THE ART OF WASTE MANAGEMENT IN A CIRCULAR ECONOMY. CASE STUDY ZABRZE MUNICIPALITY

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Abstract

Advance technology helps us in the depicting reality in a particular phenomenon of plastic packaging and waste management. Waste collection constitutes a large proportion of the total modern Urban and municipal solid waste management costs nationwide and the world at large. In Republic of Poland precisely in Zabrze waste management presently account for 40-50% of the total municipal cost. It is therefore very urgent and crucial to improve the waste collection system through developing an optimization management process and geographical Information System (GIS) technology. In Zabrze there is lack of an advanced modelling framework for decision makers to analyze and simulate various spatial waste management problems, including waste collection points and sorting mechanism. The study uses Geographical Information Systems (GIS) and type of settlement as per urbanization and development to help in waste management, especially in analyzing and mapping distribution of items and facilities within a study environment. An analyze of demographic distribution was examined and an estimate of Solid Waste Collection Points in Urban city of Zabrze was observed using ArcGIS. Infancies was place on access road network, population distribution, commercial activities, and settlement approach to then determine waste volume and waste category.

The approach used in this study to achieve the aim and desire result was map of settlement in terms of population distribution and structure, infrastructure, road network, commercialization and industrialization, waste classification, waste development from production to life span, waste identification, inventory for the solid waste collection points in Urban Silesian city of Zabrze and to examine the type and patterns of the distribution. Data related to the list of the collection points was sourced from ArcGIS survey which was

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then used for taking the coordinated points of each solid waste collection point in the study area. ArcGIS online was/is used to collect and analyze the result.

Keywords: waste management, Circular economy, sustainable design, bio-economy, plastic packaging, and policy sustainability

JEL Classification: -

1. Introduction

Over the last two decades, substantial process sustainability activities has been recorded in literature reviews about waste and circular economy. According to [1], restructuring and redesign of manufacturing system is the best option to control waste management. Circular economy greatly relies on good practice and better waste management for a smoot implementation [2]. The process simulation sustainability is becoming a standard road for evaluating changes in a short time. The concept of sustainable process in plastic packaging and waste management development and collection points is a strategy of urban city-based policy that help evaluate the creation of products and goods using a systematic process, non-pollution system and environmental externalities. The strategy for sustainable production and waste management is circular economy [3]. The creation of negative impact on our today's environment stem from many channels. Therefore, there is a duty to preserve energy resources and raw materials while perusing positive economic viable. The process industry has a unique position since it transforms raw materials feedstock into intermediate and end-uses. We believe that the industry empower organization to improve competitive in waste management, it will drastically reduce negative resources and energy insufficient as industries effort to minimize cost. According to **[4],** Waste collection is one of the most critical logistics activities in modern cities with considerable impact on life, urban environment, city attractiveness, traffic flow and municipal budget.

For individuals, industry, and government to reduce waste, we should largely recognize that all large components of industrial property like value chain have to consider including raw materials, feedstock, source of raw materials and feedstock. The manufacturing process of all goods and services beginning with the intermediate production and end-uses, users need and waste flow between sources to finish or bottom line of its diminishing return has a source.

The waste system in the era of eco-sufficient and eco-efficient that aim to promote a more sufficient and efficient use of raw materials and energy. This can be done in a way that promotes a more efficient and sufficient positive economic cost and environmental externalities and reduce industries Cost. For us to achieve such a positive impact we need waste design or eco-design where environmental parameters are taken into consideration right from the design of products and processes. Eco-design or waste design control waste right from operational contributions of sustainable development from production level to to finish or end results [15].

2. Classification and characteristics of the study area

This section will contain the information that will help better implement waste management in the city of Zabrze. In order to be efficient and effectively in implementing a waste collection points there must be a proper definition and classification of the city like geographical location, administrative setup, population distribution, commercial activities, road network distribution

For us to properly allocate and put in place to collect waste management and recycle we need a analysis. The population and administrative division of a town help in waste management system proper. A city and town like Zabrze can be properly access with the use of a system put in place by the administration of Zabrze. A good road network help us to properly put in place a waste management system that that help the community and public at large. A good commercial system and industrial set up help us understand the type of waste predominant in every city. If possible, this study will try to analyze the type of food commonly consume in the city to be able to designed a system of waste management that can easily set up a waste mechanism

2.1 Geographic map of Zabrze

Zabrze is a city in Poland. Its area is 29 square miles 80 km2 and Latitude 50.3249, Longitude 18.7857 .Zabrze is located in the Silesian Voivodship, which was reformulated in 1999. Before 1999 it was in Katowice main capital office. It is one of the cities composing the 2.7 million inhabitant conurbation referred to as the Katowice urban area, itself a major center in the greater Silesian metropolitan area which is populated by just over five million people. The population of Zabrze as of December 2019 is 172,360.

2.2 Administrative partition of Zabrze

Zabrze city council decided on 17 September 2012, that a new administrative division of the city. Zabrze was subsequently divided into 15 districts and 3 housing estates.

Figure 1 administrative set-up Zabrze: Source, Owner

The figure 1 above represent the various districts in Zabrze. The city is partition into several districts to ease the cost of waste management and administration. In this city waste collection points are distributed easily due to population settlement and administrative set up as represented in the above diagram**.**

2.3 Roar network distribution

The international E-road network is a numbering system for roads in Europe developed by the United Nations Economic Commission for Europe (UNECE). The network is numbered from E1 up and its roads cross national borders. It also reaches Central Asian countries like Kyrgyzstan, since they are members of the UNECE. The Polish A4, which is part of the European E40. Main international traffic arteries in Europe are defined by ECE/TRANS/SC.1/2016/3/Rev.1 which consider three types of roads: motorways, express roads, and ordinary roads.

Figure 2 road distribution network in Zabrze by gpmap Zabrze

The A4 autostrada in Poland is a 672 km (418 mi) long east–west motorway that runs through southern Poland, along the north side the Sudetes and Carpathian Mountains, from the Polish German border at Zgorzelec-Görlitz (connecting A4 autobahn), through Wrocław, Opole, Gliwice, Katowice, Kraków, Tarnów and Rzeszów, to the Polish-Ukrainian border at Korczowa-Krakovets (connecting to the M10). It is a part of European route E40.

2.4 Settlement format of Zabrze

The pattern of rural settlement can differ from a single farm to a cluster of houses. (Dispersed, linear and nucleated.) In the past most of the population lived in rural areas.

Figure 3 population distribution of Zabrze by gpmap of Zabrze

From the (Fig 3) we can see the yellow dotes on the map. This does represent the population +of Zabrze. With this population distribution we are able to know where high volume of waste will be found and we can easily managed. From the map we can see that majority of population is located around the following districts (Biskupice, Guido, Zaborze Polnoc, Zandka, Centrum Poludnie, Os. Tadeusza, otarbinskiego, Mikulczyce, Os. Mikolaja Kopernika, Maciejow and Pawlow). For proper was management system and approach attention should be place on this areas and in this districts because it has a higher population concentration.

2.5 Commercial activities in Zabrze

The majority of the inhabitants of Zabrze are involve in activity such as farming, fishing, forestry, and mining. The type of activities of an inhabitant determines the type of waste in that locality. An area with high industrial set up has more waste than an area of land with

agricultural setting. A commercial area is more likely to have more waste than a locality made up of petite business. Like other towns in this populous region, it is an important manufacturing center,having coalmines, iron, wire, glass, chemical and oil wor ks, and local Upper Silesia Brewer.

Figure 4 Commercial concentration of Zabrze by gpmap Zabrze

From the (fig 4) we can see the green and red icons in the diagram. They indicate location of commercial activities in the town of Zabrze. To properly and effectively manage waste we can focus on this districts (Mikulczyce, Os. Tadeusza Kotarbinskiego, Centrum Polnoc, Centrum Poludnie, Zandka and Guido).

2.6 Waste classification

Table 1, waste classification by owner (2021)

S/No	SOURCE	DEVELOPMENT PROCESS	TYPE OF WASTE	VOLUME
1	Residential waste	Consumption of Finish Products	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, white goods, batteries, oil, tires), and	High

			household hazardous wastes	
2	Industry waste	Construction of consumer and non-consumer products	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	High Volume
3	Institutional waste	Writing and documented items from:☺) Schools, hospitals, prisons, government centers	Surgical parts, Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes	Mixed volume
4	Construction waste	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, iron etc	Mixed volume
5	Municipal waste	Reclamations, Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational area, sludge	Mixed volume(high/low)
6	Commercial waste	Stores, hotels, restaurants, markets, office building	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous waste	Mixed volume(high/low)

7	Agriculture waste	Crops, orchards, vineyards, dairies, feedlots, farm	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g., pesticides)	Very low volume

Production processes, brand, quality, classification, size and systems used can play a very important role in waste management. In an industrial environment and world at large. A huge economy, large environmental issues are either directly related to product which in return provides large number of environmental issues which either directly relate to production processes and uses of products or services.

2.7. Municipality of Zabrze and waste collection scheme

The general development and production of municipal waste in Zabrze is estimated at 1000s tons per month. Waste collection is carried out manually and mechanically, using bins station in specify areas and -end loaded compaction trucks with 40-ton average capacity. The crew size on the vehicle is three persons, a driver who never leaves the truck due to required safety regulations and two workers who move and align the bins with the hydraulic lifting mechanism of the truck. The Municipality of Zabrze is empirically divided into 18 districts collection zones and each of these districts are further divided into sub-sectors base on population of such a district. Waste is collected in each sub-sector every other day. Most of the bins vary in quantity from size, of 120 and 240 L capacity to 300 L depending on the district, but a few larger volume wastes exist in some central points.

3. Problems identified within the waste management in Zabrze

There are many problems face by waste management sector today due to the high and rapid increase in population. Sustainable logistic system has not been well developed for waste management [12]. As a result to effectively and efficiently distribute a waste collection point we need the geographical set-up, scenery, population, settlement structure of the area.

We identify that most system of waste management doesn't take into consideration that geographical location of some of the area of waste disposal especially increase generated waste [11]. For every system to effectively manage waste it must take into consideration the population distribution of that environment. Residential areas within an urban locality generate very insignificant amount of waste than a locality of an urban area, So, in order to perfectly solve the problems and preserved lives we must take into consideration many activities that create hazard to the society created from poor waste disposal. Rapid growth and urbanization is leading to management challenges in waste management systems [13].

Population concentration also help policy makers to effectively and efficiently manage waste within a given locality. A good locality that make good used population helps in a

great way to mitigate the negative impact of waste disposal. A system that is made up of young people turn to exhibited high volume of waste. Young people have a high demand and desire for new things and so too the volume of waste is available in their disposal.

Commercial nature of a town determine the available and volume of waste in that locality. This has always been a problem but fail to be identify by most of the waste administrators. A highly commercial town turn to generate more waste than a locality manage up of local retail shops. From the map of Zabrze we seen that some cities generate more waste than other cities due to abundant of waste disposal. For this reason we urge stack holders to take into consideration the nature of commercial activity carried out within a town to determine the type of waste and amount of waste disposal in that locality. Sociocultural and political situation of a city hinder proper waste management [14].

3.1 Discussion of material and method

The most important point of the proposed analysis is GIS technology. GIS will and is going to provide an effective mean to import waste from bins and export to dumping center or recycle centers, manage, and analyze the spatially based data. The methodology used in this work comprised of Step 1 establishes the spatial database of the distribution of the study area. Step 2 is dedicated tracing of road network to better reallocation of waste collection bins by routing optimization for minimum time, distance, fuel consumption and gas emissions with the use of GIS spatial analysis functions. Finally, Step 3 consists of the determination of waste category tracing from residential waste, industrial waste, commercial waste, waste sourcing from quality and possibly defining a common-particular waste type to develop waste recycle mechanism.

3.2 Discussion of spatial data to be developed

For us to properly analyze and implement the spatial data for the optimization of the waste demographic collection points in Zabrze, a possibly database within an ArcGIS system framework will be developed. The database system will or going to provide a section of this study and the main source of spatial database system will be:

1) An analogue map of Zabrze.
2) A digital data from various official administration of Zabrze (e.g., National Statistical Service, trucks, access card to visit various waste centers, field survey license).
3) A data derived from field work / on-site data capture with the use of GPS technology.

3.3 Allocation of waste collection points

This phase of the methodology is connected to the reallocation of waste demographic collection points. The analysis is implemented with the help of GIS environment with the

use of a modern sophisticated system analysis functions. The reallocation of waste collection points is a modern newly proposed positions which will be based on a number of criteria / restrictions:

- ✓ Firstly, the number of required demographic waste points was/is determined based on the type and daily and weekly waste quantity in different districts and the decision to modify waste collection points.
- ✓ Secondly the number of waste collection points is based on population distribution of that said district
- ✓ Thirdly, Road network also help us better understand how to allocate waste collection points.

4. Analysis of art of waste strength management in a circular economy

When a proper waste collection optimization vehicle routing is trace and mark using ArcGIS by implementing a modelling design for efficient and effective utilization. The optimal path finding algorithm of system is the best alteration of the classic **[7],** which solves the problem of optimal route selection on an undirected, nonnegative weighted graph in a reasonable computational time. In the literature, many modifications and new algorithms have been used for the incorporation of these aforementioned restrictions

The vision that takes into account the product life cycle and the limit of involvement in a system to according to the concept of supply chain in an industry to trace and develop systems to manage waste management. There is always a goal to improve decision making at all times and different levels of production. Because all waste stamp from production. To effectively achieve waste management and achieve a desirable effective, we have to tackle production decisions, choice of production, time of production, method of production, etc.

Diagram on development of waste development

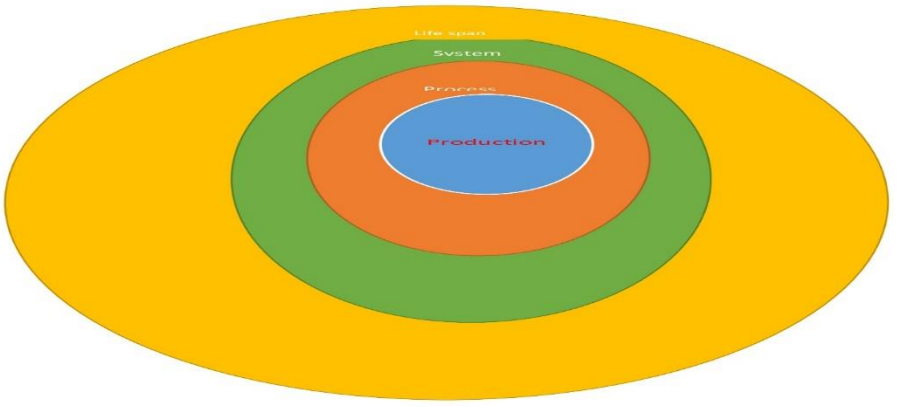

Figure 5 Diagram of waste development by pascal (2021)

PRODUCTION. A good production help to provide and produce quality materials that will help to secure the environment. In general, good products are better taken care of than poor products. In life exists the power of diligent? For instance, a good car is well taken care of due to its value than a cheap one. A production line that is built to produce high quality products turned to provide more waste than a poor and locally made.

PROCESS. A good process of production takes into consideration so many aspects and so too produce a good quality product. A poor process takes into account nothing or little consideration.

SYSTEMS. A system designed to provide a secure solution can help to reduce waste. A well-built system provides a better positive outcome than a poor system. Nowadays many companies still use systems or try to maintain systems that were developed by our ancestors. From eyes surveillance and survey most toxic waste comes from this older systems.

LIFE SPAN. A longer life cycle product terms to produce very little waste impact than a short life cycle product. From observation long life cycle products are often very small in quantity and provides us and environment with little or not hazard than short life cycles products. A short life cycle products are often very large in quantity. This large cycle range from millions tones and very different, similar in nature and difficult to manage.

System Frontier. Production process are vest with system involvement in process put in place to develop products. This same production process are the results of our waste deposit. The process to study this process is defined as a system delimitation interconnection. It must be said that the production. Process generally focused on items that will deliver operations and does not or little done for the negative externalities such as economic, environmental and society impacts it must be highlighted that an integrated approach for pollution reduction which aims to prevent emissions into the air, water and soil and environment is increasingly seen.

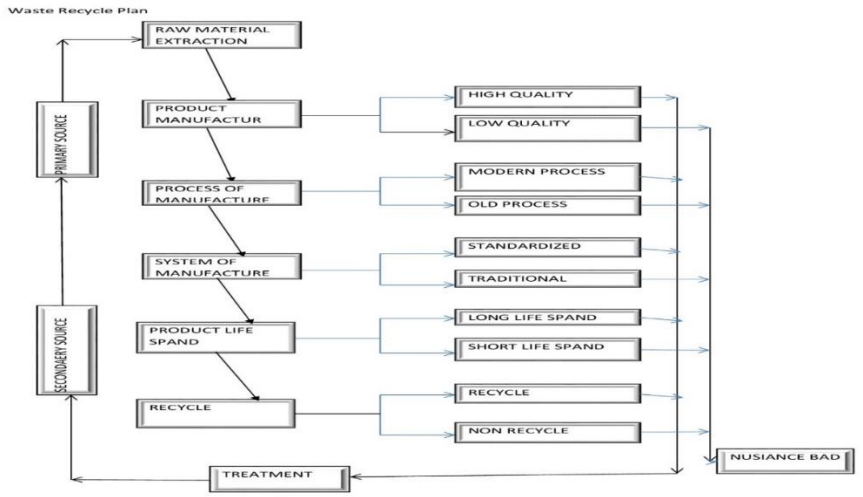

Figure 6 Waste recycle management system appraisal plan by Benjamin (2021)

From table we need a system to keep our society free from waste deposit. System can be put in place to effectively manage waste. Waste management to be effectively manage need a system to identify its development and source

4.1 Development of sustainability process for waste and plastic packaging

The creation of products, goods and services using various processes has dramatically and drastically source ill-environmental challenges. According to [7], most developed countries have a well-developed sustainable goal. The sustainable concerns based on development of modern products, goods and services through various industry 4.0 systems and non-respectively are aim at safeguarding resource and material hazard on environment through process simulation. The modern day industry have a standard position of transforming materials into products, goods and services but with modern day system, newt goal of environmental responsibility of eco-efficiency and effectiveness friendliness is place. It is now a duty that all components of production and non-production industry, organizations, institutions and administrations must holistically evaluate her values to include linear model or circular models if circular Economy.

Production process play a genuine role in achieving eco-efficiency and effective friendliness in inducing positive contribution to modern day economy. Today the world is negatively affected by global warming. Large environmental challenges directly related to process of production that negatively impact the soil, air, and water.

The modern day industry that produces products, goods and services to consumer market must produce, used, recycled it's products. It is very essential to upgrade procedure, process

of production of making new products, goods and services. This process will help to generate waste that can easily be collected, treated and transform from curative to prevention approach.

The modern-day industry must take into consideration product quality, process of production, brand nature, production system, life cycle and management process. The modern vision of product quality to Life cycle form a good sustainable scope management chain for waste and plastic packaging.

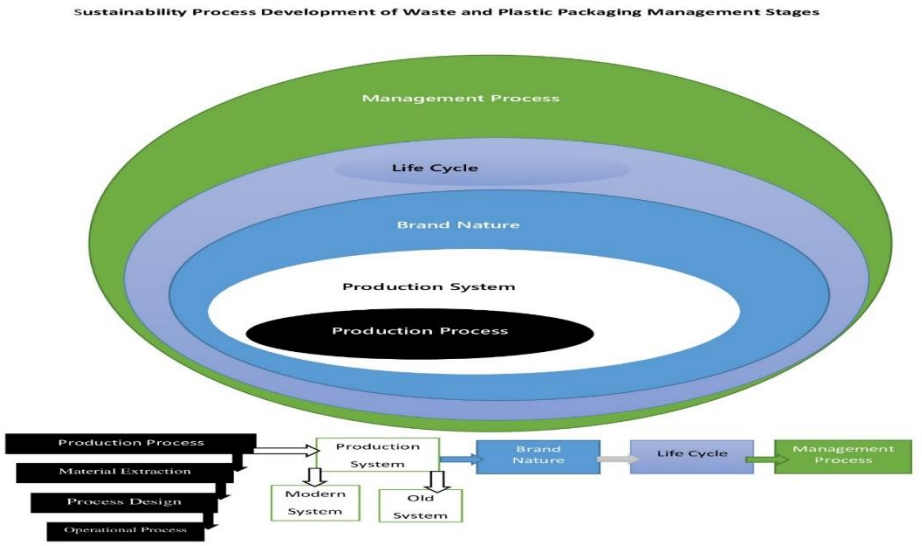

Figure 7 sustainability process development of waste and plastic packing stages by owner (2021)

This sustainable scope of practice can help mitigate sustainable plastic packaging impacts on the economy. It can help improve decision making in every stage industrial processes. According to [6], emissions have been integrated into process simulation as global warming potential and ozone layer depletion and acidification. This can be achieved by many other companies through technical and economic Designs in sustainable process of environmental activities are highly concern with environmental components. Since environmental concerns are treated as constraints to the economy, due to Optimization problems [21]. The main challenge in it which is constrained to its unfriendly mature, there are therefore regulations imposed. To reduce and eventually cut down waste generated within process sustainability is a good means to incorporate environmental considerations.

Many legal acts and criteria on environmental integration level of regulatory packs on companies must indicate exhaustive limits. Many production units have contributed to upstream waste even with regulatory packs put in place [22]. It is seen that flowsheets have

indicated a fall in environmental impact of a company process but company sustainable process indicated high waste through energy used.

4.2 Process designers' role in recycling

The level of system appraisal involved in plastic packaging and waste management in sustainable process includes all items and their interconnections. Environmental waste design issues have several threats [8]. It is normal that designed, development, consumption and distribution stages focus on closed process operations with little consideration to dismantling phase of all above procedures.

Most often than not evaluation criteria involved may misevaluate the impact of plastic packaging and waste management. To effectively evaluate the performance effect and get reasonable results, details should be given to designed, development, consumption and distribution stages.

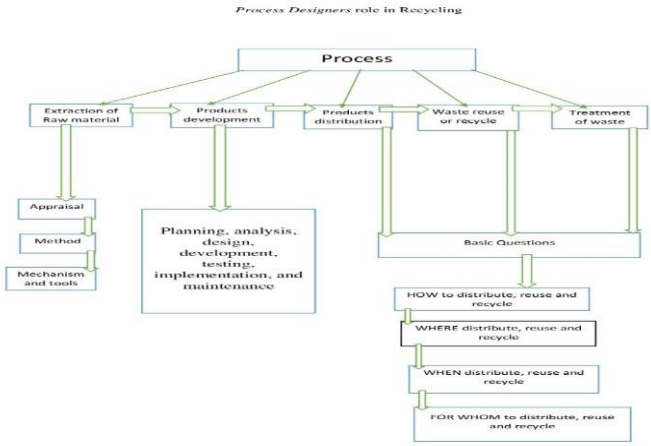

Figure 8 Process design in waste management. Source: Owner

From the above figure 8, boundaries of systems involved all process of production. Each stage generated waste. Transport system generated waste can be minimized with the usage of hydrogen fuel. A non-well-designed stage leads to a rough flow. Many adjustments generated waste.

The most important consideration for a multi criteria process of Sustainability is to take keen interest and diligent in design stage. A poor designed carries a bad faith in the course of reuse. With respect to implementation of (directive 96/61/EC), integrated approach involves prevention and control principles, approach, and techniques to achieve higher level environmental protection. This strategy must consider cost and benefits. These (directive

96/61/EC), assessment applied a life cycle process design, operations, and decommissioning plant like the one above

4.3 Sustainable process design for plastic and waste management

Product process involves several stages. The production engineering curriculum approved several stages of process production for sustainable projects. The stages are project initiation, preliminary design, detailed design and final design. Traditional design process makes us understand that project initiation stage combine activities of stakeholders, identification and evaluation of other options for sustainable needs [19].

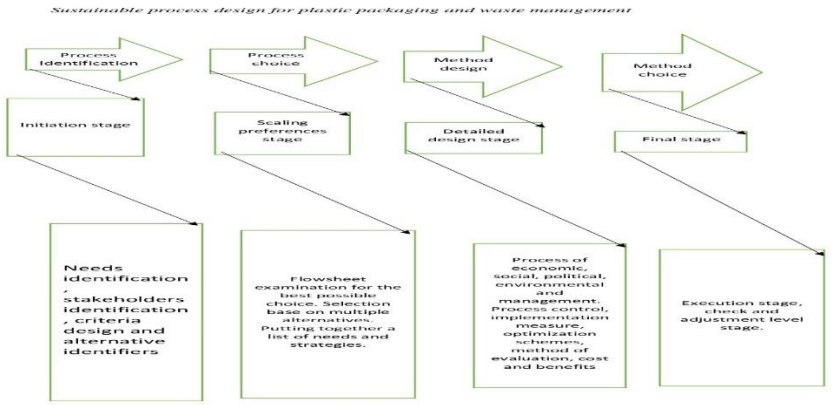

Figure 9 sustainable process design criteria. Source: Owner

Figure 9 above represent the most relevant process design criteria that are relevantly account routinely leads to better management and recycling [9]. Micro-economic indicators like (cost and profit), environmental criteria like (water usage and energy used), social criteria like (safety) and management criteria like (principles, legal acts, process, and strategies [16]. The process design sustainability qualitatively identifies the goods and drawbacks of all criteria that leads to product development, used and open door on how this built-up can be redo.

Product development has the following stages system. Planning, analysis, design, development, testing, implementation, and maintenance. The waste management and recycling process failed short of consideration to process sustainability development [17]. Caution should be taken to this effect. Every stage should be legal binding to redo legal act. Most maintained engineers due lack knowledge about product development stages. Most recyclers create unknown waste that differ from real components [18].

According to the American institute of chemical engineers, process sustainability design contains two approaches AICHE which represents (ID) and IChemE which represents (3D).

These two approaches signal the process of sustainability and system of sustainable practices. The institution mentioned that eco-efficiency standards defined ratios, resources use, environmental consequences, numerical values created dominant and how this can be reversed.

4.4 Process design sustainability waste and plastic packaging

According to European bio-economy policy implementation. The following policies are use based on five level of different plastic packaging of

1) Green paper on EU plastic waste

2) Strategy for plastic in a circular Economy

3) Report on a circular Economy for plastic

4) Report on circular Economy Action plan implementation

5) Sup Directives

Policy implementation will take into account following measures

1) The regulatory framework needs for plastics with biodegradable and comparable properties.

2) The need for specific labelling in order to distinguish plastics for the purpose of recycling for different plastics such as compostable, conventional and biodegradable waste.

3) The waste collection and treatment scheme for biodegradable plastic

After police implementation for Europe for its members coutry. The blog also put together scope of legal aspects for plastic packaging which are observed base on the following areas

1) Food and nutrition safety. Such as exposure to contamination, components of food contact materials, migration from waste to food. This legislation is controlled by Europeean Food and Safety Authority

2) Eco-design. Such like Recycling which are targeting for particular type of waste, Technology of (collection, preparation and recycling) of waste, biowaste treatment.

3) Packaging reduction

4) Package recycling targets

The legal ACTS of European Union uses the following steps

1) Regulations (regulation(EC)No 178/2002.The general food law)

2) directives (Directives (EU) 2018/852 of the European parliament and of councils of 30 may 2018 amending directives 94/62/EU on packaging and packaging waste

3) National acts implementation and directives (Directives (EU) 2019/904 of European parliament and of council of 5 June 2019) on the reduction of the impact of certain plastics products on the environment.

4) Over sees national regulations

5. Conclusion

Multicriteria approach to processes of sustainable plastics packaging and waste management system is required. Modern scientific systems are tackling process design sustainability that can be quantified. Process sustainability implementation will systematically change, transition, and help tackle major environmental, economic, societal and managing challenges faced by the world today. In order to achieve this desired impact to enhance a free vibrant economy, a new-how-process sustainability transition is required. The new-how-process sustainability is needed with the help of European bio-economy policy sustainable goals in line with millennium sustainable goals. Millennium sustainable development goals are needed for policy to support Interactions among multiple sectors with ample implementation interest including policymakers, businesses, scientific communities, social movements and interest groups.

This study examined the impact of the implementation of European bio-economy policy implementation and evolutionary processes on Africa ecosystem, and how they typically will be based on sourcing new methods, searching policies, reflecting new methodology, advancing new experiments and educating the globe on new trends and changes.

Government of both developed and developing countries have adopted various measures, policies, and programs to achieve global warming better result but not have been able to fully do so because policies lack inclusiveness. Many different policies of different nations are a barrier to these systems.

To advance a sustainable bio-economy in the world, this paper calls for the adoption and development of a holistic bio-economy policy of European Union which should be an integral part of the national developmental agenda for every nation. A responsible bio-economy sector is a necessity of effective governance and coordination to make it cut across all the relevant economic sectors.

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