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Waste and circular economy (CE) : an evolutionary view and a panacea for sustainability of waste industry in Ghana.

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ABSTRACT

CE evolutionary approach is still relatively unknown in Ghana irrespective of its groundbreaking 7-8 May, 2016 business opportunities seminar for many attendees. For instance, over 200, 000 working population in Suame magazine in Kumasi are unaware of their involvement in a category of CE. (Market survey of waste and CE in Ghana, 2016). Consequently, this paper explores novel transformation towards the CE and waste from an evolutionary approach and sustainability in Ghanaian waste industry.

CE is defined as "an industrial economy that is restorative by intention and design "(MacArthur, 2015). CE which serves as driving waste management market with proactive government and private measures to decrease dumping, adopt sustainable waste and practice of 5 Rs (Refuse, Reduce, Reuse, Rot, and Recycle) for service delivery and revenue generation.

CE approach aims at mitigating of climate change and calls for actions to transform the dominant linear economy (LE) economic system currently in Ghana that encourages massive consumption and environmental pollution thereby leading to socio - economic un sustainability (Dahmen, 1950; Costanza, et al. 1997; Daly, 1991)

Key Words : Plastics ; Circular Economy; Transformation; Evolutionary View; Socio- - Economic Sustainability and Plastic Waste Industry.

Introduction and Context of Study

Plastics and other forms of waste serve as a life-changing resource, but at the same time have qualities that make them useful alongside poor waste management that have contributed to Ghanaian waste challenge. The world's industrial innovation used plastic waste for packaging, shoes, furniture, bags, toys, automotive manufacturing, household appliances, electronic goods and agriculture in the arena of industrial ecology irrespective of adverse effects of unprocessed ones on biodiversity, climate change, marine pollution, and chemical contamination when produced and disposed poorly in the environment. (Geyer et al. , 2017) .

Plastic waste recycling is a very important strategy towards CE but achieving circularity required an action at every point in the product lifetime from design to

waste management. This can be achieved through Alliance six action areas : Front-end Design (design product to last long and easy to repair),Access to Collection (infrastructure with enabling convenient and necessary recovery of waste),
Participation and Engagement (awareness creation to instil sustainable participation), Sorting according to type, dry or wet, Processing (recovery and recycling methods) and End Markets derive demand for recycled materials from all recycling methods (Alliance, 2021)

Concept of CE, Transitional Evolutionary and Sustainability

CE which is restorative by intention and design "(MacArthur, 2013) serves as a strategy to transform plastics to mitigate climate change gained a sterling attention in national and international policy arena in both engineering and natural science literature.

The transitional evolutionary and sustainability approaches focus on economic industrial system including management and strategic niche management; ecological and multi-level socio - technological innovation
systems (Kemp, 2009).

The CE discourse is mainly based on ecological view complemented with an evolutionary mechanisms of industrial transformation (Armaghan Chizaryfard et. al., 2020) has both positive and negative impact present in Ghana that has about 12,710 tons of solid waste is generated daily, with 10% collected and dumped into drains and open spaces thereby creating environmental impacts like infectious diseases, land and water pollution, floods and loss of biodiversity. AMA and TMA have plastic waste output of 1kgs /ppd with population of 2.7 million and waste of 2,700 tons per day. 25 CE SMEs recycle 320 tons at the value of EUR 44,100 daily and pays EUR 1.15 million to waste collectors. AMA and TMA are chosen for the research due to their contribution of over 10% waste output in Ghana.

Ghanaian Plastic Recycling Waste Companies

In all we have over 25 well established plastic recycling waste companies presently operating in Ghana. These companies processed 320 tons of plastic per day comprising pure water sachet waste. These consumed in Ghana and the rest imported Togo, Mali and Burkina Faso. Products made from recycle plastics include take away carrier bags, shoes, bowls, buckets, car mats, dustbins, chairs, tablets, bottles and many more. Even though the above list is impressive, plastic recycle materials are very weak in Ghana and this contributes to release of 73 million of plastic bottles into the environment every with its attendance environmental pollution and health hazards.

The proposed solution of the above focuses on promoting a circular economy that is defined as "an industrial economy that is restorative by intention and design "(Macarthur, 2013). CE which serves as driving waste management market with proactive government and private measures to decrease dumping, adopt sustainable waste and practice of 5 Rs (Refuse, Reduce, Reuse, Rot, and Recycle) for service delivery and revenue generation.

The improvement of the above system is done through ten (10) " R Strategies") as shown as follow : In all the stages, refuse is collected(R0), market the product(R1), a reduction is achieved (R2), reuse by another(R3), repair(R4), refurbish(R5), Re manufacture(R6), repurpose(R7) resources are e-cycled (R8) and energy is recovered(R9).

This approach is currently minimal in transformed waste application to energy, agriculture and other sectors in Ghana. The actors involvement or relationship that make up the system

will enable system actors to be involved in all the project cycle to contribute innovation (co creation and innovation), improved business climate and transform consumers to supplies when engaged in CE " R strategies" by creating enabling sharing, collaborating and networking with other stakeholders and organisations as shown in the table below :

The R-strategies are depicted in Table 1 is adapted from Market survey of waste and CE in Ghana, 2016**. From a sustainability point of view the low R strategies are the preferred options (but all initiatives are laudable).**

Type	R#	Name	Strategy
Smarter product use and manufacture	R0	Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
	R1	Rethink	Make product use more intensive (e.g. through sharing products, or by putting multi-functional products on the market)
	R2	Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend the lifespan of the product or its parts	R3	Re-use	Re-use by another consumer of discarded product which is still in good condition and fulfills its original function
	R4	Repair	Repair and maintenance of a defective product so it can be used with its original function
	R5	Refurbish	Restore an old product and bring it up to date
	R6	Remanufacture	Use parts of a discarded product in a new product with the same function
	R7	Repurpose	Use discarded product or its parts in a new product with a different function
Useful application of materials	R8	Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	R9	Recover	Incineration of materials with energy recovery

Table 2. R-Strategies in the Circular Economy (Ibid adapted from Market survey of waste and CE in Ghana, 2016**). R -rankings of selected CE initiatives in Ghana.**

#		R0	R1	R2	R3	R4	R5	R6	R7	R8	R9
1	Suame Magazine in Kumasi					X	X				
2	Katemfe leaves as food packaging	X									
3	Bamboo bicycles initiative	X									
4	Closing the Loop	X								X	
5	City Waste Recycling									X	
6	Environment 360									X	
7	Safi Sana			X						X	X
8	GRIPE: Building from plastic modified concrete			X							
9	Switch Africa industrial symbiosis program				X						
10	COLIBA waste management app	X								X	
11	Agbogbloshie Makerspace Platform				X	X	X	X	X		
12	Nelplast from plastics to asphalt roads									X	

'' With the above strategies in hand, it's possible to categorize a range of current CE initiatives in Ghana and get an impression of the current state of affairs. The cases originate from the EU CE event, the Africa CE network and additional research. They are presented in random order. Below is brief explanation of the initiatives(Not exhaustive):

1. Suame Magazine in Kumasi is the largest artisan engineering cluster in sub-Sahara Africa/West Africa. It has a working population of over 200,000 and approximately 12,000 shop-owners, mainly engaged in vehicle repairs and refurbishment and metal works. This places Suami Magazine in the R4, R5 and R6 category of the circular economy, although probably none of the 200,000 workers is aware of this.

2. In earlier days, large Katemfe leaves (Thaumatococcus daniellii; local name: "Ahaban") were often used in Ghana for food packaging and consumption. Now this habit is being re-introduced as a way to curb plastic packaging. Interestingly, the Katemfe leaves are reported to have medicinal properties in a sense that they reduce fats and cholesterol in the blood. They also enhance the flavour of food. This is a typical example of an R0 CE strategy: the Katemfe leaves offer the same function as plastic, and more!
3. The bamboo bicycles initiative scores an R0 for offering the same function with a different product. What is especially sustainable in this case is that use is made of bamboo, which replaces the metal frame and is abundantly available in Ghana.The company wants to diversify into e-bikes and solar bikes. It is a truly purpose driven company – they have given away 500 bamboo bicycles to Ghanaian youngsters.
4. Closing the Loop is an ingenious business model (R0) for the recycling (R8) of discarded mobile phones in Ghana. The Dutch company has a mobile phone offset program, in which it strikes a deal with big Governmental organizations and private companies in the Netherlands. The moment these companies purchase new mobile phones for their employees, they pay Closing the Loop to collect an equal amount of discarded mobile phones in Ghana. The precious metals in the phones add to the business model. Closing the Loop aims to expand its operations in Africa. This business model could probably be applied to other products as well.
5. City Waste Recycling (CWR) – Ghana based CWR recycles waste (category R8) ranging from e-waste and batteries to sawdust and plastic. It sources its materials from local industries and waste collectors in the city of Ho. From this waste, CWR generates products such as plastic pellets, printed circuit boards and biogas (compost). It exports recycled e-waste products.
6. Environment360 creates community and corporate recycling programs in Ghana. This places the company in the R8 category. It collects the waste and sells of the recyclables. It further works on awareness raising on waste recycling and sanitation issues.
7. Safi Sana-The Netherlands based and previously mentioned company Safi Sana collects faecal and organic waste from urban slums (toilets, food markets, industries and slaughterhouses). This waste is treated in a digester to create organic fertilizer, irrigation water and biogas. Thus, a reduction of the use of resources is achieved (R2), resources are recycled (R8) and energy is recovered (R9). The biogas is used to produce electricity and the irrigation water and part of the organic fertilizer are used to grow seedlings.
8. GRIPE is the Ghana Recycling Initiative by Private Enterprises, an industry coalition of eight major manufacturing companies. Its pilot of a five-seater toilet facility in Kumasi built from the first plastic modified concrete gains the coalition a spot in the R2 category.
9. Switch Africa's industrial symbiosis program for three regions in Ghana (Ashanti, Greater Accra and Western Region) is an activity in the R3 category, where waste of one company is used as a resource by another.

10. Agbogbloshie Makerspace Platform. AMP is a maker collective sited at and around the Agbogbloshie e-waste scrapyard in Accra. It serves as a regional hub for recycling and local manufacturing. Materials, parts and components are reclaimed from expired consumer goods, remade as feedstock for new manufacturing and repurposed with new use-value. Initiated by DK Osseo-Asare and Yasmine Abbas in 2012, AMP has engaged over 1500 youth from West Africa, Europe and USA. It ranks R3 to R7 on our CE scorecard.
11. Nelplast is turning plastic garbage into stone-like pavement blocks which can be used to build new roads. Nelplast can use just about any form of plastic waste to create their asphalt-like material. This technology can be categorized in the R8 section of the CE (recycling).

All the above examples show the variety of ways that the CE is already taking shape in Ghana (and there are many more). In some cases, it is a question of reaching back to old habits, such as wrapping foodstuff in Katemfe leaves, using baskets instead of plastic bags when going to the supermarket, or engage in home composting in the back yard. In Suame Magazine and at the Agbogbloshie Makerspace Platform one could speak of a "poor man's CE", well suited to the Ghanaian circumstances and with an occasional innovative twist. The bamboo bicycle initiative is vintage CE in a sense that it is a redesign of a well-known product to replace expensive parts (with a significant environmental footprint) with locally available material, in this case bamboo.In addition to the sustainability gain is the fact that the end product is a bike, which can replace the use of a car for short distances. Finally, the "Closing the Loop" initiative is an effort to achieve sustainability gains through a materials offset program in phones between the Netherlands and Ghana (and possibly more countries in the future).

An important aspect of the CE approach is the emergence of a so called "sharing economy". Here, business concepts are based on the replacement of ownership of equipment, tools, consumer goods etc. by a mechanism of sharing resources. In the market study no formal examples of the sharing economy were encountered, although no doubt at an informal level a lot of resources are shared in Ghana. One sector in which the sharing economy could be promising is agriculture. Ghana, surprisingly, depends on food imports. Sustainable and circular agriculture (including circular solutions for organic waste), possibly based on cooperative (sharing) models may answer a need and could even play a role in ameliorating the challenging land ownership situation"(Market survey of waste and CE in Ghana, 2016).

All the aforesaid examples can serve as an inspiration for additional ideas to promote the CE in Ghana. This is the goal of the Ghana chapter of the African CE Network. '' (Ibid adapted from Market survey of waste and CE in Ghana, 2016).

Evolutionary Approach of Transformation to CE

The Ghanaian CE discussion above presents the evolutionary approach of processes in Ghana. The approach and framework integrates evolutionary aspects of transformation from economic, technological and ecological sustainability perspective as shown in Ghanaian waste CE.

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