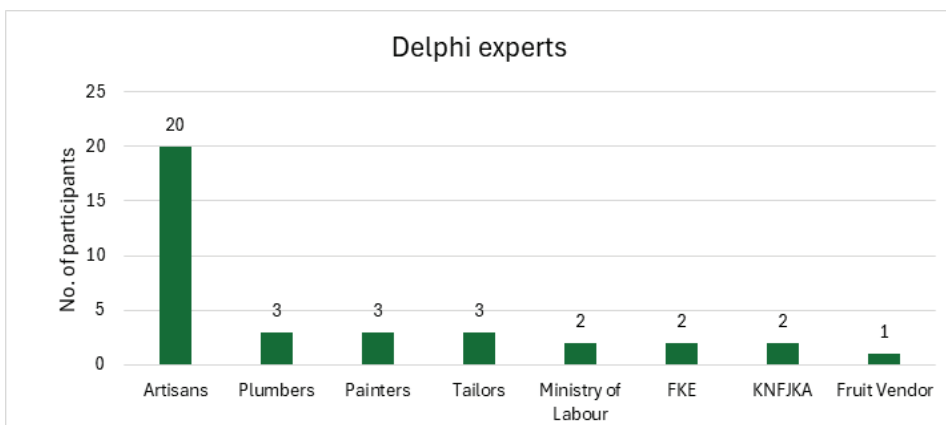
Cross-impact analysis leads to the formation of a quartet map divided into four quadrants (areas) representing four types of variables (Scenario Matrix). The difference between these variables lies in their influence and dependence, where

the influential and dependent variables represent input and output variables, respectively (Alipour et al. 2017). The distribution of factors within one of the four quadrants of the influence map infers distinct aspects of factor impact, and the evolution is based on varying levels of factor influence and dependence (Arcade et al. 1999). The horizontal axis of the potential direct influence/dependence map as indicated in Figure 5.2 shows the degree of dependency, and the vertical axis shows the extent of influence.

4.2 Sampling Design

Purposive sampling design was used in this study. The study focused on the Jua Kali sector in Kenya specifically the Jua Kali experts. The target sample was 30 experts, but 36 Jua Kali experts managed to participate in the two rounds of Delphi. A questionnaire was administered to twenty Jua Kali artisans, three plumbers, three painters, three tailors, two experts from the Ministry of Labour, two experts from the Federation of Kenya Employers, two experts from the Kenya National Federation of Jua Kali Association, and one fruit vendors, a total of 36 Delphi participants. This was done for the two rounds. This paper used a structured interview where a questionnaire was filled in by the interviewee after an elaboration by the interviewer. According to (Kombo and Tromp, 2006) structured interview is a verbally and systematically administered questionnaire that is fast and efficient. It is an attempt to collect data from every member of the population being studied rather than choosing a sample. Interviews were used because they helped the researcher to collect large amounts of data in large areas within a short time thus saving time for the study (Orodho, 2003). The questionnaires used contained both open-ended and closed-ended questions which were based on the research question and objectives of the study. The questionnaires were self-administered to the relevant respondents.

Figure 4.2: Delphi experts



Source: Authors compilation, 2024

4.3 Data

This study utilized data from various sources including the Office of the Statistical Abstracts, the International Labour Organization (ILO), the National Bureau of Statistics (KNBS), and the Federation of Kenya Employers (FKE). Extensive literature was done to identify the drivers that are likely to revolutionize the Informal Jua Kali sector using 4IR technologies.

5. Futures of the Informal Jua Kali Sector

This chapter presents the results and discussion on the study, revolutionizing the informal labour market through Fourth Industrial Revolution in the informal Jua Kali sector in Kenya through 2063.

5.1 Futures of the Informal Jua Kali Sector Through the Adoption of 4IR in Kenya by 2063

To achieve the first objective of this study, an extensive literature review was instrumental in identifying the drivers of change in the informal Jua Kali sector. A total of 10 drivers were identified and classified using the PESTEL framework as shown in Table 5.1. Cross-impact analysis served as a valuable method and a comprehensive one for evaluating the intricate relationships between variables within a system, facilitating a deeper understanding of their potential impacts on one another. By constructing a cross-impact matrix and systematically assessing the interactions between variables, decision-makers gain insights into the complex dynamics at play. This method enables the identification of critical factors, the exploration of various scenarios, and the development of robust strategies in the face of uncertainty.

Kuru (2015) emphasized the significance of cross-impact analysis in strategic planning and risk management, highlighting its utility in anticipating future developments and informing proactive decision-making. Consequently, through its structured approach to analyzing interdependencies, cross-impact analysis offers a powerful tool for navigating complexity and enhancing organizational resilience (Kuru, 2015). The cross-impact table is filled by the values obtained from the administered questionnaire. Table 4 shows a cross-impact analysis to obtain key drivers that are used to build scenarios after the drivers have been subjected to the MICMAC tool.

Table 5.1: Scenarios based on the PESTEL framework for Jua Kali sector revolutionization through 4IR

Framework	Drivers of change	References
Political	Number of government policies enacted to regulate and support the integration of 4IR technologies in the informal Jua Kali labour market	Musamali, Jugurnath, and Maalu (2023)
	Political stability in the country	Sagwa, Mreji, and Orina (2024)
Economic	Increase in access to financial capital for informal Jua Kali workers and entrepreneurs engaging in 4IR-related activities	Anne-gertraude (2018), King (1996), Ayyagari, et al., (2007) Fredrick (1990), Agelu (2014)
	Financial inclusion in the Jua Kali sector	Anne-gertraude (2018); King (1996);Fredrick (1990); Agelu (2014)
Social	Growth in digital literacy rates among informal Jua Kali workers	Khan et al. (2019), Kinyanjui, (2011), Fox et al (2021),
	Social inclusion and gender equality in the informal Jua Kali sector	Khan et al. (2019); Fox et al (2021)
	Rate of adoption of 4IR technologies in the informal Jua Kali sector	Momanyi, Rasugu Riechi, and Khatete (2024);Michael Danquah (2017); Fox et al (2021); Robson, et al., (2009)
Technological	Innovation and technological advancements	Chakravorty et al. (2021); Fox et al (2021); Michael Danquah (2017); Nalubega et al (2019)
Environmental	Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector	Ransom (2017); AWADH (2010)
Legal	Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms	Deganis, Tagashira, Yang, (2021).

Source: Authors' computations, 2024

Table 5.2: Cross-impact matrix (Delphi round one results)

	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀
T ₁		2	3	3	2	1	2	2	3	3
T ₂	2		3	3	2	3	1	1	2	3
T ₃	2	2		3	3	1	3	3	3	2
T ₄	2	3	3		3	3	2	3	3	3
T ₅	2	3	3	3		2	2	3	2	3
T ₆	2	3	1	2	2		2	2	2	2
T ₇	3	3	3	2	3	3		2	2	1
T ₈	3	3	3	2	3	3	2		3	3
T ₉	3	0	2	0	3	3	2	3		3
T ₁₀	2	3	1	3	3	2	3	2	1	

Source: Author, 2024

High impact= 3, Moderate impact=2, Low impact= 1 No influence =0

T1 = Number of government policies enacted to regulate and support the integration of 4IR technologies in the informal Jua Kali labour market

T2= Political stability in the country

T3= Increase in access to financial capital for informal Jua Kali workers and entrepreneurs engaging in 4IR-related activities

T4= Financial inclusion in the Jua Kali sector

T5= Growth in digital literacy rates among informal Jua Kali workers

T6= Social inclusion and gender equality in the informal Jua Kali sector

T7= Rate of adoption of 4IR technologies in the informal Jua Kali sector

T8= Innovation and Technological Advancements

T9= Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector

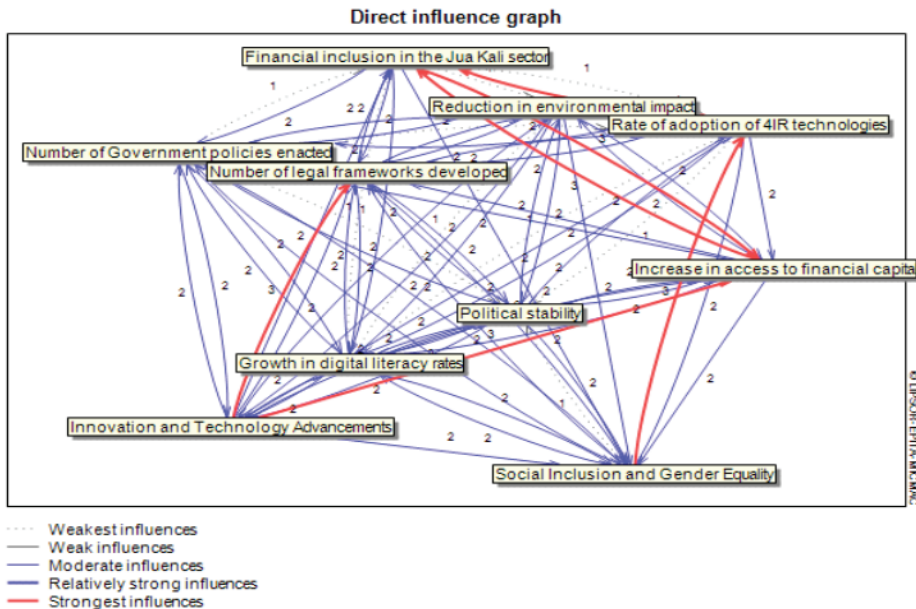
T10= Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms

5.2 Selecting Drivers to Build Scenario Axis in the Scenario Matrix (MICMAC Tool Analysis)

Using the scenario matrix method involves selecting drivers with the highest systemic impact, meaning they significantly influence other drivers in the cross-

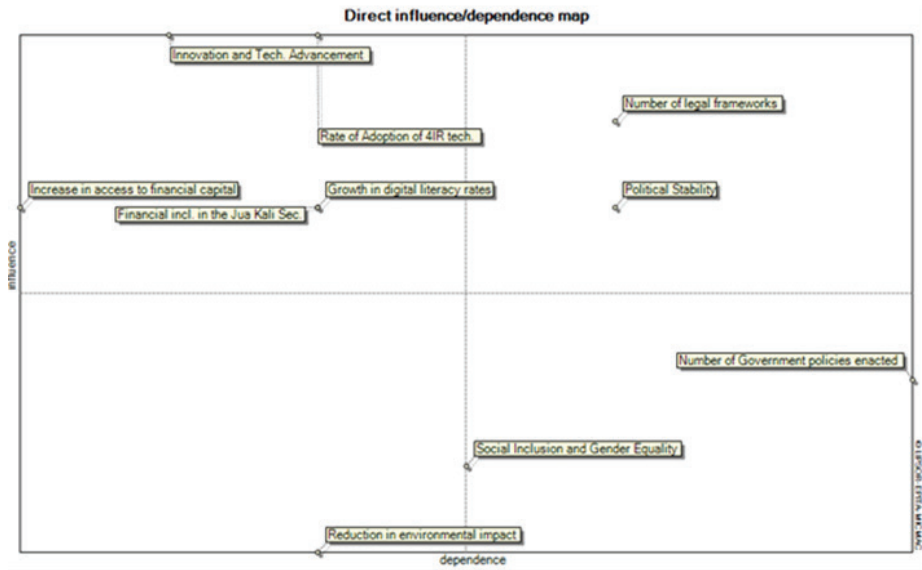
impact (Riahi et al.,2017). The most important driving force is the factor that has the highest influence and the least dependency, which is located in the upper left corner of the matrix on the Potential Direct Influence/Dependency Map as shown below in Figure 5.2. Thus innovation and technological advancements, the rate of adoption of 4IR technologies in the informal Jua Kali sector, and growth in digital literacy rates among informal Jua Kali workers as the key driving forces are combined to form a digital renaissance in one axis in the scenario building while financial Inclusion in the Jua Kali Sector and Increase in access to financial capital for informal Jua Kali workers and entrepreneurs engaging in 4IR-related activities also forms another axis as Financial Inclusion in Scenario building. Factors in Quadrant I are referred to as relay factors. Relay factors are both highly influential and highly dependent on other factors and thus represent unstable and emergent outcomes within the informal Jua Kali Sector. Relay factors play an important role in the future of the informal Jua Kali Sector if the driving forces they depend on have a significant change. Factors in Quadrant II are the key driving forces towards the revolutionization of the informal Jua Kali sector. Factors within Quadrant III are called autonomous factors and have little influence or dependence on other factors and thus exert negligible influence on the informal Jua Kali sector. Factors in Quadrant IV are known as result factors. Result factors have low influence, and their dependence is highly sensitive to the evolution of influent and relay factors.

Figure 5.1: Potential direct influence graph



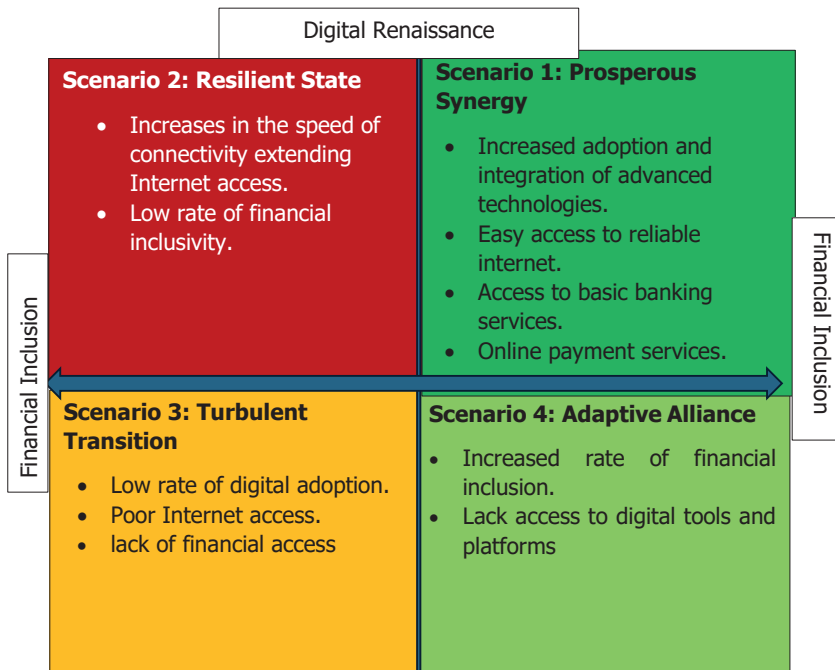
Source: Authors' computations, 2024

Figure 5.2: Potential direct influence and dependency for drivers



Source: Authors, computation, 2024

Figure 5.3: Scenario matrix: Futures of informal Jua Kali sector



Source: Authors, 2024

5.3 Future Scenarios in the Informal Jua Kali Sector

Scenarios are plausible long-term future projections evaluated by the expert panel that are likely to occur. Scenarios show how different driving forces initiate events, shape trends, and create structures for possible futures. In light of the foregoing discussions, this study seeks to overview and analyze future images of Kenya's Informal Jua Kali Sector through the lens of the 4IR by 2063. The revolutionization of the informal Jua kali sector scenarios reviewed in this study is selected based on a crucial consideration such as covering all types of scenarios.

Scenario one: Prosperous synergy

Driving forces play significant roles in reshaping the future of the informal Jua Kali sector in the wake of 4IR. In Scenario 1, which is a possible future scenario we might experience by 2063, there is a possibility that the country is likely to experience high financial inclusion and high digital renaissance. Based on comparative analysis, in the plausible future, 2063, the informal Jua Kali sector in Kenya will experience an increased adoption and integration of advanced technologies, easy access to reliable internet, connectivity, and electricity for implementing 4IR, access to basic banking services such as savings accounts, credit facilities, and payment services for Jua Kali artisans and businesses. A good example is Etsy in the U.S. Such will enable the Jua Kali sector to use their mobile phones to market their products, use mobile money, and connect with their customers or suppliers cutting down middlemen who sometimes exploit them financially.

Jua kali sector models are simple and for this reason, attempts to “formalize” them in the wake of 4IR have had limited success (Bruhn and Mckenzie, 2014). The issue is not all about whether they pay taxes or are registered businesses but, in most cases, their earnings are low enough to slide under the floor, for paying taxes charged by local authorities whom sometimes they bribe. By 2063, the Jua Kali sector will increase its capital base enabling them to pay taxes easily as their products will go globally as a result of high-tech adoption. This will as well be a boom to women as (Chen and Carre, 2020) argue that women working in this sector who are less than men earn less than men. Jua Kali clients will also be at ease choosing the products they want from a variety in terms of colour, design, and material and making payments at the click of their phones wherever they are. In general, all these will boost the GDP of Kenya by 2063, as a result of advanced Jua Kali operations. These findings are consistent with the findings of (Louise F. and Landry S., 2021) whose study focused on the 4IR and the Future of work in Africa.

Scenario two: Resilient state

In the second scenario, there will be a possibility of high technology renaissance with low financial inclusion. This scenario might lead to a revived Informal Jua

Kali industry in Kenya by 2063 though will not be sustainable. This is because despite the high digital renaissance within the country by 2063 in the wake of 4IR, and with the massive increases in the speed of connectivity extending Internet access, the rate of financial inclusivity is still low in the sector inhibiting financial access that could spur rapid growth of the Jua Kali sector. This scenario cannot last for long. There will be a lack of finances to support government initiatives that accelerate growth in the sector whose activities are capital intensive as well. This is coupled with a lack of growth in the number of digital platforms connecting informal Jua Kali workers to economic opportunities and lack of mobile banking, access to credit for informal Jua Kali workers, and the prevalence of cashless transactions.

Scenario three: Turbulent transition

In this scenario, there exists low financial access and low digital renaissance. This Scenario characterized by a very low rate of digital adoption, and poor Internet access that also leads lack of financial access that could lead to the growth of the informal Jua Kali sector. This is likely to create a case of a deteriorating economy not only in the informal sectors but also in the formal sector. Lastly, the investors will not be ready to invest in the Jua Kali industry in the country either because of delayed, interrupted or diverted 4IR technologies inhibiting digital renaissance and financial access to other sectors by 2063. This is the status quo.

Scenario four: Adaptive alliance

In this scenario, in the wake of 4IR Kenya will experience high rates of financial inclusion with low digital renaissance. The increased rate of financial inclusion enhances the growth of the Jua Kali sector but is limited in terms of technological advancements. This means that the growth in this sector will not be sustainable. Despite having access to financial services, Jua Kali artisans and micro-entrepreneurs may lack access to digital marketing, online payment systems, and platforms that could enhance their productivity, efficiency, and competitiveness. Without digital technologies such as mobile applications, e-commerce platforms, or digital marketing tools, businesses may struggle to reach new markets, streamline operations, and adapt to changing consumer preferences.

6. Conclusion and Policy Recommendations

6.1 Conclusion

This study aimed to identify policy gaps concerning the role of 4IR technologies in the informal Jua Kali sector. More specifically, two policy objectives guided the research: examining the future of Kenya's informal Jua Kali sector through the lens of 4IR technologies by 2063 and recommending a policy framework for integrating the informal Jua Kali sector with 4IR technologies through 2063.

In 2063, Kenya anticipates a Jua Kali sector that incorporates innovation, technology adoption, and financial inclusion to enhance sustainability in the sector in the wake of 4IR technologies. This will ensure that this sector unlocks its full potential as a driver of economic growth, social development, and sustainable prosperity. Chiefly, 4IR technologies will be employed in production, designing, and as a marketing strategy through e-commerce for Jua Kali products. In addition, customers' experiences will be more immersive due to the advancement in the quality of the produced products.

Notably, there is an unprecedented future that indicates possibilities of full adoption of 4IR technologies in the informal Jua Kali sector. However, some challenges are likely to impede the widespread adoption of 4IR technologies. Some of the future possibilities include strong collaboration among stakeholders in this sector which is likely to result in sufficient policies and laws to support the adoption of 4IR technologies. One of the major challenges likely to prevent these scenarios is the perceptions in terms of job loss involved in fully adopting the 4IR technologies. In essence, the Fourth Industrial Revolution offers a unique opportunity where the country can build a future where all workers, including those in the Jua Kali sector, thrive in the digital age.

6.2 Policy Recommendations

By implementing the policy recommendations listed below, the informal Jua Kali workers can be empowered to unleash their entrepreneurial potential and pave the way for a more inclusive and prosperous future in the digital economy by 2063.

Access to finance and resources

In the era of the Fourth Industrial Revolution (4IR), access to finance and resources is pivotal for modernizing and enhancing the informal Jua kali sector. Digital finance solutions, such as mobile banking, peer-to-peer lending platforms, and blockchain-based financial services, can provide artisans with the necessary capital to invest in advanced technologies. Microfinance institutions and banks should develop tailored financial products with favourable terms, focusing on minimal collateral and low-interest rates to encourage tech adoption.

Additionally, government grants and subsidies specifically aimed at integrating 4IR technologies, like automation tools, 3D printing, and AI-driven systems, can empower Jua Kali businesses to innovate and scale.

Resource access must also include training and capacity-building programmes that focus on digital literacy and the use of advanced manufacturing technologies. Establishing partnerships with tech companies can facilitate the transfer of knowledge and provide access to cutting-edge tools and software. Moreover, creating shared innovation hubs equipped with modern machinery and digital infrastructure can allow artisans to experiment and improve their production processes. By ensuring that the Jua Kali sector has both the financial means and the technical resources to embrace 4IR, the government and private sector can foster a more competitive, efficient, and sustainable informal economy.

Development of digital infrastructure to increase 4IR adoption

In the Fourth Industrial Revolution (4IR), the development and enhancement of digital infrastructure are crucial for improving the informal Jua kali sector. Access to high-speed Internet is fundamental, enabling artisans to connect with digital marketplaces, access online training, and utilize advanced digital tools. Establishing affordable and reliable Internet services in urban and rural areas can bridge the digital divide and ensure inclusivity. Additionally, creating digital hubs equipped with modern computers, 3D printers, and other innovative technologies can provide Jua Kali artisans with the resources needed to modernize their production processes and increase efficiency. These hubs can also serve as centers for digital literacy training, helping artisans acquire essential skills for operating in a digital economy in the wake of 4IR. Investment in cybersecurity measures is equally important to protect businesses from digital threats and ensure secure transactions. By prioritizing digital infrastructure, the government and private sector can facilitate the integration of 4IR technologies into the Jua Kali sector, driving innovation, expanding market reach, and enhancing overall economic resilience.

Market access and E-Commerce

In the context of the Fourth Industrial Revolution (4IR), improving market access and leveraging e-commerce can significantly transform the informal Jua kali sector. Digital platforms and online marketplaces provide Jua Kali artisans with unprecedented opportunities to reach a global audience, transcending traditional local market limitations. E-commerce enables artisans to showcase and sell their products online, facilitating broader customer engagement and increased sales. Implementing training programmes on digital literacy and e-commerce skills is crucial, helping artisans to effectively navigate and utilize these platforms.

Additionally, partnerships with established e-commerce companies can provide logistical support, such as warehousing and shipping services, further simplifying the process for Jua Kali businesses. Utilizing social media and digital marketing strategies can also enhance visibility and brand recognition. By integrating these digital tools and platforms, Jua Kali artisans can better align with 4IR advancements, fostering innovation, improving market competitiveness, and driving sustainable economic growth in the sector.

Regulatory framework and support

In the Fourth Industrial Revolution (4IR), an adaptive regulatory framework and comprehensive support system are vital for advancing the informal Jua kali sector. The government needs to modernize regulations to accommodate digital business operations, making it easier for Jua Kali enterprises to formalize and benefit from technological advancements. Simplified digital business registration processes and tax incentives for tech adoption can encourage artisans to integrate new technologies like AI, IoT, and automation into their work. Support should include training programmes focused on digital skills, cybersecurity, and the effective use of e-commerce platforms, ensuring artisans are well-equipped to thrive in a digital economy. Establishing innovation hubs and providing access to digital infrastructure, such as high-speed Internet and advanced machinery, can further enhance productivity and innovation. Policies that protect intellectual property rights in the digital space and promote fair digital trade practices are also essential. By creating a supportive and forward-looking regulatory environment, the government can help the Jua Kali sector harness the full potential of 4IR, driving sustainable growth and competitiveness.

References

- Agelu, J. (2014). “Jua Kali” youths and how they negotiate work in the informal economic sector in Kenya and Uganda. The Pennsylvania State University.
- Amoah J. A., Ellis L.C. Osabutey, Abiodun Egbetokun (2018), “Contemporary challenges and opportunities of doing business in Africa: The emerging roles and effects of technologies”, *Technological Forecasting and Social Change*, 131: 171–174.
- Anne-gertraude, J. (2018). *The Voice of Informal Sector Entrepreneurs: A Case Study of Jua Kali Associations of Homa Bay Town, Kenya* (Doctoral dissertation, University of Nairobi).
- AWADH, A. H. (2010). *An assessment of the viability and potential of bamboo micro-enterprises in environmental conservation and poverty alleviation in Nairobi City, Kenya*.
- Ayentimi, D. T., and Burgess, J. (2019). Is the fourth industrial revolution relevant to Sub-Saharan Africa? *Technology analysis and strategic management*, 31(6), 641-652.
- Ayyagari, M., Demirgüç-Kunt, A. and Maksimaic, V. (2007), *Firm innovation in emerging markets*. World Bank Policy Research Working Paper No. 4157. World Bank.
- Becker, G. S. (2009). *Human capital: A theoretical and empirical analysis, with special reference to education*. University of Chicago press.
- Berkhout, F., and Hertin, J. (2002). Foresight futures scenarios: developing and applying a participative strategic planning tool. *Greener Management International*, (37), 37-52.
- Beyene, A. A. (2018). *Unlocking the Potential of the Informal Economy in Kenya: A Step Toward Achieving Inclusive Growth*. Retrieved from <https://www.worldbank.org/en/country/kenya/publication/unlocking-the-potential-of-the-informal-economy-in-kenya>
- Boucher, W. I., and Amara, R. (1977). *The study of the future: an agenda for research* (Vol. 770036). National Science Foundation.
- Bruhn, M., and McKenzie, D. (2014). Entry regulation and the formalization of microenterprises in developing countries. *The World Bank Research Observer*, 29(2), 186–201. <https://doi.org/10.1093/wbro/lku002>.
- Brynjolfsson, E., and McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. W. W. Norton and Company.
- Calderon, C., Kambou, G., Korman, V., Kubota, M., Canales, C. C. (2019). Africa’s pulse, No. 19, April 2019: An analysis of issues shaping Africa’s economic future. The World Bank. <https://doi.org/10.1596/978-1-4648-1421-1>
- Chakravorty, T., Bhatt, V., Chakravorty, T., and Chakraborty, S. (2021). Analysis of digital technologies as antecedent to care service transparency and orchestration. *Technology in Society*, 65, 101568.
- Chen, M. and Carre, F. (Eds). (2020). *The informal economy revisited*. Routledge, Taylor and Francis. <https://library.oapen.org/handle/20.500.12657/39924>.

- Chen, M. (2023). The pandemic, informality, and poverty: Rethinking economic policy responses to the informal economy, CPAN Policy Brief 9. Institute of Development Studies. <https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/18042>
- Chen, M. A., and Carr, M. (2001). Globalization, social exclusion, and work: With special reference to informal employment and gender. *International Labour Review*, 140(1), 31-64.
- Cornell University, INSEAD, and WIPO (2018), *The Global Innovation Index 2018: Energizing the World with Innovation*. Ithaca, Fontainebleau, and Geneva.
- Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319-340.
- Deganis, I., Tagashira, M., and Yang, W. (2021). Digitally enabled new forms of work and policy implications for labour regulation frameworks and social protection systems.
- Dutz, M. A. and O'Connell, S. D. (2013), *Productivity, innovation and growth in Sri Lanka: An empirical investigation*. World Bank Policy Research Working Paper, No. 6354. World Bank.
- Elgin, C., Kose, M. A., Ohnsorge, F., and Yu, S. (2021). Understanding informality. Munich Personal RePEc Archive, 109490. <https://mpra.ub.uni-muenchen.de/109490>
- Fields, G. S. (2005). A guide to multisector labor market models. In C. O'Higgins (Ed.), *Handbook of employment and the economy* (pp. 107-127). Edward Elgar Publishing.
- Fox, L., and Signé, L. (2021). The fourth industrial revolution (4IR) and the future of work: could this bring good jobs to Africa. *Evid. Synth. Pap. Ser*, 51.
- Fox, L., and Signé, L. (2021). The fourth industrial revolution (4IR) and the future of work: could this bring good jobs to Africa. *Evid. Synth. Pap. Ser*, 51.
- Fox, L., and Signé, L. (2021). The fourth industrial revolution (4IR) and the future of work: Could this bring good jobs to Africa. *Evid. Synth. Pap. Ser*, 51.
- Fox, L., Jayne, T.S., Fuglie, K., and Adelaja, A. (2020). Agricultural productivity growth, resilience, and economic transformation in sub-Saharan Africa: Implications for USAID. USAID, BIFAD, and Association of Public and Land-Grant Universities. https://www.usaid.gov/sites/default/files/documents/BIFAD_Agricultural_Productiv
- Fredrick, N. (1990). *The Juakali artisans backgrounds, survival strategies, capital accumulation patterns and scales of production* (Doctoral dissertation).
- Gough, D., Thomas, J. and Oliver, S. (2012). Clarifying differences between review designs and methods. *Systematic Reviews*, 1(28).
- Government of Kenya (2001), *The Industrial Property Act 2001*, Nairobi: Government Printer
- Hertin, J., I. Lorenzoni, J. Skea and F. Berkhout (2020) *Review of Relevant Climate Impact and Futures Literature* (Brighton, UK: SPRU—Science and Technology Policy Research).

- Holmes, R., McCord, A., HagenZanker, J., Bergh, G., and Zanker, F. (2013). What is the evidence of the impact of employment creation on stability and poverty reduction in fragile states? A Systematic Review. Overseas Development Institute. Retrieved March 19, 2018, from <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications... files/8386.pdf>
- Hossain, M. (2015), "A review of literature on open innovation in small and medium enterprises", *Journal of Global Entrepreneurship Research*, 5:6.
- Hovick, S. R. (2018). A critique of diffusion theory. *Participations: Journal of Audience and Reception Studies*, 15(1), 504-523.
- International Labour Organization. (2022). Getting Skills Right Equipping Health Workers with the Right Skills Skills Anticipation in the Health Workforce: Skills Anticipation in the Health Workforce. OECD Publishing.
- Irena. (2019). Future of solar photovoltaic: Deployment, investment, technology, grid integration and socio-economic aspects. International Renewable Energy Agency.
- Jack, W., and Suri, T. (2014). Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution. *American Economic Review*, 104(1), 183-223. DOI: 10.1257/aer.104.1.183
- Jurgensen, K., and Valodia, I. (2019). Technological Change and the Future of Work—Some Issues from a Developing Country Perspective. *20 Years of G20: From Global Cooperation to Building Consensus*, 115-126.
- Khan, S., Hossain, M. A., and Hasan, M. R. (2019). Impact of Digital Platforms on Informal Sector: Evidence from Developing Countries. *International Journal of Information Management*, 45, 262-272.
- King, K. (1996). *Jua Kali Kenya: change and development in an informal economy, 1970-95*. Ohio State University Press.
- Kinyanjui, M. N. (2011). *Jua Kali Strategies for Socio-Economic Change in Nairobi*. Hemispheres, (26), 29.
- KNBS (2016). *Micro, Small and Medium Establishments (MSME) Basic report*. Nairobi: Kenya National Bureau of Statistics
- Liao, H., Liu, X., Wang, C., (2012), "Knowledge spillovers, absorptive capacity and total factor productivity in China's manufacturing firms", *International Review of Applied Economics*, 26 (4), 533-547.
- Loayza, N. V. (2018). *Informality: Why is it so widespread and how can it be reduced* (English). Research and Policy Briefs, no. 20. Bank Group. <https://documents1.worldbank.org/curated/en/130391545228882358/pdf/Informality-Why-Is-It-So-Widespread-and-How-Can-It-Be-Reduced.pdf>
- Loko, B., Diouf, M.A. (2009), *Revisiting the Determinants of Productivity Growth: What's New?* International Monetary Fund.
- Marginson, S. (1993). *Education and public policy in Australia*. Cambridge University Press.
- Maundu, M., (2012), *Process and Product in Science and Technology Learning in Kenya Schools: A study of Selection and Classification skills in Jua Kali and Primary School settings*. Unpublished IDRC - sponsored Research Report.

- McCall, B., Smith, J., and Wunsch, C. (2016). Government-sponsored vocational education for adults. In *Handbook of the Economics of Education* (Vol. 5, pp. 479-652). Elsevier.
- Mendi, P. (2007), "Trade in disembodied technology and total factor productivity in OECD countries", *Research Policy*, 36 (1): 121-133.
- Michalos, A. C. (Ed.). (2014). *Encyclopedia of quality of life and well-being research* (Vol. 171). Dordrecht: Springer Netherlands.
- Momanyi, C., Rasugu Riechi, A., and Khatete, I. (2024). Digital skills and the use of digital platforms in the informal sector: a case study among Jua Kali artisans in Nairobi in Kenya. *International journal for research in vocational education and training*, 11(1), 96-118.
- Mulrean, C. (2020). *Women in the Fourth Industrial Revolution: A gendered perspective on digitalization in Kenya, Nigeria, and South Africa* (Doctoral dissertation, master's thesis, European Institute and LUISS Guido Carli University) Retrieved from: https://www.ie-ei.eu/Ressources/FCK/image/Theses/2020/MULREAN_Thesis_GEGPA_2020.pdf.
- Nalubega, T., and Uwizeyimana, D. E. (2019). Public sector monitoring and evaluation in the Fourth Industrial Revolution: Implications for Africa. *Africa's Public Service Delivery and Performance Review*, 7(1), 1-12.
- Ngulube, P. (2020). *Digital Inclusion and Skills Development in Kenya*. Retrieved from [https://www.researchictafrica.net/publications/Research_ICT_Africa_LIRNEasia_Working_Paper_Series_\(Online\)/2020-WorkingPaper85-Digital-Inclusion-and-Skills-Development-in-Kenya.pdf](https://www.researchictafrica.net/publications/Research_ICT_Africa_LIRNEasia_Working_Paper_Series_(Online)/2020-WorkingPaper85-Digital-Inclusion-and-Skills-Development-in-Kenya.pdf)
- Ngulube, P. (2020). *Digital Inclusion and Skills Development in Kenya*. Retrieved from [https://www.researchictafrica.net/publications/Research_ICT_Africa_LIRNEasia_Working_Paper_Series_\(Online\)/2020-WorkingPaper85-Digital-Inclusion-and-Skills-Development-in-Kenya.pdf](https://www.researchictafrica.net/publications/Research_ICT_Africa_LIRNEasia_Working_Paper_Series_(Online)/2020-WorkingPaper85-Digital-Inclusion-and-Skills-Development-in-Kenya.pdf)
- Ohnsorge, F., and Shu, Y. (2022). The long shadow of informality: Challenges and policies. World Bank. <https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-1753-3>
- Popper, Z. A., and Tuohy, M. G. (2010). Beyond the green: understanding the evolutionary puzzle of plant and algal cell walls. *Plant physiology*, 153(2), 373-383.
- Portes, A., and Schauffler, R. (1993). Competing perspectives on the Latin American informal sector. *Population and Development Review*, 19(1), 33-60.
- Ransom, J. N. (2017). *Informal Innovation and Climate Change: The Role of Kenyan Jua Kali Metal Workers in Developing and Distributing Fuel-Efficient Cookstoves* (Doctoral dissertation, George Mason University).
- Riahi, K., et al. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, 42, 153-168.
- Robson, P., Haugh, H. and Obeng, B. (2009), "Entrepreneurship and innovation in Ghana: Enterprising Africa", *Small Business Economics*, 32: 331-350.
- Rogers, E. M. (1962). *Diffusion of Innovations*. Free Press.

- Sciortino, R. (2021). The Paradox of Social Protection in Southeast Asia: A Regional Overview of the Health and Socioeconomic Impacts of COVID-19 and Responses. ” In Routledge’s Handbook on Civil and Uncivil Society in Southeast Asia, edited by Eva Hansson and Meredith Weiss; 155–174. London: Routledge
- Srija, A., and Shirke, S. V. (2014). An analysis of the informal labour market in India. *Economy Matters*, 45(12), 28-29.
- Technopolis and Research ICT Africa and Tambourine Innovation Ventures. (2019). Study on unlocking the potential of the Fourth Industrial Revolution in Africa. <https://4irpotential.africa/>
- Williams, C. C. (2008). Internal migration and informal labour markets in Vietnam. *International Journal of Social Economics*, 35(11), 769-782.
- World Bank. (2019). Kenya Economic Update: Unbundling the Slack in Private Investment. Retrieved from <https://openknowledg>
- World Bank. (2019). Kenya Economic Update: Unbundling the Slack in Private Investment. Retrieved from <https://openknowledge.worldbank.org/bitstream/handle/10986/32532/9781464814637.pdf>
- World Bank. (2019). World Development Report 2019: The Changing Nature of Work. Retrieved from: <https://openknowledge.worldbank.org/bitstream/handle/10986/31755/9781464814224.pdf>.

Appendices

Appendix 1: Delphi Round one

Questionnaire: Your input to this questionnaire is highly appreciated Revolutionizing the Informal Labour Market Through 4IR (Case of Jua Kali sector)

Dear Respondent,

We are conducting research on the future of Kenya's Informal Jua Kali Sector through the lens of the 4IR by 2063 using cross-impact analysis. Your insights are valuable for understanding the futures of Kenya's Informal Jua Kali Sector and identifying areas for improvement in integrating advanced technologies into the informal Jua Kali sector. Could you spare a few minutes to fill out our questionnaire? Your response will be kept confidential. Thank you for your participation.

Best Regards,

Don Okello

PART 1

1. What is your name
2. Occupation/Role
3. Contact Information

PART 2

Q1:

How does the Number of government policies enacted to regulate and support the integration of 4IR technologies affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Political stability in the country				
Increase in access to financial capital for informal Jua Kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q2

How does political stability in the country affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies in the informal Jua Kali labor market				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q3

How does an increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	Hig impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q4

How does financial inclusion in the Jua Kali sector affect the following?

High impact=3 Moderate impact=2.....Low impact=1 No impact =0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q5

How does growth in digital literacy rates among informal Jua Kali workers affect the following?

High *impact*=3 Moderate *impact*=2 Low *impact*=1 No *impact*=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Social inclusion and gender equality in the informal Jua Kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q6

How do social inclusion and gender equality in the informal Jua Kali sector affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q7

How does the rate of adoption of 4IR technologies affect the following?

High impact=3Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q8

How do innovation and technological advancements affect the following?

High impact=3

Moderate impact=2

Low impact=1

No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q9

How does the reduction in environmental impact resulting from the adoption of eco-friendly technologies affect the following?

High impact=3 Moderate Impact=2.....Low Impact=1 No Impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q10

How do the number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				

List other driving force

.....

Thank You.

Appendix II: Delphi round two

Questionnaire 2: Your input to this questionnaire is highly appreciated. Revolutionizing the Informal Labour Market through 4IR: Case of Jua Kali sector

Dear Respondent,

We are conducting research on the future of Kenya’s Informal Jua Kali Sector through the lens of the 4IR by 2063 using cross-impact analysis. Your insights are valuable for understanding the futures of Kenya’s Informal Jua Kali Sector and identifying areas for improvement in integrating advanced technologies into the informal Jua Kali sector. Could you spare a few minutes to fill out our questionnaire? Your response will be kept confidential. Thank you for your participation.

Best Regards,

Don Okello

PART 1

1. What is your name
2. Occupation/Role
3. Contact Information

PART 2

Q1

How does the Number of government policies enacted to regulate and support the integration of 4IR technologies affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				

Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q2

How does political stability in the country affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies in the informal Jua Kali labor market				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q3

How does an increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua Kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q4

How does financial inclusion in the Jua Kali sector affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q5

How does growth in digital literacy rates among informal Jua kali workers affect the following?

High impact=3

Moderate impact=2

Low impact=1

No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q6

How do social inclusion and gender equality in the informal Jua Kali sector affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q7

How does the rate of adoption of 4IR technologies affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q8

How do innovation and technological advancements affect the following?

High impact=3

Moderate impact=

Low impact=1

No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector.				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q9

How does the reduction in environmental impact resulting from the adoption of eco-friendly technologies affect the following?

High impact=3

Moderate impact=2

Low impact=1

No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Environmental sustainability				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q10

How does environmental sustainability affect the following?

High impact=3

Moderate impact=2

Low impact=1

No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms				

Q11

How do the number of legal frameworks developed to protect the rights of informal workers engaged in digital platforms affect the following?

High impact=3 Moderate impact=2 Low impact=1 No impact=0

	High impact	Moderate impact	Low impact	No impact
Number of government policies enacted to regulate and support the integration of 4IR technologies				
Political stability in the country				
Increase in access to financial capital for informal Jua kali workers and entrepreneurs engaging in 4IR-related activities				
Financial inclusion in the Jua Kali sector				
Growth in digital literacy rates among informal Jua Kali workers				
Social inclusion and gender equality in the informal Jua kali sector				
Rate of adoption of 4IR technologies in the informal Jua Kali sector				
Innovation and technological advancements				
Reduction in environmental impact resulting from the adoption of eco-friendly technologies in the informal Jua Kali sector				
Environmental sustainability				

Thank You

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