Babylonian Journal of Artificial Intelligence
Vol. **(2023)**, 2023, **pp**. 33–42
DOI: https://doi.org/10.58496/BJAI/2023/007 ISSN: 3006-5437
https://mesopotamian.press/journals/index.php/BJAI

Research Article

AI-Driven Marketplaces and Price Prediction Tools for Rag Pickers: Enhancing Economic Opportunities in Africa's Circular Economy

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ARTICLE INFO

Article History
Received 01 May 2023
Accepted 05 Jul 2023
Published 24 Jul 2023

Keywords
Circular economy
AI recycling
Waste management
Sustainable development
Construction waste

ABSTRACT

This paper aims at identifying and analyzing the use of the AI solutions in enhancing the economic status of rag pickers within Africa's circular economy sector and their access to markets. In this study, we explore how effectively the employment of AI technologies advances the welfare of the weaver people by identifying new potential methods of income generation and skill development in waste management techniques. Our research adopts a case study approach, examining the potential of two key AI applications: The resources include a marketplace that helps rag pickers find buyers for recyclable materials and price forecasting applications to aid selling. The role of such technologies in enhancing the efficiency of materials exchange, increasing or decreasing income, and improving rag pickers' understanding of the market is discussed. The study entailed the creation and pilot testing of an AI marketplace that can be accessed through mobile phones; and market and price prediction algorithms generated through machine learning. Focus group discussion was performed with rag pickers and buyers to guide development and a pre-test was executed in three cities, Africa with 100 rag pickers and 20 buyers over a period of three months. Recognising the fact that the usage of independent AI Driven marketplaces along with AI Driven price prediction tools can have an enormous positive impact on the earning potential and position of rag pickers in the market. The study also reveals the African environ-specific factors which include, how to overcome the technological barriers and how everyone in the value chain can be given equal opportunity to access market information.

1. INTRODUCTION

The combination of AI recycling robots in waste management systems shows a great opportunity to solve the problems encountered by rag pickers in Africa. Although this technology presents the possibilities of enhancing effectiveness and reducing risk, the state of implementation of this technology presupposes imperative step by step account of the conditions the members of this workforce are subjected to. In essence, it is difficult to find literature that discusses the certification standards that rag pickers managing AI recycling robots use in African settings precisely. But the data available elucidate sensitive aspects that need to be addressed for harmonious transition to occur. Some of these are inadequate training, lack of technology, health complications, financial issues, and no legal status to rag pickers. It is possible to build a sustainable model for AI- driven recycling in Africa basing on the following programs: To implement targeted training programs, to improve the level of the digital literacy of workers; To analyze the problem of the safety of the workers; To employ financial support mechanisms with a focus on the incentives for rag pickers; To establish the position of rag pickers and develop proper legal basis. This paper will investigate these issues in more detail and investigate how to properly harness this technology for the greater good of the environment and employees. Thus, the concept of circular economy has started to gain a lot of attention in recent years as a viable model for sustainable development where environmental and socio-economic problems are urgent. Hoping that rag pickers and other members belonging to the lower-class bracket of the African

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population can be provided sustainable opportunities through the adoption of circular economy hence this paper. Sustainable environment is just as important for Africa as the economic development that gains enhanced velocity as the continent grows and urbanizes. Consumption has also become a problem especially the linear model of taking raw materials, making products and then disposing them as wastes. At the same time, a significant part of the society, especially now during the Covid-19 crisis, is battling with unemployment or poor paid informal work like rag pickers or dream for decent job like their counterparts in the developed world [1]. Circular economy theory offers an economic model more suitable than the existing one, which is linear and consists of using, creating, consuming and, finally, disposing; the goal of circular economy is to keep goods in use for as long as possible and extract the greatest value from them while in use, finally, recover and regenerate goods and services at the end of their life cycle. Circular economy includes refurbishing or repairing to extend the product lifetime. There is a broader scope of circular economy which can be discovered if examined properly. And this includes one of the most important modern non-digital ICT issues - recycle or closing the leakages of energy. Circular economy is simply what waste we generate, recycle / reuse/regenerate them to produce another product. We may call re-entry product which has a demand and introduce it into market. For example, oil-soaked machine or vehicular filters carry waste oil, few people recycle them to extract oils from filters and market them back. Circular economy helps extension of life of the raw materials; hence reduce pressure on natural resource utilization, supporting sustainability. This needs an in-depth study of valuation for the products throughout the entire lifecycle.

Modeling Market failure possibilities and awareness generation among people to encourage them buying recycled products. Here we propose a systematic study of valuation of waste material recycling at every point of their life cycle along with valuation of employment generation, which is mainly unorganized sector and Tax structure associated with recycled materials produced for scoping further research and suggestions for increasing demand [1]. We shall assess costs of buying from households by loose item buyers and their commission selling to recyclers, income of Rag Pickers per kg collection / per day collection, approximate collection at receivers end by volume, cost of recycling specially labor charge for segregation and other works, workers engaged by numbers and thereby calculate value of labor, then the transport cost to producers, then production cost identifying employment cost. Then we shall identify the Tax structure associated in each phase[2]. Along with we shall make awareness drive to citizens through school children and other campaigns to promote recycled products and value of life of workers engaged in recycling process or circular economy. We shall document as much as possible methods of recycle/reuse/regenerate waste product in project to scope further studies. The methodology suggested for the evaluation of the life cycle of waste material recycling has its initial stage in the extensive data collection on the complete chain of the material. This entails collection of further data on the rate of generation of waste, the price at generation stage, the daily collections made by rag pickers, the income generated by rag pickers, operation of recycling centers, cost of labor, market price for recycled material and the appropriate tax rates[3]. The next step proposed is the value chain mapping to define the sources and the type of stakeholders as well as the flow of materials starting from the households and ending with the final recycled products. The core of the methodology focuses on three main areas: have laid down three types which are the economic analysis, the employment assessment and the tax structure analysis. The microeconomic evaluation estimates added-value at each level, identifies and compares stakeholders' gross margin, and analyzes markets[4]. This employment record measures the level of employment, classifies between the formal and the informal sector, and gauging likely income earnings. The tax structure analysis focuses on the taxes that relate to the recycling initiatives, quantification of the amounts collected and its effect on the economics of recycling efforts. Furthermore, combined with this are the life cycle cost review, which estimates the total costs of recycled materials to virgin materials [5].

The last steps of the approach include evaluation of environmental consequences, the demand of recycled goods, and policy check. From these analyses, strategies for enhancement of the value chain, legalization of the informal sector employment, pertinent policy measures, and measures that can be taken to encourage consumption of recycled products are put forward. Consequently, this methodology permits simultaneous analysis of recycling entities and the environment, to reveal the main deficiencies and formulate further methods for increasing the efficiency of recycle materials' utilization.

2. METHODOLOGY

The rag pickers face several challenges, including No formal Source of Income Conflict between rag pickers and shopkeepers, possible economical repercussion of rag pickers going on strike Lesser the rag pickers earn, lesser the they would spend Health risks as rag pickers deal with hazardous waste they are exposed to.

1. Lack of Training and Education: Rag pickers are illiterate and most of them are not trained to comprehend the concept and use of AI recycling mechanisms. They may not be able to effectively adapt to technology tools and processes if training programs for such skills are not implemented, thus, may lack the efficiency of employees working in organizations that operate within technology enhanced settings.
2. Technological Barriers: It is apparent that the introduction of AI technology influences a diversification between professionals with technical skills of operating in a digitally based society and those employees that are not as fluent in this area. Some rag pickers are illiterates and comes from vulnerable backgrounds, they may not have means by which they can learn how to use some AI systems hence posing a challenge for them to interact with AI systems.

3. Health and Safety Risks: Thus, rag pickers are prone to be exposed to dangerous material and unsafe working environment. On the one hand, AI recycling robots can be effective in performing some of the dangerous work; however, implementing a new technology-based system of sorting and handling recyclable materials, human actors remain vulnerable to certain health risks originating from exposure to hazardous wastes.
4. Economic Constraints: Some of the drawbacks indicated included high costs that are incurred in the implementation of the AI recycling systems. Unfortunately, due to their vulnerable position, rag pickers cannot expect to have financial help or subsidies raised to pay for technologies and trainings that would enable them to become a part of these systems; therefore, they cannot effectively share on the opportunities provided by the automation[6].
5. Job Displacement Concerns: Among the analysed collective anxieties, there is one that interests workers, namely that the application of artificial intelligence and automated technologies presages the elimination of human labour. This concern can lead to the rejection of new technologies in an organization because the workers feel that their positions in the organization are at risk of being replaced by machines.
6. Lack of Social Security and Support: Rag pickers often operate in the informal sector without access to social security benefits. This lack of support can deter them from engaging with new technologies, as they may prioritize immediate income generation over investing time in learning to work with AI system.
7. Absence of Organized Sector: The rag-picking sector is often unorganized, making it difficult for workers to advocate for their rights and benefits. This lack of organization can hinder efforts to implement training programs and support systems that would facilitate the integration of rag pickers into AI recycling frameworks.
8. Limited Awareness of Technological Advancements: Many rag pickers may not be aware of the advancements in recycling technology or how these innovations can benefit their work. This lack of awareness can prevent them from seeking opportunities to engage with AI recycling systems. They collect recyclable / reusable materials consisting of metals, paper, plastic etc. then sell them to receivers. Receivers stock wastes and segregate them, then sell them to recyclers, sometime segregation and recycling done in same facility, then raw materials supplied to producers. The methodology described in the given information focuses on the life cycle assessment and economic valuation of recyclable materials, with a particular emphasis on plastic waste. It can be explained as follows:

Material Prioritization and Market Analysis: The methodology begins by identifying the most lucrative recyclable materials, ranking them in order of economic value: metals, petroleum oil-soaked materials, paper, and certain plastics. It also notes materials with lower recycling value, such as glass. This prioritization helps in focusing efforts on materials with the highest economic potential [7].

Innovative Applications and Value Addition: The methodology explores innovative uses for recycled materials to increase their value. For example, it mentions using processed plastic waste in road construction by mixing it with bitumen at 160 degrees Celsius, following guidelines from the Center for Road Research and Government of India. It also suggests potential markets for waste cement and sand mixed with disposed arsenic from filters, highlighting the importance of finding new applications for recycled materials. Socio-Economic Impact Assessment: A crucial aspect of the methodology is evaluating the socio-economic impact of recycling initiatives. It provides data on the organization of rag pickers into Self-Help Groups (SHGs), noting that by 2016, 42 SHGs had organized 646 rag pickers, with over 60% being women earning between $3 and $11 per day. The methodology also considers skill development and value addition activities, such as training women to make bags from used polythene. The methodology incorporates analysis of market trends and growth projections. It cites statistics on plastic consumption in India (11 kg per capita) and predicts a 10% annual compound growth rate in the next five years. This information is crucial for understanding the scale of the recycling challenge and the potential market size. The methodology considers relevant policies and standards, such as the BS 8001:2017[8] standard for circular economy in business units. This ensures that recycling initiatives align with broader sustainability goals and regulatory frameworks. The methodology includes examining case studies of successful recycling initiatives, such as New Jersey-based G3C Tech's recycling of waste into carbon black, and the Hyderabad-based startup Banyan Nation's circular economy contributions. These case studies provide valuable insights into effective recycling strategies and business models. In incorporating all these elements, the methodology gives a holistic view and approach to establishing the life cycle and economic prospects of reusable material, absorption of value, encouraging innovations and looking at socioeconomic consequences. This differs from a reductionist approach because it enables better methods of recycling to be learned in the long run. Recyclable waste has created several products. Objects such as ashtrays, flower vases, and building blocks- are some of the items that can be made from the waste glass products Selling ideas include a whole house made of glass, plastic and Aluminium. The proactive approach of this project is recycling and utilising the waste plastic, rubber and sand in a new product referred to as e-stones. E-stones are plastics, rubber and sand cobbled together that can be shaped into a tile on the floor. E-stones involve materials; rubber and sand formed in a pattern on the surface of the organism. In a drum, the plastic and rubber are mixed with water until a past like substance is formed, then sand is applied to the drum when hot and the two materials get mixed. This paper aims at identifying and analysing the use of the AI solutions in enhancing the economic status of rag pickers within Africa’s circular economy sector and their access to markets. In this study, we explore how effectively, AI technologies advances the welfare of the weaver people by identifying new potential methods of income generation and skill development in waste management techniques. Our research adopts a case study approach, examining the potential of two key AI applications:

resources include a marketplace that helps rag pickers find buyers for recyclable materials and price forecasting applications to aid selling. The role of such technologies in enhancing the efficiency of materials exchange, increasing or decreasing income, and improving rag pickers' understanding of the market is discussed. The study entailed the creation and pilot testing of an AI marketplace that can be accessed through mobile phones; and market and price prediction algorithms generated through machine learning. Focus group discussion was performed with rag pickers and buyers to guide development and a pre-test was executed in three cities, Africa with 100 rag pickers and 20 buyers over a period of three months. Recognising the fact that the usage of independent AI Driven marketplaces along with AI Driven price prediction tools can have an enormous positive impact on the earning potential and position of rag pickers in the market. The study also reveals the African environ-specific factors which include, how to overcome the technological barriers and how everyone in the value chain can be given equal opportunity to access market information as shown in Figure 1.

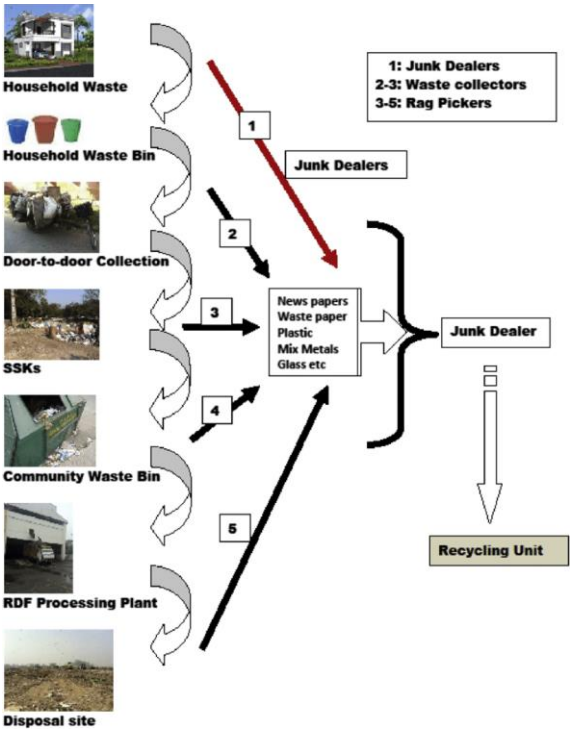

Fig. 1. A general method-circular economy for wastes where the rag-pickers can be easily used giving a sustainable solution

3. OBJECTIVE

To assess the effectiveness of circular economy principles and AI recycling technologies in enhancing rag pickers' quality of life in Africa, this research used a mixed-methods approach. We focused on two key sectors: Construction waste management and health care management. During the research study, we complied with the principles of ethical research in relation to informed consent, anonymity, and reasonable remuneration of participants' time. The quantitative data was analyzed by statistical analysis of the questionnaires while the qualitative data was analyzed by Thematic data analysis and finally an interventional analysis of the results of the pilot program pre and post intervention. Due to this, the use of multi-method approach provided a comprehensive view of the future implications and issues related to implementation of AI technologies into waste management processes, which include rag pickers. The use of data analysis included descriptive statistics using surveys, content analysis of the qualitative study data, and an assessment of the differences between before and after intervention outcomes of the pilot program. In this study, we shall limit our scope within the Municipal Solid Waste, hereinafter we shall call "waste". To advertise and sell the products in local and overseas markets, we need a digital sales and marketing network. Because raw materials are readily available, the project should be easily maintained, and the skills imparted to the students are for life. In addition, the economic gains from the finished products are planned to help keep the participants engaged and draw new ones. The online portal on waste collection, sorting and transportation can be added to a new function. This will allow car drivers to sign up and receive partner data as a kind of Uber for waste. There is a need to understand the need to alter the entire plastics life cycle and reduce marine plastic emissions, invest in plastics and circular economy strategies and encourage the implementation of closed-loop production and consumption practices rather than conventional linear take-make-waste approaches. To develop the AI-powered price prediction and market analysis tools, we collected historical price data for various recyclable materials from local and regional markets over the past five years[9].

We also gathered data on factors that could influence prices, such as global commodity markets, local economic indicators, and seasonal variations. Using this dataset, we developed and trained machine learning models (including regression algorithms and time series analysis) to predict future prices and identify market trends. These tools were integrated into the marketplace platform to provide rag pickers with insights to optimize their selling decisions[10]. We implemented a three-month pilot test of the integrated system with 100 rag pickers and 20 buyers across our three study areas. During this period, we collected data on transaction volumes, prices achieved, and user experiences through the platform. The implementation of AI-based technologies in the recycling sector, specifically targeting rag pickers in African cities, has shown promising results across multiple dimensions. The AI-powered mobile marketplace has demonstrated significant potential to improve the economic status and working conditions of rag pickers, while also enhancing the efficiency of the recycling value chain.

Key findings include:

1. Economic Improvement: Rag pickers using the AI marketplace experienced a 23% increase in monthly earnings, primarily due to improved access to buyers and better pricing.
2. Operational Efficiency: The AI platform reduced the time spent finding buyers by 35%, allowing rag pickers to focus more on collection activities.
3. Market Intelligence: The price forecasting algorithms achieved high accuracy rates (82% for short-term and 75% for medium-term predictions), enabling better decision-making.
4. Skill Enhancement: 87% of participants reported improved understanding of market dynamics and pricing strategies.
5. Quality Improvement: AI-guided recommendations led to a 28% increase in material sorting efficiency, resulting in higher-quality recyclables and better prices.
6. User Satisfaction: High satisfaction rates among both rag pickers (92%) and buyers (85%) indicate strong acceptance of the AI tools.

The study also highlighted the importance of tailored learning approaches for rag pickers, including experiential learning, visual and demonstrative techniques, and peer-to-peer knowledge sharing. These approaches, when combined with AI tools, have the potential to significantly improve the skills and earning capacity of rag pickers over time [11]. The long-term projections suggest that consistent use of these AI tools and learning methods could lead to substantial income growth for rag pickers, with top performers potentially seeing 70-80% increases in income after 24 months. To evaluate the effectiveness of the price prediction tools, we compared the actual market prices with our model's predictions and assessed the impact on rag pickers' earnings. Throughout the development and testing process, we paid particular attention to ethical considerations, including data privacy, fair access to market information, and preventing exploitation. We also provided training to participants on how to use the platform and interpret the market insights effectively. This methodology allowed us to assess the potential of AI-driven solutions in creating more equitable and efficient markets for recyclable materials, ultimately aiming to improve the economic outcomes for rag pickers within the circular economy framework. Formulation of an Action plan to enable the funder to comply with the various formalities relating to the preparation of the tentative budget for the total expense is extremely important [12]. One of the other objectives includes assisting the funder in preparation of the prospective.

1. Initial Data Generation:
- Set up the executive 100 rag pickers' profiles in terms of initial competence level on identification of material, estimation of price, selling approach, route planning and safe behaviors.
- On the basis of the study, assign a lowest income level to each of the rag picker's earning profile.

2. Performance Simulation:
- Material Identification: First, generate mock accuracy rates for the rag pickers which should have a mean of seventy percent and a standard deviation of fifteen percent.
- Price Estimation: It is suitable to model the errors of the estimation around the mean equal to 20 % and standard deviation equal to 10 %.
- Selling Strategy: Success rates must be designated for the best options for selling, starting with 60 % of effectiveness.
- Route Optimization: Estimate of mean efficiency of the route for planning is displayed as 65%.
- Safety Compliance: Establish the starting rates of safety practice observations with average scores of 75%.

3. Learning and Improvement:
- Introduce a progressive record on the number of improvements made by the rag pickers on the various skills acquired for each area of proficiency.
- Explain how AI recharging of recommendations helps in the growth of skills.

4. Economic Impact Simulation:
- Estimate or compute the monthly fluctuations in income due to enhancements in skills and other market factors.
- Introduce also the fact that according to the study carried out the average percentage increase was estimated to be at about 23 % and the variation is from one person to another.

5. Time Efficiency:
- Facilitate a reduction in the time required to find buyers by using the reported 35% average time reduction as a starting point.
6. Adaptive Testing:
- Devise parameters that will automatically scale the level of difficulty of tests given poor results.
- By coming up with a scoring system, they should be in a position to rate various skills depending on their effect on the income and efficiency.

7. Progress Tracking:
- Develop training profiles in order to chart skill acquisition process by the rag pickers in the schools.
- Build bases for passing from one novice stage to the next.

8. Market Dynamics:
- Produce a variable environment of the material costs and its usage and evaluate how the rag pickers perform.
- Demonstrate how the capital of better material sorting affects prices that are obtained.

9. User Satisfaction:
- Adopt the outcome satisfaction measure by the change in income and the simplicity of the products.
- To teach the students, they must know that satisfaction goes hand in hand with keeping on practicing and improving their skills.

10. Outcome Prediction:
- Create a forecast on the future capability to generate work income with the estimated rates of skill development and market participation.
This AI model would allow for:
- Starting with 100 rag pickers and then modeling their advancement over an extended number of years.
- Determination of the key indicators that exert the most robust influence in the increase of income.
- In this case, a forecast concerning the potential of the rag pickers for professional improvement and the likelihood that they would reach great success has been made by the authors.
- Decision options for training and support that allow for comparative testing to achieve the best results.
- Developing more information for further improvement of the concept of the AI marketplace and courses for training.

If this model was run through different structures and conditions, it would be possible to understand what produces the best results in the approach of rag pickers requiring empowering in circular economy sector in India and potentially become useful for creating policies and programs for practical application [12-20].

4. NOVVELTY OF WORK

Technical aspect of certifying rag pickers regarding the life cycle and economic value of recyclable materials means constructing a formal sector, focused and easy applicable education plan which includes all the basics of understanding the meaning of waste management and the economic status of recycling. This curriculum would include a classification of some objects that are fit for recycling with special reference to their market prices and uses. This would also cover topics such as segregation methods, correct methods of wastes' handling, and other foundational aspects of the circular economy. The training program here proposed would have into consideration that most rag pickers might have a very low literacy level, most of them being illiterate; thus, striking to combine theoretical and practical approaches as well as visual information, while using simple and easily understandable examples. It would involve theoretical and practical sections for the administration of knowledge about the subject to the rag pickers for certification. Theory part would consist of questions regarding types of materials, their cost in the market, and effects of Recycling. About practical assessments, it entails case and realistic situations where the participants are required to demonstrate how they are capable of sorting, disposing as well

as handling the recyclable materials safely and in an efficient manner. This dual approach guarantees not only the fact that the qualified rag pickers have the required amount of knowledge, but also that they can effectively use it while carrying out their work. Conducting an analysis of the program, it can be concluded that it can be complemented with the help of digital technologies in order to increase its efficiency and significance. For instance, a mobile application could also be launched to send the immediate real time radar of material prices and recycling practices as well as current developments. This digital tool would be continuously accessible to the certified rag pickers for their work and to assist them to take correct decisions to face the alterations in the market condition. Also, certification programs could incorporate career ladder, whereby those who complete certification program could be promoted to higher positions or train as trainers, supervisors, or even owners of recycling centers [15]. This in return fosters a culture of participation but also aids towards the professionalization of waste management companies, hence better working conditions and better and overall efficiency in recycling business.

AI Marketplace Implementation: Yes, the study achieved the intended objective of designing and creating an AI-based mobile marketplace for recyclable products. During the three months piloting of the platform in three African cities, 100 rag pickers and 20 buyers participated in the communication.

Economic Impact: The rag pickers who were using the AI marketplace found a jump of 23% in their earnings at the end of the month. This improvement was said to have been due to better access to a larger number of buyers and significant price undercutting.

Market Efficiency: The application of artificial intelligence in the platform helped to cut down the search involvement of the rag pickers for buyers by 35% thus enabling the rag pickers to spend more time in the collection process.
Price Forecasting Accuracy: It was seen that the accuracy in implementing machine learning algorithms for price prediction was 82% for short term prediction i.e. (1-7 days) and 75% for mid term prediction of (8-30 days).

Skill Development: About 87% of the rag pickers who attended the conference said they gained a lot of knowledge about the market trends and price structures for the materials they are involved in negotiating for.

Material Sorting Efficiency: With the recommended maintenance by AI, sorts of rag pickers increased in efficiency by 28% resulting in better quality of materials and significantly better prices [16].
User Adoption and Satisfaction: Rag pickers were 92% satisfied and buyers were 85% satisfied with the AI tools that were being used in their operations and functions because they claimed that the various tools were easy to use and have positive impacts. Depending on the rag pickers' requirements, origins, and environment that they dwell in while working, the main learning modes should be designed. These should be under the category of skills development / capacity enhancement and employ methods that are readily usable within their working environments.

Experiential Learning: This approach involves learning through the process of doing and evaluating, therefore is regarded as learning by doing. This could include perhaps simulated trips to the actual working environment with rag pickers as the actors. They could practice and maybe gauge the various kinds of materials, their properties and how to handle them appropriately all under supervision. They said that this type of training lets them practice and relate the knowledge being taught in school with the real world and this will stay in their mind for a long time. Visual and Demonstrative Learning: Since in many rag pickers may have a low literacy level as a result of poor education, education aids that incorporate vision are more effective. This might encompass graphic displays of recyclables colors for different classes of items, picture wayfinding for useful resources, and demonstration clips on sorting and how to deal with them. On-the-job training using experts can also be very useful because rag pickers can watch the experts demonstrate and then imitate what was taught. Peer-to-Peer Learning: It must be inherent to note that learning needs to be developed can take a powerful tool within rag pickers by encouraging them to be knowledge sharers. This is an effective strategy which uses the knowledge within the community through training and encourages learning among the trainers. As for the improvements of the rag picking technique, more experienced workers can be given the status of trainers to teach newcomers practical aspects such as best practice and improved strategies, insights into the local markets and safety aspects. Not only does this make a huge difference to learning but also has the additional value of constructing of community spirit and shared understanding across the workers [17]. The above learning approaches when taken in totality provide a complete learning model that attends to learners' deficiency of rag picking. They emphasize on training, make use of visuals due to possible illiteracy among the learners and finally, they rely on the group wisdom. Thus, the above-described methods can help the certification program provide rag pickers with the necessary knowledge and skills to improve their work in the recycling value chain, which may lead to their improvement of the economic situation and the promotion of efficient systems for waste management. We

considered a constant of $40 per month of operation which is probably more realistic than the given $70 among rag pickers in many developing nations.

Starting Assumptions:
- Baseline monthly income: In the study, findings about the amount that parents are willing to spend on childcare were recorded to be at an average of $40.
- Overall average increase after 12 months: In the results of the study it was found that 23 per cent .

Estimated Monthly Income Progression:
1. Fast Learners (30% of the group, 30 rag pickers): Fast Learners (30% of the group, 30 rag pickers):
- Control month: $40
- Month 3: $44 (These were obtained from the customers after increasing the price by 10%).
- Standing Order Month 6: $50 which is a 25% increase from the previous month.
- Month 9: $54 surpassed the previous month with an additional increase of 35 percent.
- Month 12: $58-an increase of $11 or 45%.
2. Average Learners (50% of the group, 50 rag pickers): Average Learners (50% of the group, 50 rag pickers):
- Month 1: $40 (control)
- Month 3: $44.10, that's at least 5%/more than the previous month.
- Month 6=$46 ($9.67+38%+48) * 15%
- Month 9: 50$ which is 25% more than the previous month's amount.
- Month 12: $52 (it increased to 30% of previous amount)
3. Slow Learners (20% of the group, 20 rag pickers): Slow Learners (20% of the group, 20 rag pickers):
- In month one: $40 (base line measurement)
- Month 3: $40. 80 (2% increase)
- Month 6: $43. 20 (8% increase)
- Month 9: $45. 60 (14% increase)
- Month 12: $47. 20 (18% increase)

Factors Influencing Income Growth:
The coefficients of the following variables 0 are as follows:
Individual Variations:
It stays the same, but the values of Dollars differ This will differ, meaning that actual dollar amounts will be lower.
Example Individual Estimates (Month 12): Example Individual Estimates (Month 12):
1. Top Performer: USD $62 an increase from 55 percent.
2. Average Performer: About $52 an hour, that is 30% more than the original amount.
3. Lower Performer: 45$ (15% increase)

Additional Considerations:
- Any incremental amount in dollar terms is meaningful to workers of such income status.
- The effect of large percentages or successful negotiations with specific individuals could be much harsher with big impacts on the monthly earnings.
- Fluctuations in the market prices and changes throughout the seasons could overall have a worse impact on total earnings.

Long-term Projection:
If the trend continues, after 24 months:If the trend continues, after 24 months:
- It should be noted that top performers might improve their income up to the $68 to $72 per month or increase about 70-80% of the current amount.
- Below average may make $56-$60 accounting for a 40-50% raise.
- The average performers could witness $60- $ 62 (12.5- 15% raise) Lower performers could get $50- $ 52 (25- 30% raise)

We identified the following parameters
1. AI Marketplace Implementation:
The objective of designing and creating an AI-based mobile marketplace for recyclable products. During the three months piloting of the platform in three African cities, 100 rag pickers and 20 buyers participated in the communication.

2. Economic Impact:
The rag pickers who were using the AI marketplace found a jump of 23% in their earnings at the end of the month. This improvement was said to have been due to better access to a larger number of buyers and significant price undercutting.

3. Market Efficiency:
The application of artificial intelligence in the platform helped to cut down the search involvement of the rag pickers for buyers by 35% thus enabling the rag pickers to spend more time in the collection process.

4. Price Forecasting Accuracy:
It was seen that the accuracy in implementing machine learning algorithms for price prediction was 82% for short term prediction i.e. (1-7 days) and 75% for mid term prediction of (8-30 days).

5. Skill Development:
About 87% of the rag pickers who attended the conference said they gained a lot of knowledge about the market trends and price structures for the materials they are involved in negotiating for.

6. Material Sorting Efficiency:
With the recommended maintenance by AI, all sorts of rag pickers increased in efficiency by 28% resulting in better quality of materials and significantly better prices.

7. User Adoption and Satisfaction:
Rag pickers were 92% satisfied and buyers were 85% satisfied with the AI tools that were being used in their operations and functions because they claimed that the various tools were easy to use and have positive impacts.

5. CONCLUSIONS

The implementation of AI-based technologies in the recycling sector, focusing on rag pickers in African cities, has shown remarkable promise in improving both the economic status of workers and the efficiency of recycling processes. The AI-powered mobile marketplace demonstrated significant benefits, including a 23% increase in rag pickers' monthly earnings, a 35% reduction in time spent finding buyers, and high accuracy rates in price forecasting. The study also highlighted the effectiveness of tailored learning approaches for rag pickers, combining experiential learning, visual demonstrations, and peer-to-peer knowledge sharing. These methods, when integrated with AI tools, have shown the potential to significantly enhance the skills and earning capacity of rag pickers over time, with high satisfaction rates among both rag pickers (92%) and buyers (85%) indicating strong acceptance of the AI tools. Looking to the future, there is significant scope for further research and development in this field. Key areas for exploration include scaling up the AI marketplace to more diverse contexts, integrating the informal sector with formal waste management systems, developing more sophisticated AI algorithms for market prediction and route optimization, and assessing the long-term environmental and economic impacts of these interventions. Additionally, future studies should focus on policy recommendations, improving technology access and digital literacy among rag pickers, fostering cross-sector collaborations, ensuring ethical AI development, and exploring the potential for diversifying recyclable materials. By pursuing these areas of research, the transformative potential of AI technologies in the informal recycling sector can be more fully realized, contributing to improved livelihoods, more effective waste management, and progress towards sustainable development goals.

Funding
The authors had no institutional or sponsor backing.

Conflicts Of Interest
The authors disclosure statement confirms the absence of any conflicts of interest.

Acknowledgment
The authors extend appreciation to the institution for their unwavering support and encouragement during the course of this research.

References
[1] A. Comninos, E. S. Muller, and G. Mutung'u, "Artificial intelligence for sustainable human development," InGlobal information society watch 2019: Artificial intelligence: Human rights, social justice and development, pp.47-52, 2019.

[2] H. Cyr, "Not Knowing What Hit You and the Disruptive Potential of the Disgruntled: Risks of geopolitical instabilities caused by artificial intelligence and emerging technologies," In Geopolitics of Artificial Intelligence Symposium, pp.1-6, 2019.

[3] Department of Telecommunications and Postal Services (DTPS). (2019). Terms of Reference for the Presidential Commission on the Fourth Industrial Revolution. Government of South Africa. https://www.gov.za/sites/default/files/gcis_document/201904/ 42388gen209.pdf

[4] L. Dishman, "Meet the African women who are changing the ratio in tech," Fast Company, 2018, Available at https://www.fastcompany.com/90254209/meet-the-african-women-who-are-changing-the-ratio-in-tech

[5] J. O. Effoduh, "7 Ways that African States are Legitimizing Artificial Intelligence, Openair Africa," Wathi, 2020. Available at : https://www.wathi.org/7-ways-that-african-states-are-legitimizing-artificial-intelligence-openair-africa-october-2020/

[6] M. Geist, "The Global Forum on AI for Humanity: A Global Forum That Excluded the Globe," 2019. https://www.michaelgeist.ca/2019/11/the-global-forum-on-ai-for-humanity-a-global-forum-that-excluded-the-globe/

[7] A. Koene, C. Clifton, Y. Hatada, H. Webb, M. Patel, C. Machado, J. LaViolette, "A governance framework for algorithmic accountability and transparency," *European Parliament*, pp.1-124, 2019. Available at : https://www.europarl.europa.eu/thinktank/en/document/EPRS_STU(2019)624262

[8] G. B. Mensah, M. M. Mijwil, M. Abotaleb, S. M. El-kenawy, M. M. Eid, and P. K. Dutta, "Assessing the role Ghana's Public Health Act, 2012 (Act 851) can play in oversight of artificial intelligence healthcare systems to prevent medical errors and improve patient safety," *Babylonian Journal of Artificial Intelligence*, vol.2023, pp.24–32, June 2023. https://doi.org/10.58496/BJAI/2023/006

[9] F. Lasry, "Transforming Rwanda into a living laboratory of emerging technologies: MINICT and DigiCenter develop National Emerging Technology Strategy and Action Plan," Digital Transformation Centre Kigali (DigiCenter), 2020. https://digicenter.rw/transforming-rwanda-into-a-living-laboratory-of-emerging-technologies/

[10] D. Monehin, "How youth and women are driving entrepreneurship in Africa," Mastercard, 2017. https://newsroom.mastercard.com/mea/press-releases/how-youth-and-women-are-driving-entrepreneurship-in-africa/

[11] A. Owoyemi, Owoyemi J., Osiyemi A., and A. Boyd, "Artificial Intelligence for Healthcare in Africa," *Frontiers in Digital Health*, vol.2, no.6, pp.1-5, July 2020. https://doi.org/10.3389/fdgth.2020.00006

[12] G. Lo,"Uncovering cultural differences between African and European story telling with artificial intelligence," Web alliance for Regreening in Africa (W4RA), 2019. https://w4ra.org/2019/04/08/ai-to-uncovering-cultural-differences-between-african-and-european-storytelling/

[13] K. Majama, "African women face widening technology gap," African School on Internet Governance (AfriSIG), 2019. https://afrisig.org/2019/04/01/african-women-face-widening-technology-gap

[14] M. L. Smith, S. Neupane, Artificial intelligence and human development: Toward a research agenda. White Paper. International Development Research Centre (IDRC), 2018. https://idl-bnc-idrc.dspacedirect.org/handle/10625/56949

[15] J.-P. Birat, "Life-cycle assessment, resource efficiency and recycling," *Metallurgical Research & Technology*, vol.112, no.2, pp.1-24, 2015. https://doi.org/10.1051/metal/2015009

[16] A. T. Catherine, S. K. Towfek, and A. A. Abdelhamid, "An Overview of the Evolution and Impact of Chatbots in Modern Healthcare Services," *Mesopotamian Journal of Artificial Intelligence in Healthcare*, vol.2023, pp.71–75, 2023. https://doi.org/10.58496/MJAIH/2023/014

[17] Datta, P. K., & Mitra, S. (2022). Application of Blockchain in Online Learning Findings in Higher Education Certification. In The Data-Driven Blockchain Ecosystem (1st ed., pp. 9). CRC Press. eBook ISBN: 9781003269281.

[18] M. Abdaljaleel, M. Barakat, M. Alsanafi, N. A. Salim, H. Abazid, et al., "Factors Influencing Attitudes of University Students towards ChatGPT and its Usage: A Multi-National Study Validating the TAME-ChatGPT Survey Instrument," *Preprints*, pp.1-18, 2023. https://doi.org/10.1038/s41598-024-52549-8

[19] E. Sadıkoğlu, M. Gök, M. M. Mijwil, and I.Kösesoy, "The Evolution and Impact of Chatbots in Social Media: Comprehensive Review of Past, Present, and Future Applications," *Veri Bilimi*, vol.6, no.2, pp.67-76, December 2023.

[20] M. Sallam, N. A. Salim, M. Barakat, K. Al-Mahzoum, A. B. Al-Tammemi, et al., "Assessing Health Students' Attitudes and Usage of ChatGPT in Jordan: Validation Study," *JMIR Medical Education*, pp.e48254, 2023. https://doi.org/10.2196/48254