Blockchain with smart contract for reverse shopping of retail industry branded plastic packaging

UNIVERSITY OF WOLVERHAMPTON
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Dissertation Title: BLOCKCHAIN WITH SMART CONTRACT FOR REVERSE SHOPPING OF RETAIL INDUSTRY BRANDED PLASTIC PACKAGING.

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ABSTRACT

Retail industries use an enormous number of plastics, especially packaging. "Reverse Shopping," that is, the returning of branded plastic packaging to the point of purchase (respective retail brands) by deploying blockchain with smart contracts, is our research focus. Employing a local blockchain, implemented in a basic format to store records of collected plastic packaging matched by the smart contract when returned, which also incorporates a reward mechanism courtesy of digital 'coin offerings' (cryptocurrency). To date, both blockchain and smart contracts are operationally standalone in this regard. We are proposing an innovative design model that advocates for (a) Including reverse shopping on retail industries' branded plastic packaging (as opposed to third-party collection points, such as recycling bins). (b) Fostering a 'reverse order' between retailers and manufacturers, like that between retailers and consumers. (c) Aid ethical and transparent sustainability.

TABLE OF CONTENTS

ABBREVIATIONS

ABI – Application Binary Interface

ACI - African Clean-Up Initiative

API – Application Programming Interface

APRA - Africa Plastics Alliance

ATAF - African Tax Administration Forum

ASDA – A British Supermarket Chain

CEO – Chief Executive Officer

CIS - Commonwealth of Independent States

COVID-19 – Coronavirus disease 2019

'C to P' – Consumer to Producer

CTV – (culture, technology, and votes)

DB - Database

DDoS – Distributed Denial of Service

EU – European Union

EPR - Extended Producer Responsibility

GHG - Green House Gases

GOV – Government

GPS – Global Positioning System

GUI – Graphical User Interface

Hon – Honourable

HTML – Hyper Text Mark-up Language

IBM – International Business Machines

IDE – Integrated Development Environment

IoT – Internet of Things

JSON – JavaScript Object Notation

KEPRO - Kenya Extended Producer Responsibility Organization

MIS - Morit International School

MP - Member of Parliament

MS WORD – Microsoft Word

NAFTA - North American Free Trade Agreement

NGOs – Non-Governmental Organisations

PEMRG - Plastics Europe Market Research Group

PDF – Portable Document Format

PR – Public Relations

'P to C' – Producer to Consumer

RDBMS – Relational Database Management System

Rt – Right

SDG - Sustainable Development Goals

SHA-256 – Secure Hash Algorithm 256

SME's – Small and Medium Enterprises

TSV – (tourism, science, and votes)

TTD – (tourism, technology, and diplomacy)

UK – United Kingdom

USD – United States Dollars

WRAP - Waste and Resources Action Programme

XML – Extensible Markup Language

FIGURES

TABLES

CHAPTER 1 – BACKGROUND

The supply chain feeds shopping. However, there are ‘reverse supply chains;’ ‘reverse shopping’ is not. While ‘reverse shopping,’ geared by the research, functions towards the starting theme of ‘recovery.’ These ‘reverse supply chains’ function only towards the end theme of ‘recycling.’ Where other writers probe models through analysis of different channels and modalities. Including an enumeration of four kinds of 'reverse supply chains' by Feng, Govindan, and Li (2017), namely: a single traditional recycling channel, a single online recycling channel, a centralised case for a dual-recycling channel, and a decentralised case for a dual-recycling channel. The research ignores the online mode but sticks to the ‘physical’ mode with an understanding that the consumer(s) is the centre of facilitating the modes and channels. Often bearing most of the brunt (rightly or wrongly) of whatever ‘green’ theme, touching sustainability framework concerning materials. The research understanding in summary is below:

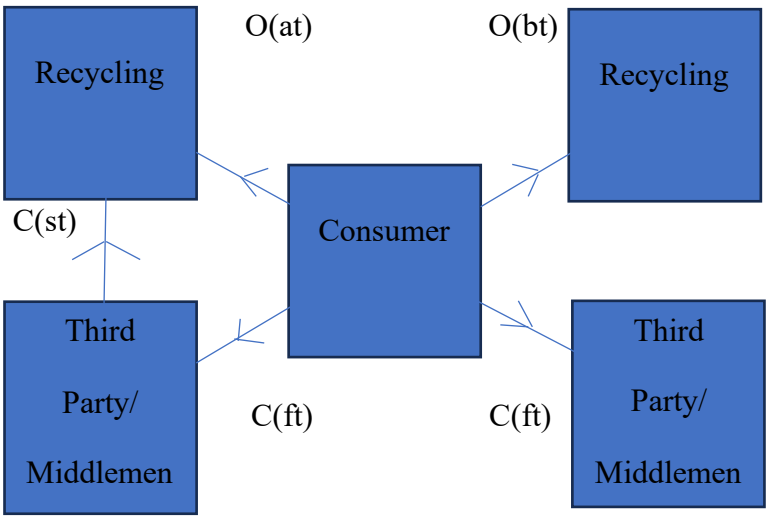


Figure 1: THE RESEARCH SUMMARY OF 'REVERSE SUPPLY CHAINS'

Where:

- C(ft) – refers to the customary first transfer from consumer(s) to 'banks'.
- C(st) - refers to the customary second transfer from 'banks' to 'recycling' end theme.
- O(at), O(bt) - relates to the transfers courtesy online mode.

Hence:

- The sequence of 'C(ft)' and 'C(st)' combined results in a customary 'single channel of recycling'.
- The 'O(at)' sequence alone results in an online 'single channel of recycling'.
- The 'C(ft)' and 'O(bt)' combined sequences result in a centralised 'dual channel of recycling'.
- The 'C(ft)', 'C(st)', and 'O(at)' combined sequences together result in a decentralized 'dual channel of recycling'.

Therefore, the research aims to pursue the starting 'recovery' theme, centred on retail industries through the channel of 'reverse shopping.' Modelled in circular economy concerning plastic packaging, though with exclusivity to their 'brand'

plastic packaging for restrictive boundary purposes, shielded from an avalanche where even estimation accords 311 million tons plastics produced, a considerable portion of these plastics are in use for packaging (such as drinking bottles) Bornscheuer, (2016) as an example. Still problematic, as Rejeb *et al.* (2023) state, “Plastic waste is piling up throughout the world at an alarming pace. Most plastic waste generated in highly populated areas is disposed of on land or sent to the sea. The plastics generated are often non-biodegradable and have a complicated decomposition process. These pollutants linger in the natural environment for a long time and may cause harm to terrestrial and marine ecosystems.” Indeed, with the incorporation of technologies (blockchain and smart contracts). This awareness has caused society to seek improvements in collaboration, responsibility, and resource optimization to impact economic, environmental, cultural, legal, and political change. Gong *et al.* (2022) state, “Also, the traceability and high transparency of blockchain and the application of smart contracts can effectively build a global recycling network. In addition, … blockchain technology can improve the transparency of recycling value chains and make them more accepting of supervision from society and consumers.” Encouraging a novelty in attempting the implementation of blockchain and smart contracts towards recovery.

1.1 PROBLEM STATEMENT

This thesis explores the potential of a new, narrow, sustainable, and ‘reverse’ centred approach concerning packaging (plastics) and blockchain with smart contracts in the retail industry. As plastic packaging waste decreases due to retail industry-themed outreaches, Young *et al.* (2017) accentuate that it only takes a few months for that pattern to reverse after such outreaches when overtaken by other promotional concepts even though the ripple effect of such outreaches had diffused to consumers and permeated communities. Achieving tasks in adherence to

responsible shopping and sustainable consumption by consumers who identified as not knowing, participating, or recalling such events as discovered in a field study in conjunction with ASDA (a UK retail industry). Hence, through ‘reverse shopping’ incorporation, the ‘outreaches’ are converted to ‘occurrences,’ further becoming normalized and not ‘overtaken’ by other promotional concepts. Encouraging its participation in a circular economy (increased timeline in using the specified substance abiding in the ‘end to start feedback’ of inputs) against a linear economy (intensive usage from production to consumption). Knowledge of blockchain application for the circular economy, especially in the context of assessing its performance comes as a most recent update, needing examination and industrial testing due to its importance in conjunction with further scrutiny on propelling circular economy in achieving its modelled prerogative; (Kouhizadeh, Zhu and Sarkis, 2023) stated.

The above conversion from linear to circular regarding plastic *packaging* encourages ‘reverse shopping’ (reducing or removing third-party involvement) by applying blockchain and smart contracts to the relationship between retail industry brands and their respective consumers and manufacturers. Using blockchain in the circular economy of plastics, producers, recycling outfits, and separators routinely access safeguarded information with the ability to arrange a supply chain of tracked materials, including plastics, sort bought orders, and thereby raising the use of recovered materials including plastics; Chidepatil *et al.,* (2020) noted. It is worth noticing, that this builds on the retail industry's embracing of innovative technologies. Geared in application to usurp, shadow their competitors, and remain in the limelight of pole position candidates for potential and recurring customers through accrued benefits, including mobile applications, digital signage, ubiquitous stores, and self-service technologies.

Cascading down to the growing avalanche of existent literature recording propositions of roundtable agendas in conjunction with innovative systems catering to different consumption niches. Or a cut across collaborative optimization amongst same vein vectors like a partnership between public and private entities, liaising on policy design hinged on being the centre of potential and or probable proposals in implementation alongside policymakers, have essential parts in ensuring arrival at intended targets for the sector with an emphasis on and in quickening the journey via mechanisms; (MacArthur, 2017) reported.

1.2 OBJECTIVES

Following HM Revenue & Customs (2020) and HM Revenue & Customs (2021) policy on plastic packaging, our research using blockchain with smart contracts in ‘reverse shopping’ aims to improve plastic packaging recovery in a circular economy model - a recovery geared towards the same channel of traditional shopping with an emphasis on brands. Branding is prevalent in the retail industry, and this is the subject of this investigation and exploration. Heralding the contribution of this research in designing and developing a crypto reward system utilizing a smart contract were identified major stakeholders (producers, retail industries, and consumers) are pitched in interrelated connectivity from a ‘circular economy’ model implementation that promotes the transition of goods and products from production through to consumption and back to production in a cyclic manner. All in alleviating leakages and accumulation of waste (plastic packaging), to be precise and curtailing unnecessary additional nodes where avoidable while others set up partnerships with them, in account of considerations both direct (the nonchalant production to consumption to disposal) and the indirect (the ‘escape’ from planned transitional

points during the sustainable processes like collection points). Our objectives are as follows:

Objective 1: To investigate the lifecycle of plastic packaging in the retail industry, especially in areas needing improvement regarding recovery.

Objective 2: To explore the incorporation of ‘reverse shopping’ into the circular economy model regarding aiding plastic packaging recovery in the retail industry.

Objective 3: Develop a system based on objective two which implements objective 1 for the research aim: Blockchain with smart contract for reverse shopping of retail industry branded plastic packaging.

1.3 RESEARCH QUESTIONS

Contemporary reports such as Sharma (2020) inform, "Start-up Plastic Bank that collects and recycles ocean plastic is leveraging blockchain technology. Plastic Bank offers incentives issued through digital tokens. When the plastic waste reaches Plastic Bank centres, digital tokens are distributed through smart contracts. Every single transaction is then recorded on the Hyperledger Fabric platform. Then, finally, Plastic Bank sells its recycled plastic to manufacturers", stemming from "Blockchain with Smart Contract for Reverse Shopping of Retail Industry Branded Plastic Packaging" as the aim, the campaign objectives as yardsticks for actualisation are pointed out to be canvassed in direct viability to the proposed practical impact of efficiency courtesy the template and research conduits of sourcing peer-reviewed articles, examinations, detailed analysis, and critiqued submissions for a better, more appropriate, and suitable presentation depositing arguable agreements, disagreements, and neutrality all contextually listed below:

Research Question 1: How is the lifecycle of plastic packaging addressed in retail industries? Paired accordingly to **Objective 1**: To investigate the lifecycle of plastic packaging in the retail sector, especially in areas needing improvement regarding recovery. The greater focus is on uncovering the details of recovering plastic packaging with restrictions to what and how it entails in the retail industry since the greater emphasis is on other areas like recycling. Where Companies like (Katche, 2019) reports, “Global consumer goods companies operating across Africa have launched the Africa Plastics Alliance (APRA) to intensify plastic recycling in sub-Saharan Africa where the Alliance covers various plastics and recycling value chains from manufacturing and processing to branding and recycling, a collaborative effort that seeks to improve living conditions by solving the problems associated with plastics. The Alliance is made up of multinational companies Nestle, Unilever, The Coca-Cola Company, and Diageo – with a shared vision to explore the untapped potential in plastics recycling and at the same time tackle plastic pollution.” without third parties. Shifting the focus onto recovery aids in raising responsibility for plastic packaging within the sectoral influence of retail industries, plus the research streamlining approach specifically on their brands (retail brand plastic packaging) provides a critical analysis of their relationships (with and or between their consumers and their producers) as understanding an of plastics in general concerning its lifecycle is thus:

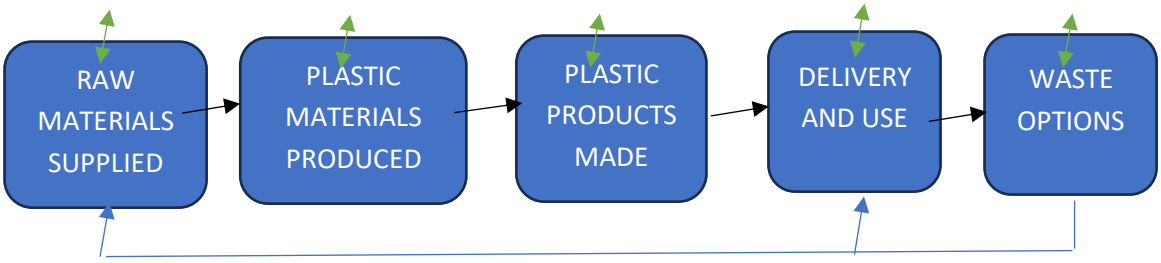


Figure 2: PRODUCT LIFECYCLE OF PLASTICS

Where:

- Waste options at the last stage means the combination of the following: landfill, transformation to energy, recycling, and possible environmental pollution.
- The green double-head arrows mean the import and export of aids and/or assistance in or at those stages.
- The black arrows represent the progression routes in the plastic lifecycle from one stage to the other.
- The blue line and arrows below mean the return loop of inputs back to the stages (serving as part of inputs for raw materials supplied and an amendment for reusability.

Realized from existing reality, as Plastics-The-Fact (2020) states, “Today, 60% of plastic products and parts have a use phase between 1 and 50 years, or even more. This time-lapse determines when they will potentially become waste, which is why, in a single year, the quantity of collected plastic waste does not match the quantity of production or consumption”.

Research Question 2: How should retail industries’ operations be designed in a circular economy that encourages ‘reverse shopping’? Paired accordingly to **Objective 2**: To explore the incorporation of ‘reverse shopping’ into the circular economy model regarding aiding plastic packaging recovery in the retail industry. Identifying the needed diversification measure(s) in actualizing ‘reverse shopping’ of retail brand plastic packaging outside existing frameworks. Plus, measure(s) of inclusion in achieving a circular economy in and attached to the retail industry as a standout initiative. Considering nation(s), as (Ventures Africa, 2021) states, “Fast forward to 2021, we have made tremendous strides in the fight against plastic

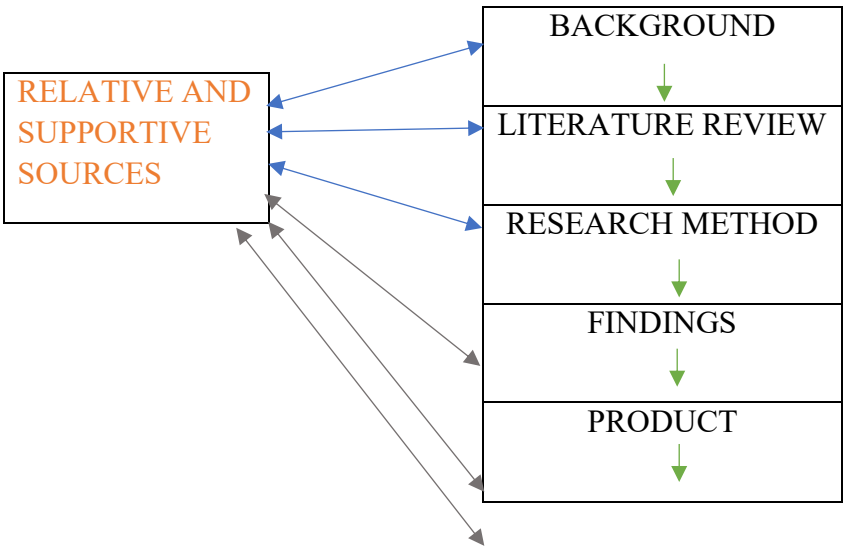
pollution as a nation, with a ban on specific single-use plastics in all protected areas taking effect from June 2020. There are also ongoing and ambitious plastics initiatives in the country, such as the Kenya Plastic Action Plan and the development of the Kenya Extended Producer Responsibility Organization (KEPRO), once established, will ensure plastics are collected, sorted, and recycled after use; giving producers a significant responsibility for the post-consumer phase of single-use goods under a scheme referred to as an Extended Producer Responsibility (EPR)". There in the quoted collection is the anchor on which this research aims to recover retail brand plastic packaging courtesy of 'reverse shopping' in a circular economy model, which advocates a reduction if not elimination, of third parties (collection points) but an incentivized encouragement of reversing the shopping experience through 'reverse flow'. A 'reverse flow' is in the sense that, as subscribed retail industries by their respective consumers, they receive their respective retail brand plastic packaging (reverse product flow). The consumers, in turn, subscribing to their respective retail industries receive digital coins as rewards through (reverse money flow) courtesy of their participation. All in all, trying to make and move the needle a little as in the grand scheme of things concerning plastic recovery is lagging due to it (plastic and indeed packaging) being the workhorse material of the world (Stuchtey, M., Swartz, S., Vanthournout, H., 2016) believes.

Research Question 3: To what extent does the system of objective three satisfy the research title? Paired accordingly to **Objective 3**: To develop a system based on Objective 2, which implements Objective 1 for the research aim of the thesis title. The above pairing (research question 1 with objective 1 and research question 2 with objective 2) are combined in arriving at research question 3, aligned with objective 3. So, the accomplishment is through technologies (blockchain with smart contract) implementable use in assisting recovery of highly used retail brand

commodity (plastic packaging). The possibility of obtaining and contributing to records on recovery reportage through this narrowed research system implementation as with recycling that gets most if not all the attention, yielding records of after-use recycled plastics at 30 million tonnes out of 365.5 million tonnes produced plastic in 2018, 30.8 million tonnes out of 374.8 million tonnes of produced plastics in 2019, 31.6 million tonnes out of 375.5 million tonnes of produced plastics, and 32.5 million tonnes out of 390.7 million tonnes of produced plastics in 2021; (Plastics-The-Fact, 2022) reports. Similarly different purpose but enlightened by (Peshkam Michael, 2019), a European start-up (Circularise), initiated in recent years, implemented a system where blockchain applies in serving of an accurate pricing system for any material recycled, with further ability to show the count of such times the material recycled has been through the process of recycling."

1.4 THESIS METHODOLOGY

The thesis methodology conveys the thesis workflow explained with a block diagram consisting of all thesis chapters, references, and an appendix. Presented below:



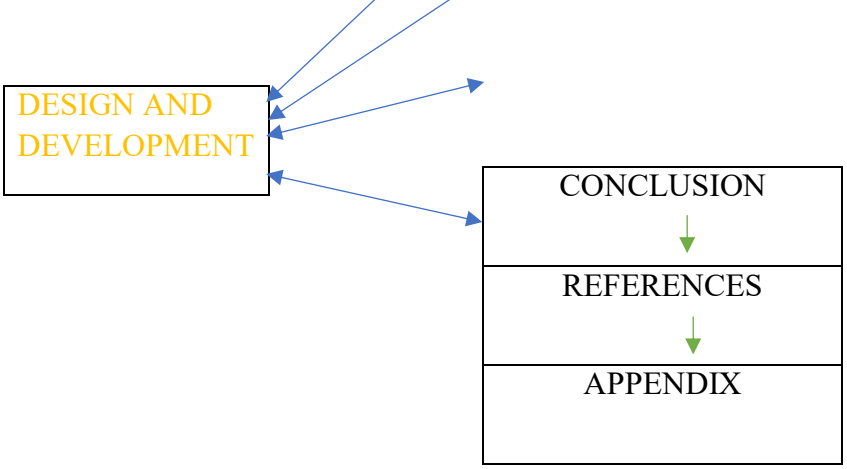


Figure 2: DIAGRAM OF THESIS METHODOLOGY

Where:

- Relative and supportive sources imply that the researcher critically analysed the read and cited literature sources in the review for their relativity, recency, and supportiveness.
- Design and development imply the engine of research transportation from an ideology to reality.
- The tower of blocks implies the chapters of this thesis.
- The green arrows imply the thesis progression and flow from one chapter to another.
- The blue arrows imply the primary use in communication to the thesis.
- The grey arrows imply the secondary use in communication to the thesis.

1.5 SIGNIFICANCE AND IMPACT

The significant aspect of this research measures through the impacts it has on society, according to international policies, the study addressed the following:

- For the 2018 EU Plastics Strategy: The retail industry has a narrow gaze on their customized plastic packaging within the circular design, with a further implementation to facilitate transparent, sustainable reporting for goal measurements and practice scrutiny.

- For the 2018 Global Plastics Platform: Further stakeholders (manufacturers and customers) are captured in the circular design, which promotes the distributed, responsible allocation of duties and encouraging recovery, recycling, reuse, redistribution, or redirection.
- For the 2018 New Plastics Economy Global Commitment: Indirectly approached through striving against ‘relinquished outsourcing’ but pursuing ‘increased ownership’ of retail industry branded plastic packaging.
- For the 2018 Global Plastic Action Partnership: Here, in the focal sector of the retail industry, the top major brands could buy in as the smart contract commercial rewards for customers can endear brand tourism.
- For the 2018 Platform for Accelerating the Circular Economy: In a nucleus, the combination of the circular design capturing stakeholders (retail industry, customer, producer) and the coin reward system (cryptocurrency) courtesy of the technology of blockchain and smart contract strengthens that partnership of public-private through encouraging transparency, ethics, more negotiated or compromised sustainability and profit balance.
- For the 2019 Circular Plastics Alliance: The (recover, recycle, and reuse) theme in conjunction with the captured stakeholders (customer, retail industry, and producer); the plastic packaging value chain is embedded with the intent in improving recyclability.
- For the 2019 Plastic Leak Project: Again, the recurrent theme of circular economy, which has been already treated above, and the mapping of plastic packaging in the retail industry.

In this research, we have sought to address the impact of blockchain using smart contracts on the retail industry’s use of branded plastic packaging, emphasising on

reverse shopping in a leaner or narrower circular economy fashion, including other adjoining issues such as politics.

1.6 THESIS OUTLINE

The thesis outline conveys the thesis's overall structure, consisting of chapters, references, and appendixes. Alongside their respective items, themes, and layers, presented tabularly below in Table 1:

Table 1: THESIS OUTLINE

Research Thesis	Items	Theme	Layers
Chapter 1: Background.	Problem Statement, Objectives, Research Questions, Thesis Methodology, Significance and Impact, and Thesis Outline.	Introduction of foundational preambles for further construction of research thesis.	Research Scope.
Chapter 2: Literature Review.	Composition of areas – Plastics and Packaging, Circular Economy, Blockchain, Smart Contract. With their respective contributions.	Systematic Review of literature related to and in research scope.	Research Gaps.
Chapter 3: Method.	Methodology	Detailed sequential steps in executing the research aim.	Research Plan.
Chapter 4: Findings.	Assets and Limitations.	Analysed pointers deduced from Chapters 2, 3, and 4.	Research Pointers.
Chapter 5: Product.	System design and development.	Actual execution of research aims as per Chapter 3 detailed sequential steps.	Research System.

Chapter 6: Conclusion.	Assessment, Shortcomings, and Recommendations.	End review of research accordingly.	Research Review.
References	List of citations.	Alphabetical order with Harvard style.	Research Citations.
Appendix	Supporting works.	Correlating and corroborating information.	Research Appendages.

Thereby, the outline of the thesis in brief:

- Literature review: (Government, Papers hinting at problem) in Chapter 2 of a systematic review of research theme touching on the blockchain with a smart contract for reverse shopping of retail industry branded plastic packaging and reviewing critically, literature on plastics, packaging, circular economy, blockchain, and smart contracts considering the research theme of recovery.
- Method: Chapter 3 clarifies the methodology (steps) for conducting the research and the respective procedural process for achieving them.
- Findings: Chapter 4 is the result extraction from the above combination of Chapters (2 and 3).
- Product: Chapter 5 of presenting implementations in Development (Technology Plan Behind – Cryptocurrency via Blockchain Application), and (Smart Contract for Circular 'flow circulation' and 'PlasticCoin' execution in retail industry sector)
- Conclusion: Chapter 6 summarises the assessment, shortcomings, and recommendations.
- Reference: Mirror list of all cited sources in the thesis.
- Appendix: Other documents.

CHAPTER 2 – LITERATURE REVIEW

A broader and more general consideration concerning the research recovery theme (‘reverse shopping’) of retail brand plastic packaging is the waste management sector, where approaches of varying interest, scope, capture, and degree in use.

Among all, three stand out to be of more weight in terms of work undergone – (Waste segregation: sorting of waste to match labels, suitable functions, and further appropriate operations), (Real-time waste collection and disposal: calculative timing via indicative sensors for identifying and prompt discharge of duties), and (Optimised routing: pre-ordained co-ordinates arrangement to counter avoidable transportation delays and also prevent contamination in cases of toxic related waste amidst populated areas often dense).

In these cases, the circular economy ecosystem uses blockchain and smart contracts to support the creation and adoption of creative business models. For example, it facilitates low-cost real-time micropayments and introduces circular pay-per-use models.

Also, blockchain and smart contracts are still functioning steps to implement new circular economy networks, in which waste diversion to by-product usage for circular economy maintenance Rejeb et al., (2023).

This chapter covers the systematic review of identified, related literature to the research. Gauging from the widely accustomed practices where a combination of the later critically researched niches is isolated in treatment, it is imperative to analyse their present composition via certain influential factors such as Material (Organisation), Technology (Scale), Model (Recovery), and Locale (Geographic).

- The material behind the drive, with organisations employing its use, called for established and dedicated massive efforts to encourage assessment, announcement, and adherence. Assessment is a check of practices,

announcements made, and proclaimed policies, and adherence is a gauge of compliance accompanied by stated resultant measures.

- The scale of technology the organisations implement in their respective contributions to ascertain whether the commitment is genuine. The veracity in translation is like or differs across organisations depending on niches.
- Organisations centred on the material, plus the developmental application courtesy of the technology, embrace the recovery model in conceptualisation and design. Conceptualisation encapsulates the model with its essence's necessities. Design, in derivation, focuses on the tailored features and attributes added to the encapsulated model.
- The locale of geographic coverage directs the underlying genuineness of the above-combined factors in motion due to ‘plastic politics’, restriction to physical locality, and exclusion of online or e-commerce.

2.1 PLASTICS

Plastics are substances that encompass a wide range of synthetic and naturally occurring substances that are capable of flow. They can be moulded, extruded, cast, spun, or applied as a coating. (Cassou, 2018). Plastics are so broad in range and entrenched in use that they have become an industry. The European plastics industry in 2018 employed over 1.6 million direct labour employees through nearly 60,000 small and medium enterprises (SMEs) (Plastics-The-Fact, 2019). Foreseeing a rise in such numbers as more labour will be needed, given (Plastic-The-Fact, 2022) report of European plastic production increase to 57.2 million tonnes. As a result of plastics being a dominant and dependent material, their replacement is not yet foreseen, though sparse areas have heralded substitutes into the mix. Re-echoing Geyer, Jambeck, and Law (2017) stated, “A world without plastics seems unimaginable today”, lending credit to the research choice as its

material amidst other favourites. It is worth noting that 359 million tonnes of plastics were produced worldwide in 2018, as Plastics Europe Market Research Group (PEMRG) (2019) states:

- Three per cent was from the Commonwealth of Independent States (CIS).
- Four per cent was from South America.
- Seven per cent was from Africa and the Middle East.
- Seventeen per cent were from Europe.
- Eighteen per cent was from the North American Free Trade Agreement (NAFTA).
- Fifty-one per cent was from Asia (China at 30%, Japan at 4%, and the rest at 17%).

It is worth noting that in 2022, the above percentages of the global distribution of plastic production either remained the same or slight variations of increase or decrease (Plastics-The-Fact, 2022) were observed. To date, the production rates would only climb as countries and sectors continue to participate in obtaining plastics due to their flexible resourcefulness in addressing their various and respective needs across the chain. Even the COVID-19 pandemic only slowed it (plastic production) down as Plastics-The-Fact (2022) states, “After a stagnation in 2020 due to the COVID-19 pandemic, the global plastics production increased to 390.7 million tonnes in 2021.” Such sectors include agriculture, engineering (automotive, electrical, electronic, mechanical), building and construction, medical, and retail (packaging). Where in 2018, the allocation of produced plastics used by each sector was 3.4% in agriculture, 4.1% in household, leisure, and sports, 6.2% in electrical and electronic, 9.9% in automotive, 19.8% in building and construction,

39.9% in packaging, and 16.7% of produced plastics in others including medical Plastics Europe Market Research Group (PEMRG) (2019). Two years consolidation of Geyer, Jambeck, and Law (2017) graph below:

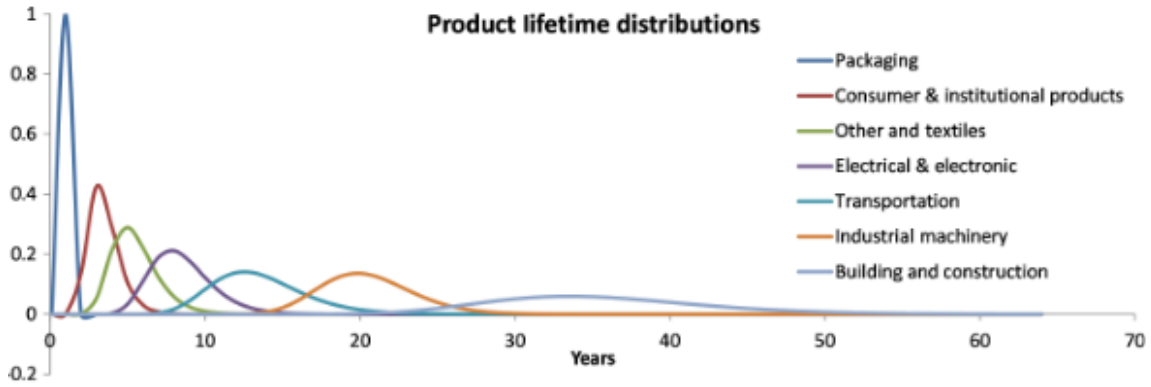


Figure 3: PRODUCT LIFETIME DISTRIBUTIONS OF PLASTICS

2.1.1 PACKAGING

This inference from the above sector allocation, where retail courtesy packaging used the highest % of plastics produced, at 39.9%. Plus, topping the above plastics distribution lifetime of product graph, packaging is a significant component in tackling plastics. Still (plastic packaging) maintained its lead as the allocation of produced plastics used by each sector was 3.4% in agriculture, 4.1% in household, leisure, and sports, 6.2% in electrical and electronic, 9.6% in automotive, 20.4% in building and construction, 39.6% in packaging, and 16.7% of produced plastics in others including medical, furniture among others from Plastics Europe Market Research Group (PEMRG) (2020). With a further extension of its (plastic packaging) above lead in the distributive and applicable global plastics production use at 44%, with a slight rise in agriculture from 3.4% to 4%, a rise in household, leisure, and sports from 4.1% to 7%, a slight raise in electrical and electronic from 6.2% to 7%, a slight drop in automotive from 9.6% to 8%, a drop as well in building and construction from 20.4% to 18%, and the most significant drop in others (medical, furniture among others) from 16.7% to 12% as observed by (Plastics-The-Fact,

2022) in 2021. The sustenance and gain in leadership are fathomable as plastic packaging serves various functions (protection, communication, convenience, and containment) courtesy (Robertson, 1993). Fits confidently in protection – prevention of spillage and damage, communication – assistance in relaying information, convenience – appropriate for occasions and containment – adeptly suitable for situations like travelling. Packaging may be broadly divided into three categories: ‘active packaging’ aimed at display, ‘intelligent packaging’ aimed at interactive features, and ‘smart packaging’ aimed at combining both (active and intelligent). The increasing demand for plastic packaging coordinated with pre-announced trends with monetary projections corroborated earlier by Fuertes *et al.* (2016), stating a rise in annual growth rate of 7.4%, predicting that in the next decade, the reach will be $3,600 million (USD) by the USA, $2,360 million (USD) by Japan, and $1690 million (USD) by Australia.

Prompting the research understanding of plastic packaging in Figure 3 and tabular summation below:

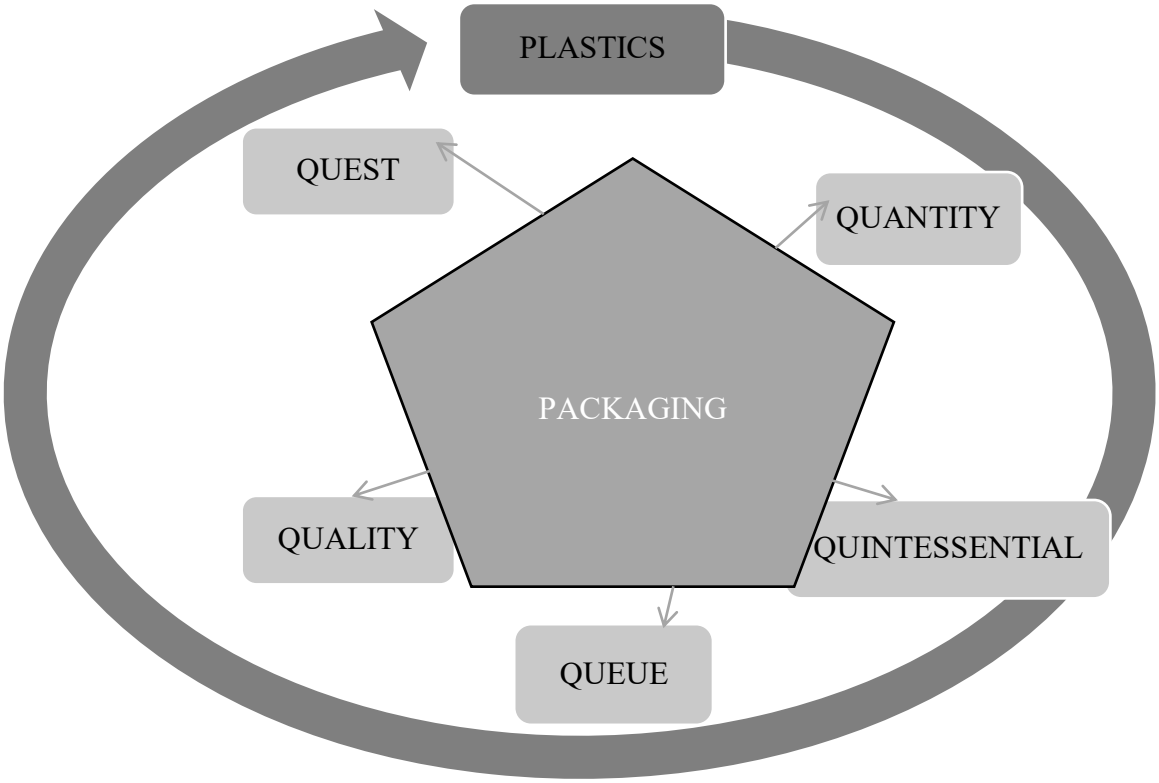


Figure 4: RESEARCH PICTORIAL UNDERSTANDING OF PLASTIC PACKAGING

Interpretatively where:

- Quantity: the amount of plastic packaging produced by producers (in succession) used (in expansion) from many quarters. Concerning the research theme, catering to the retail industries' respective brand plastic packaging.
- Quintessential: particular and peculiarity in shapes, forms, and composition of packaging designed and produced. Concerning the research theme, catering to the retail industry's enormous output of goods adopted and rendered in their respective brand plastic packaging. Examples are the plastic packaging of 'essentials' such as brand bottled water.

- Queue: the rate at which packaging is produced, used, and disposed of (lifecycle). Concerning the research theme, catering to the retail industry's positional interface between producers and consumers. Plus, it captures the share (see Figure 4) in the burgeoning use of plastic packaging. An active part of reach maintenance and extension through their respective brands - participatory contribution in a fast-paced world.
- Quality: the image portrait or brand purchase generated by packaging. The display is key regarding the research theme, tailored to the retail industry. It is embodied in their brand's plastic packaging, including representing specific considerations and communicating participatory means.
- Quest: ongoing measure in enacting compliance exhibited by packaging to a particular societal goal or cause commitment. Concerning the research theme, catering to the retail industry's brand plastic packaging.

In the tabular application below:

Table 2: RESEARCH TABULAR UNDERSTANDING OF PLASTIC PACKAGING

Classification	**Description**
Packaging sources	Where packaging can be drawn from.
Retail industry	The retail industry is a source of generated packaging via food, drinking bottles, and shopping bags.
Medical industry	The medical industry is a source of generated packaging via tubes, drug containers, etc.

Electrical and electronic industry	The electrical and electronic industry generates packaging via automatic teller machine cards and device casings, such as plugs, mobile phones, and USBs.
Manufacturing industry	The manufacturing industry is a source of generated packaging as past, present, and even future plastic demand will lead to subsequent packaging production.
Beauty industry	The beauty industry is a source of generated packaging via shower gels, trimmers, shavers, etc.
Packaging format	Forms dictating the presentation of packaging.
Shapes	Packaging comes in various shapes to cater to and complement the entity type, be it content, product aesthetics, and brand distinction. Drug containers, drinking bottles, shower gels, etc. as examples.
Sizes	Packaging comes in diverse sizes as capacity proofs to cater to and complement the measure and or volume of the entity to be its content, intended target of consumers (e.g., family), and variety diversification of product and brand.
Sensual and Density	Packaging comes in various shapes to cater to and complement the type of entity, be it content, product aesthetics, or brand distinction. Drug containers, drinking bottles, shower gels, etc., are examples.
Packaging Repository	The accumulative result of direct and or indirect depositing or placing of packaging.

Furniture	Furniture is an example of a packaging repository where packages are reposited because of their content entity, such as shower gels in toilets or bathrooms at accommodations or situational purposes of the content entity, hence products on shelves.
Bins and Landfills	Bins and landfills are examples of packaging repositories where packages are reposited because they were discarded after situational purposes like purchase, consumption, expiration, or 'use past date' of content entities like milk bottles, etc.
Recycling pools	Recycling pools are an example of a packaging repository where packages are reposited because of their disposal, collection, sorting, and 'waiting list' to be recycled or potentially isolated and ignored.
Water bodies	Water bodies such as oceans, seas, lakes, lagoons, rivers, and streams are examples of packaging repositories where packages are reposited because of unsustainable consumption, careless and reckless choices, and or dogy, pretentious postures (e.g., political, social, etc.) becoming an ugly unintended but seemingly meaningful pool to collect, sort and recycle where, when and if possible.
Packaging timeline	To highlight various key stages of the lifecycle of packaging.
Derivative	Derivative is a point in the packaging timeline as it must be indirectly produced or a direct inheritor of an already existing or produced substance like plastics.

Suiting	Suiting is a point in the packaging timeline, as it must be tailored to the myriads of industry standards and geographical regulations, especially those intended for content entities.
Post-consumption	Not in particular reference to the packaging itself, post-consumption is a point in the timeline of packaging where its original or its intended content entity is consumed or discarded, and what then entails for the packaging courtesy of choices, and decisions.
Packaging currency	Number of times and ability of packaging to be used.
Number	Numeration in packaging currency represents the number of times packaging can best be used. For one-time use, the availability of such packaging, which most times comes as part of the unique selling feature of the content entity, is 'single', while 'recurrent' is the reusability availability of such packaging, which can cater to a host of other content entities with or without their respective packaging, like shopping bags.
Ability	Ability in packaging currency stands for the proficiency of specific packaging employed and deployed due to their possession of certain criteria of qualities like 'flexible packaging.'

Prompting the targeted goals for achieving a more tolerable disparity of plastic packaging (production against consumption). Sarah Nelen of the European Commission – waste policy directorate claims that by 2030, a high percentage of packaging should be recyclable, but more important is to look at material-specific targets with plastic packaging 'more problematic' to recover and recycle than

cardboard boxes that online shops use. (cited in Simon, 2018). In summary, this is the research heartbeat (recovery) of plastic packaging. Acknowledgment of ‘more problematic’ the research justification in choosing a sector intensively utilising plastic packaging (retail industry – one of the main drivers of economies globally). With further post-consumption menace like the study of Kamilo beach in Hawaii’s Big Island, revealing that plastics, including bottles (packaging) amongst others, contributed to a 30 per cent weight ratio of the surface of the sand layer deposited by ocean currents and local eddies Cressey, (2016). This is followed by more recent evidence of after-use plastics recycled at 8.5% for packaging, below the sectoral rates of agriculture at 25.4% and building and construction at 18.1%. Though ahead of sectoral rates in automotive at 2.9%, electrical and electronics at 3.2%, household, leisure, and sports at 2.9%, and others (medical, furniture, among others) at 4.6% (Platics-The-Facts, 2022) presented.

Hence, controlling and monitoring of plastics at the end-use stage or post-consumption becomes imperative. In combatting reckless disparity in production against disposal where, Conversio Market & Strategy (2019) stated that in 2018, of plastic post-consumer waste collected, 24.9% ended up in the landfill, 32.5% was recycled, and 42.6% was used in energy recovery. Noteworthy is the issue of ‘collected’ not being explained for further insight into the means and measures employed in tackling the recovery of such. The compilation balance would be impacted when extrapolated to reach today, comprised of production trend observance, COVID-19 pandemic intrusion, and various sectors’ plastic dependence. As Wenzel (2020) states, “In seeking to slash landfill waste in half by 2030, Starbucks is embracing the circular economy and joining 450 other companies as a signatory of the Ellen MacArthur Foundation's New Plastics Economy Commitment”. Prompting a discussion of a circular economy.

2.2 CIRCULAR ECONOMY

The circular economy gained momentum, emphasising reducing the linear economy where possible. It is relevant to most industries and very much applicable to plastic packaging. Even though there is a circular economy for plastics, the recent launch of an independent report on 'pathways to a circular plastic system in Europe' (Plastics-The Fact, 2022) informs. Nevertheless, circular economy inclusion and application vary due to different circularity proposals. Types such as Reform, Technology, Transformation, and Fortress are sourced from Calisto Friant, Vermeulen, and Salomone (2020). Where:

Reform: Towards all spheres of life and willing to embrace partnering stances in the legal, environmental, political, and ecology niches, among others. Hinging on an overall balancing of profitability and sustainability in targeting the subjection of human ambitions to the earth's allowance. Through a series of progressive steps (models, novelty, and protection, among others). This circular proposal is too deep and wide for wholescale implementation, needing further divisible pieces or pieces to avoid congregating oppositions revolting in totality, including Ponte's (2019) note of 'institutional powers.

Technology: Primarily in economic enhancement with apportioned enablement of some stances in the legal, environment, politics, and ecology niches, among others. Hinging on technology-induced balancing of profitability and sustainability and targeting removing the negative impact of human ambitions on earth's allowance through improving economic patterns to cycles of circular models, novelty, and security, among others. This circular proposal latches onto a catalyst (technology) that strengthens its cause, like blockchain. An understanding of (Rejeb *et al.,* 2022) work in stating and ranking the essential enablers of blockchain in circular economy integration were veracity, transparency, privacy, security, smart contracts, traceability, information sharing, novel proposals, decentralisation, deeper

cooperation, better-influenced decisions, increased operational efficiencies, interoperability, participatory and encouragement tokens, automation, disintermediation, trimmed expenses, immutability, and legal adherence.

Transformation: Towards all spheres of life but countering niche (legal, environment, politics, and ecology, among others) partnerships insisting on radical changes. Hinging on an alteration where the sustainability of earth's allowance dictates profitability of human ambitions. Through fore-setting and stepping up earth's reserves by concurrently cancelling harmful human practices. This circular proposal addresses redress or at least fine-tuning unyielding current enacted policies as intended, mainly targeted audience practices, whereas Bartley (2018) exemplifies 'corporate providers' as one such.

Fortress: Primary to economy enhancement with a disposition towards a favourable monetary stance in the legal, environment, politics, and ecology niches, among others. Hinging on the caretaking of dwindling sustainable earth's allowance and preservation of evaporating profitable human ambitions and through imposed enactments of hybrid templates, attaining stalemate. This circular proposal can be understood as circular economy integration with protectionism (resource and market), as Mah (2021) observes in the European Union's stance on plastics.

In all this, the concept of circular economy and its several types above certainly demands more from the consumers as they are placed in the position of initiating the 'circular' relay. However, the consumer(s) are subject to their behaviours studied and are worth continuing, as captured in a framework by White, Habib, and Hardisty (2019). The framework entails identified factors such as Social Influence, Habit formation, Individual self, Feelings and cognition, and Tangibility, with furtherance in explaining the consumption psychology and their respective triggers:

- Social influence: where the presence, behaviours, and expectations of others often impact consumers. Energised by three sub-elements of social norms, identities, and desirability, as described by White, Habib, and Hardisty (2019), The only disputation is emergencies such as COVID-19, as it was not a social norm (a global interrupt), altered social identities (carriers and non-carriers), and not socially desirable. Nevertheless, consumption spiked during COVID-19 despite a dip in plastic production, as Eurostat informs (cited in Plastics-The-Fact, 2020), which is an interesting point to underscore.
- Habit formation: where some sustainable behaviours (e.g., installing an efficient showerhead) require only a one-time action, many other sustainable behaviours (e.g., taking shorter showers) involve repeated actions that require new habit formation. Energised by sub-elements of discontinuity to change unpleasant habits, penalties, implementation intentions, making it easy, prompts, incentives, and feedback from White, Habib, and Hardisty (2019). A more recent summary upgrade drawn from Novotny, Dávid, and Csáfor (2015) lists a better purchasing experience, more excellent product selection and availability, more convenient and faster checkout, ample chances of consumer behaviour research with increased targeting aim (more individualised offers and promotions), real-time and more enhanced information about products as enablers of habit formation.
- Individual self: where the individual exerts influences on consumption behaviours. Energised by five sub-elements of self-concept, self-interest, self-consistency, self-efficacy, and individual differences from White, Habib, and Hardisty (2019). Maybe fed from experiences from and or during interactions, as an earlier finding by Crabbe and Acquaah (2016)

informed that empowering front-line employees peculiarly stimulates service, recovery, and performance, especially in joint combination with training for customer service excellence rewardingly as an adherence strictly against the doom of ignorance and or nonchalant practice.

- Feelings and cognition: where feelings and cognition are grouped as broadly, consumers take one of two different routes to action – one that is driven by affection or one that is driven by cognition. It is energised by two categorised sub-elements of negative and positive emotions for feelings while information with learning and knowledge, eco-labelling, and framing for cognition from White, Habib, and Hardisty (2019)—a potential part of causing or at least influencing trend shifts, resulting in lopsided advantages. An instance is specific structured models of a new generation of retail giants, such as Amazon.com, Alibaba Group, eBay, and Rakuten Group, able to provide vast ranges of goods while minimising the risk of having to buy in many stocks to try then and sell ('Has digital retail won?', 2018) and (Hänninen, Smedlund and Mitronen, 2018).
- Tangibility: where the propagated eco-friendly actions and outcomes of sustainable consumption can seem abstract, vague, and distant from the self. It is energised by four sub-elements of matching temporal focus, communicating local and proximate impacts, concrete communications, and encouraging the desire for intangibles from White, Habib, and Hardisty (2019).

2.3 BLOCKCHAIN

Technology has always been used in conjunction with industries. Forming a partnership for various targets. Hancock (2018) declared that the UK financial sector

is reaping fintech's benefits as it employed 61,000 people and aided ten of its businesses, surpassing the 100-billion-dollar market as of June 2017. Not surprisingly, blockchain debuted in cryptocurrency (Bitcoin), echoed in industry and academia by its base technical infrastructure driving Bitcoin, Z. Zheng *et al.,* (2017). Implemented to process money practices (transfers, payments, and remittances). Hence, blockchain is a 'block' (composition of tracked amassed content of money practices in a digital system) and a 'chain' (the continuation of linking successive blocks via securely generated identifiers on the digital system).

In summary, digitally exchanged assets are labelled as owners, traded, sold, and time on a ledger, which is blockchain (Reber and Feuerstein, 2014). A note is that the digital system is saturated by secured trusted nodes or users with record copies of the above 'tracked and linked amassed content of money practices.' Invariably, forming a network differentiates the types of blockchain. A public blockchain is a network of 'strange' nodal users connected with equal authority to enforce changes. A private blockchain is a network of 'known' nodal users connected with unequal authority to implement changes. It is also termed permissioned due to allocated concentrated authority, as Kewell, Adams, and Parry (2017) describe. Hybrid blockchain is a combined network of public and private blockchain. Hence, the private blockchain should be utilised given the research 'local build' approach.

Nevertheless, a hybrid blockchain would best be adapted considering other stakeholders. Blockchain technology has extensive influence beyond currency, finance, and markets—particularly in government, health, science, literacy, culture, and art (Swan, 2015). Hooper (2018) pinpoints blockchain's incredible pluses to industries: greater transparency, enhanced security, improved traceability, increased efficiency and speed, and reduced costs.

‘Greater Transparency’: being the digitally shared transaction records by all nodal users on the same network. Where established protocol of enforcing changes is adhered to. Guarding against manual unauthorised discrepancies allows this research to leverage this attribute in the perspective of sustainable reporting concerning retail brand plastic packaging recovery (‘reverse shopping’). All in a circular economy model where Rejeb et al. (2023) inform of its integration.

‘Enhanced Security’: is interesting as the word ‘enhanced’ points to improvements in blockchain security. However, Yli-Huumo et al. (2016) had previously posited it as a significant avenue of assault on blockchain and stated to be more than half (51%) of successful assaults across the network of nodal users. Hence, utilising encryption, especially during the ‘transit’ phases of key and unique identifiers, is crucial in this research. The combination of both ‘block’ and ‘chain’ desires a considerable number of network-domiciled participants to assault from within.

‘Improved traceability’: the digital system’s ability to trace products from origin through a journey to the intended destination. Such tracking is enabled by tracking courtesy of digital auditing, where compromise by manual editing is stifled and in practice, Liu, Zhang, and Medda (2021) targeted the genuine marketability of recycled plastic materials, including packaging, driven by the aim of evaluating plastic product recyclability for plastic product buyers via a trustworthy plastic credit management system displaying credit details and dictating purchase together with enhancing plastic recyclability through consumer verification in the market thereby boosting the merchandise of recyclable plastics through a system model. An attribute worth leveraging in the perspective of ‘reverse shopping’ when recovering respective retail brand plastic packaging. A potential ‘reordering’ occurs when retail brand plastic packaging could have the same recovered plastic packaging re-produced, noted with limits or times of such considering quality, among other issues.

‘Increased efficiency and speed’: the digital system sidelining the manual error-checking, confirmation, and updating processes. Blockchain automation incorporates most manual processes plus higher preservation or loss prevention. Consolidating Ongena’s (Ongena et al., 2018) intention that data such as the weighing tickets would be automated rather than the municipality employees entering the data manually when designing a waste management system for a municipality. Leveraging this attribute in the generality of the proposed system to capture, store, and match retail plastic packaging products stocked, traded, and recovered.

‘Reduced costs’: the digital system incorporating the above attributes. The cost of documentation (and its excesses), reviews, and personnel are optional, not mandatory. Resulting in financial prudence via the pruning of operations and personnel. This research can leverage this attribute to use existing technologies in the retail industry, such as databases as ‘feeders’ of necessary data or information as partners through automation. Other features worth noting are privacy, veracity, information sharing, interoperability, deeper cooperation, better-influenced decisions, legal adherence, and novel proposals. Where in detail is as follows:

Privacy: A feature to checkmate espionage of data and information records. Private channels perform operations by nodal users of a network. As with many sectors needing to safeguard vital data and/or information, which is key, be it monetary matters, government, or healthcare, blockchain is applicable (Hooper, 2018).

Veracity: Where the automation and immutability reduce dishonesty and raise confidence in its applicable use, including waste management and recovery precisely for the research due to stakeholders in participation guaranteed a more thorough process of veracity as Rejeb et al. (2023) state, “Blockchain also contributes to creating trusted relationships among Circular Economy stakeholders

by replacing the trust in circular supply chain partners with confidence in the technology.

Information Sharing: As this research concerns retail plastic packaging products, cash flow and product flow are captured and recorded. Such records are the custodians of 'knowledge' shared with relative stakeholders.

Interoperability: A perspective of technological or digital collaborative cooperation such as smart contracts as the research selected in pairing. Even further, when intertwined as catalysts for underpinning themes like circular economy, collaboratively opined Rejeb et al. (2023) states, "… The technology helps to enhance interoperability and coordination among multiple databases, which can be updated in real-time and accessible to all users."

Deeper Co-operation: Furtherance in bridging stakeholders in industries and stakeholders across various sectors as the research aims. Strengthening cooperation and collaboration between consumers, retail industries, and producers. As evidenced in the proposal of Gupta and Bedi (2018) in managing electronic waste using blockchain and smart contracts, smart contracts help to police the source and amount of electronic waste taken, carried via logistics**,** and recycled in and from the entire journey.

Better Influenced Decisions: From the above-enhanced collaboration, decision-making improves due to blockchain digital joint execution of industries and their stakeholder's partnership. By streamlining and automating these processes with blockchain, transactions can be completed faster and more efficiently. Since record-keeping is performed using a single digital ledger shared among participants, you do not have to reconcile multiple ledgers and end up with less clutter (Hopper, 2018).

In this research case, the probability of reordering ‘reverse shopping’ retail brand plastic packaging may increase.

Legal Adherence: From its cooperative collaboration and better impact influenced decisions, legal adherence raises the bar to political interference affecting the underpinned theme blockchain is applied. As it is in waste management where ‘plastic politics’ suppers intents and purposes, this research focus on retail brand plastic packaging recovery is also alarmed though consoled as Rejeb et al. (2023) state, “Blockchain provides the necessary support to develop an adequate legal system and enhance environmental regulations by disseminating transparent and reliable information through firms and government bodies”. The technology further ensures and/or reassuring accountability through further assistance towards adherence to legal proceedings.

Novel Proposals: This is a clear representation of the research instance, indeed, amidst other similar sorts, including Steenmans, Taylor, and Steenmans' (2021) tabulation of proposed blockchain-based solutions for waste (of diverse types) management (for specific services like transparency, policy implications, automation, and so on). Points to the technology as a kindled fire. At the same time, its flame resides solely in the purposes and channelling intent of the users configured to disrupt, assist, or reset identified targets of choice. Concerning technicalities, a big leap by blockchain technology is commendable despite its previously declared weaknesses. Depicted in gains and losses in the form of challenges and limitations stemming from Swan (2015), which points out:

- Throughput: the number of transactions a technology can complete measured against time (usually in seconds). Where some observers have reported that the throughput of blockchain is lower than that of other notable

existing technologies such as ‘VISA,’ ‘Twitter.’ Blockchain be specifically tailored to the practical details’ needs of the various categorized contents.

- Latency: the measurement of completion of a single transaction measured against time. Neither here nor there as each block integrity in blockchain must be certified though at risking a longer time interval. Hence, gaining integrity as a technology but risking near loss in terms of latency completion intervals against other technologies. Concurred by (Yli-Huumo et al., 2016).
- Usability: the effectiveness and efficiency tailored to users ergonomically. As highlighted above via the categories the usability of blockchain has indeed grown extensively and might add within the categorised contents intensively in terms of depth giving rise to problems of catering to an increasing support to developers and differing platforms, end users, and clients.
- Security: the safety and guard a technology implemented brings to bear. Blockchain by its integrity checks strengthens the security of its hosts when employed. However, new variants of breaches have embedded themselves within the secure integrity strength of blockchain encroaching and inflicting losses. Examples are the defrauding of cryptocurrency coins and ‘direct denial of service’ (DDoS) on established coins via the conduit of their larger mining pools and exchange platforms.
- Privacy: the exercise of respecting content to one’s assigned authority. Despite its beneficial importance, it is often glossed over and mistakenly presumed that privacy is assumed to be intact when security is implemented. For blockchain as a technology, its use is subject to the environment (geographical location) governing laws, which can elevate or depress the technology in this feature, as policies on privacy covering data and information are as varied and as diverse across the world (Mishra, Sharma, and Pandey, 2014) agrees. However, through global alliances, grouped

countries often offer proffer ways and means of raising similarities. In tandem with the rise of mobile technology, blockchain is deployed on and through to conduct various tasks where blunders still occur. Further insight is obtained from the (Bertino, 2016) observation that an anonymous status by specific techniques is no longer able to preserve such status or ensure previous privacy because the operating system, in tandem or paired alongside the easily and readily accessible mobile applications, may, in some instances, leak sensitive details. This makes the identification of the platforms and or respective users visible.

- Exploitation: As with other technologies, prevalent or marginal in use, the goal of exploiting a technology's societal impact for intended calculated purposes contrives to scutter the benefits. Blockchain-registered chains of blocks prove beneficial as each block verity is certified consensually, and integrity is affirmed via registration. Hence, the bane courtesy of exploitation is the division of many unplanned branches of aggregate composite chains with the above verity and integrity in offering splits to uninformed users and unsuspecting consumers (Swan, 2015).
- Authentication: the procedural checks in ascertaining and allowing only suitable individuals access to certain privileges of varying degrees attested to only on their successful fulfilment of checks request. Blockchain is no less in this regard, as the very nature of this technology aims and thrives on authentication, which in turn employs encryption. Encryption is classified into symmetric and asymmetric. The symmetric encryption algorithm generates a secure key shared by the users (sender and receiver) via cryptography. Asymmetric encryption algorithm generates secure keys (more and different ones) for the users (sender and receiver) via cryptography. Both have unique strengths and weaknesses in the blockchain; depending on the encryption

method used, the respective strengths and weaknesses take root and increase the risk of breach until it can be countered and addressed appropriately.

- Wasted Resources: Also in agreement is Yli-Huumo et al. (2016). The rising energy consumption and the repetitive purchase of low-performing gadgets due to cost, speed, and race to achieve tasks are the two issues with possible solutions of economic compensations and tailored requirements such as enforcing custom processors and hardware.

2.4 SMART CONTRACT

Drawn from Swan's (Swan, 2015) second categorization - contracts, entire economic, market, and financial applications using the blockchain that is more extensive than simple cash transactions: stocks, bonds, futures, loans, mortgages, titles, smart properties, and smart contracts. For the research, with its 'local build' approach, the simple manner of a smart contract is implemented with the acknowledgement of further extension for industrial use. Due to their attributes and tasks, smart contracts could be viewed as active, prolific, dormant, and self-destructive modes. With instances of being active in registering and certificate issuance to participatory parties in waste management as part of identity management Ahmad *et al.,* (2021). As (Kewell, Adams, and Parry, 2017) earlier thought, smart contracts are digitally initiated conditions activated when triggered by meeting of such programmed conditions. Automated in style and function renders other (third-party) involvement unnecessary. Buttressed via conducted interviews from its interviewees concerning smart contracts is that:

- Aside from safeguarding issues, the significant impact measurement concerning the influential partnership of and with blockchain is the platform permitted implementation and execution of smart contracts. This

gives both the freedom and discipline to transfer every operation guideline and condition and the confidence of its (smart contract) tailored execution when triggered. (Steenmans, Taylor and Steenmans, 2021) Relayed. This is exemplified in an after-use implementation underpinned by the combination of blockchain proposed by H. Damadi and M. Namjoo (2021) and proposed to draw waste generated from city services to the respective end nodes responsible for their generation (companies, individual households) where they are being collected by authorised municipal waste collectors who in turn have a network of nodes stationed within the city for broader coverage which host an array of smart contract for execution when triggered.

- Having one('s) own smart contract online tailored to personal specifications and working execution seems straightforward, fun and exciting. It reinforces the usefulness of employing and deploying the technology (smart contract) in operations (Steenmans, Taylor, and Steenmans, 2021).

Tallying with Ethereum, which has a foundation uniquely showcasing a system of integrated contract automation – ‘smart contract’ for chronological and distributed order generation system use (Ethereum Foundation, 2018) cited by França *et al.,* (2020). Where three typical transactional engagements are orchestrated and executed in the following ways:

- Currency transfer where the data field is empty. The user’s address appears in the Sender’s data field; the online store's public address (ID) appears in the Recipient’s data field; and the purchased product's price appears in the Amount data field.

- No recipient data field entry implies deploying a new contract on Ethereum as the intention, with the data field entry bearing the details of the programmed smart contract to be deployed.
- Transaction engagement with a smart contract or strictly between smart contracts. When the sender aims to execute another smart contract, one transaction must occur, and the Recipient data field will include the address of the smart contract being executed. The Data field will consist of any encoded arguments required for the transactions.

It is worth noting that digital coin offering (cryptocurrency) is a reward mechanism that smart contracts will help facilitate—given its pedigree in combination with blockchain and its use in a circular economy, justifying the research application towards ‘reverse shopping’ for incentivisation. Recereum strives to assuage this waste deluge by encouraging individual households to sort their waste correctly with their coins saved from the cost of sorting operations, which is the differential amount from the sales of sold sorted waste to buyers (Factories, Plants) who purchase for recycling and further operations (Gopalakrishnan and Radhakrishnan, 2019). With blockchain, the nodal users are rewarded with actionable intelligence that enables activities and cash flow. Paired with blockchain and in conjunction with the model (circular economy), the research recovery theme (‘reverse shopping’) of retail brand plastic packaging aligns with Rejeb et al. (2023) stating, “Blockchain offers a smart contract facility to supply chain parties, which maximises business processes' efficiency and costs. Smart contracts make transactions between Circular Economy stakeholders more efficient and effective as they are executed automatically and independently on the blockchain. This added-value mechanism is lightweight, helping to implement the Circular Economy business logic and complying with ‘The Internet of Things’ (IoT) requirements. Smart contracts also may automate the alert

services in the product lifecycles, manage bidding systems, prevent counterfeiting, and trigger payments for returned products based on their conditions." Further justified by F. Qu, H. Haddad, and H. Shahriar (2019) to mention along with an architectural proposal of reward distribution concerning solid waste management in tandem with 'The Internet of Things' (IoT) exemplified courtesy of M. Paturi *et al.* (2021) below:

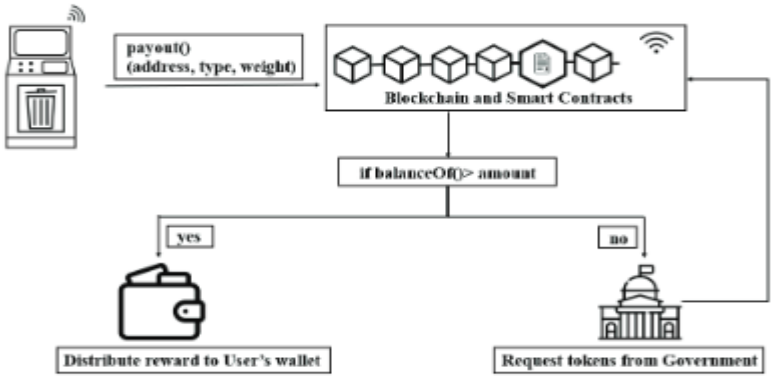


Figure 5: FLOWCHART OF PROCESSING REWARD DISTRIBUTION

Other sub-executable commands, such as the smart contract, accommodate three main functions: invest() - token acceptance, payout() – rewards distribution, and balanceof() – balance information. All of this is to cater to user and government participation. For the user, when the disposed solid waste (type and weight) is used during payment requests, and for the government, when the smart contract amount is lower than the expected confirmed reward amount, a governmental 'funding' deposit is required. This leads to the research understanding of the average smart contract utilisation is realised with the inclusion of third parties. The research diagrammatical summary is shown in Figure 6 below:

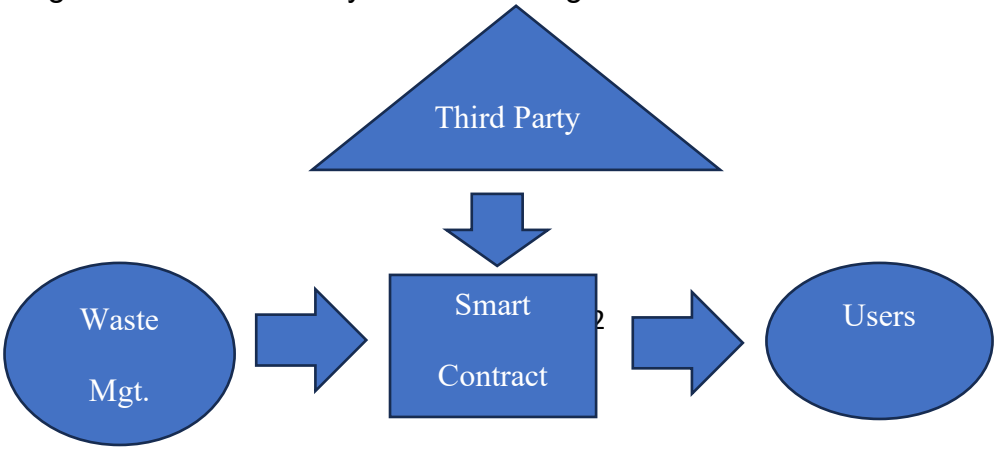


Figure 6: DIAGRAM OF THE RESEARCH UNERSTANDING SUMMARISING INTERPRETATIVELY SMART CONTRACTS USE IN WASTE MANAGEMENT

In tandem with this, a procedural perspective of the underlying implementation incorporated to guarantee the working of the above-interpreted summary. Also, the research diagrammatical expression is shown in Figure 8 below:

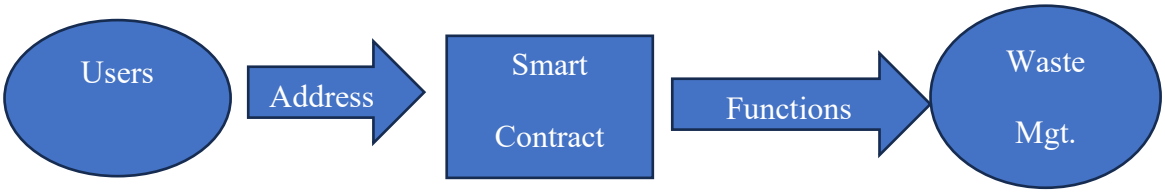


Figure 7: DIAGRAM OF THE RESEARCH UNDERSTANDING EXPRESSING INTERPRETATIVELY SMART CONTRACT UNDERLYING IMPLEMENTATION IN WASTE MANAGEMENT.

In agreement, Gupta and Bedi (2018) state, “Using smart contracts, rules can be implemented easily and hassle-free. Any two parties who decide to abide by a given set of rules can use these contracts. Ethereum allows such parties to code all the regulations, penalties, and incentives into a smart contract. If any of these parties do not follow the contract rules, necessary actions are undertaken as defined in the code. Hence, interacting parties need not trust each other or a third party in case of an agreement based on smart contracts. Smart contract proponents have found them useful in many diverse fields, including insurance, employment, supply chain management, and copyrights.” Nevertheless, warnings abound as Kewell, Adams, and Parry (2017) state, “The danger, of course, is that the contract performs no matter what: this raises questions about who writes them (Quis custodiet ipsos custodies?), how to write in flexibility to respond to and incorporate external events, and individuals’ free will in connecting with them”. Corroborating but narrowly, note that the foremost hindrances encountered in utilising smart contracts for waste

management fall into four groups: execution, safeguarding, developmental, and functional (Ahmad *et al.,* 2021).

CHAPTER 3 – RESEARCH METHOD

The method appropriated in this thesis conveys the sequence below (Figure 9). The M. Alharby, A. Aldweesh and A. v. Moorsel (2018) 'Systemic Mapping Studies' method is inherited as its pathway best help in the provision of diagnosing the research theme shown pictorially below courtesy Petersen *et al.,* June 26, (2008):

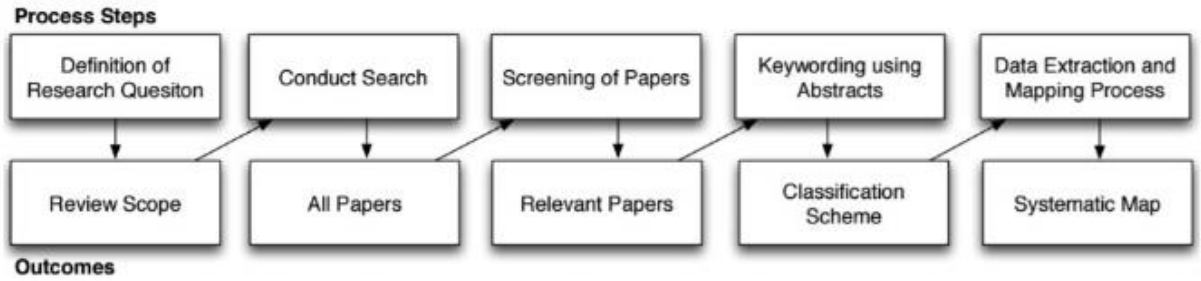


Figure 8: DIAGRAM OF STEPS OF THE SYSTEMATIC MAPPING STUDIES

The "Waterfall" criterion was followed where one stage is exhausted (unique requirements fulfilled and inputs tailored to be fed into the next) entirely before the beginning of the next for a continuous connection with no overlap. The stages are (a) Requirements – which is characterised by directive determinants (objectives and research questions); (b) Design – characterised by modelling the system (intertwining relationship) through incorporating the stakeholders; (c) Implementation – characterised by developing sub-components separately for simulating the working interaction of the intertwining relationship, (d) Integration and testing – characterised by the combination of the sub-components in the previous implementation stage in conjunction with wholesale testing for errors and flaws, (e) Deployment – characterised by market availability, and (f) Maintenance – characterised by the upkeeping repair and updates to enable continued use by clients.

3.1.1 REQUIREMENTS

From the paired objectives and research questions, search conduction through databases (‘Google Scholar,’ ‘Web Science,’ ‘Elsevier,’ ‘Science Direct’, and the University of Wolverhampton’s digital library search catalogue) was carried out within the relevant parameters (plastic, plastic packaging, plastic recycling, blockchain, smart contract, retail, retail industry, consumer). These were screened strictly to arrive at relevant papers.

For ‘circularity,’ following the shopping process, the ‘reverse shopping’ captured stakeholders are consumers or customers, retailers or customised businesses, and producers or manufacturers.

Consumers or customers, where the: ‘Use of International Serial Business Number’ – as per standard practice, tailored in advocacy to ‘fostering and aiding recovery’ of and for ‘products of plastic packaging’, thereby adding to the overall ‘value purchase’ of the trade experience empowering sustainable ‘culture’, with appropriate ‘technology’ filling gaps and earning contributory ‘votes’ to participate.

Table 3 summarises the allocation of consumer attributes captured in system design and implementation.

Table 3: LIST OF CONSUMER OR CUSTOMER ITEMS

Consumers or Customers
Use Of International Serial Business Number
To Foster and Aid Recovery
For Products Plastic Packaging
Value Purchase
Culture with Technology and Votes

Retail or customised businesses are featured in the product design where ‘Tracking of International Serial Business Number’ – as per standard practice, will be stressed and stretched towards ‘strengthening resolution through revolving’ of ‘products of plastic packaging’ between consumers or customers and producers or manufacturers, setting ‘brand standard’ apart while enriching ‘tourism’ (model advertisement) with ‘technology’ (applied) as the facilitator while also engaging in ‘diplomatic’ buy-in(s) (not manipulative but through conviction).

Table 4 summarises the allocation of retail industry attributes for system design and implementation.

Table 4: LIST OF RETAIL INDUSTRY ITEMS

Retail Industry
Tracking Of International Serial Business Number
To Strengthen Resolve Through Revolve
For Products Plastic Packaging
Brand Standard
Tourism with Technology and Diplomacy

The producers or manufacturers are featured in the product design where the ‘Matching of International Serial Business Number’ – as per standard practice, serves the frequency of ‘maintaining and increasing recovery (and probably recycling)’ of ‘plastic products and packaging’ championing the idea of an ‘ethical product’ thereby drawing ‘tourism’ (process advertisement) with query and efficient ‘science’ as a critical factor consolidated by the agreement of ‘votes’ (measurable commitment or total abstinence but not a mixture).

Table 5 summarises the allocation of producer attributes for system design and implementation.

Table 5: LIST OF MANUFACTURER OR PRODUCER ITEMS

Manufacturers or Producers
Matching Of International Serial Business Number
To Maintain and Increase Recovery (and Probable Recycling)
For Plastic Products and Packages
Ethical Product
Tourism with Science and Votes

A background format for contextual understanding yields three categorical classifications, namely – Application, Peculiarity, and Alliance where:

- The application consisted of science and technology while,
- Peculiarity consisted of culture, tourism, and,
- Alliance consisted of diplomacy and votes.

Quite clearly, from the above table of designs, the ‘consumers or customers’ were abrogated with (CTV – culture, technology, and votes) while ‘retail industry’ was abrogated with (TTD – tourism, technology, and diplomacy and the ‘manufacturers or producers’ were abrogated with (TSV – tourism, science, and votes).

The above tables 3 to 5 merged to yield Table 6 below:

Table 6: DESIGN DETAILS OF (CONSUMER OR CUSTOMER, RETAIL INDUSTRIES AND MANUFACTURERS OR PRODUCERS) ITEMS INTERCONNECTED RELATIVITY

Consumer(s)	Retail Industries	Producer(s)
Use of International Serial Business Number	Tracking of International Serial Business Number	Matching of International Serial Business Number
To Foster and Aid Recovery	To Strengthen Recovery Through Revolve	To Maintain and Increase Recovery (and probably recycling)
Brand Plastic Packaging	Brand Plastic Packaging	Brand Plastic Packaging
Value Purchase	Brand Standard	Ethical Product
Culture with Technology and Votes	Tourism with Technology and Diplomacy	Tourism with Science and Votes

The interconnected relativity is further explained below as follows:

- For the top three rows: consumers or customers ‘SCAN’ via ‘International Serial Business Number,’ the customised business (retail industries) ‘TRACK’ via ‘International Serial Business Number’ and finally, the producers or manufacturers ‘MATCH’ via ‘International Serial Business Number.’

- In the second three rows, consumers or customers are encouraged via the underlying developed blockchain application to obtain before and return after usage, respectively, thereby ‘fostering and aiding recovery.’ The retail

industries verify each pair of former specific interactions, thereby ‘strengthening resolve through revolving.’ Before the latter passage to producers or manufacturers who validate each specific pair against each other, thereby ‘maintaining and increasing recovery’ (and probably recycling).

- The third or middle three rows all have consumers or customers, retail industries, and producers or manufacturers pinned on brand plastic packaging, a key component of the research theme.

- Moving to the fourth three rows, consumers or customers stand to gain an additional value attached to their purchase – ‘Value Purchase.’ The retail industries stand to gain an additional standard attached to their brand – ‘Brand Standard.’ The producers or manufacturers stand to gain an additional ethic attached to their product – ‘Ethical Product.’

- Lastly, the bottom three rows: impacting society, regarding consumers or customers a way of consumption with a blend of technology earning their approval – ‘Culture with Technology and Votes.’ Regarding retail industries, an appeal to a business model with a mix of technology earning their participation – ‘Tourism with Technology and Diplomacy.’ Regarding producers or manufacturers, production adoption with a further science inclusion – ‘Tourism with Science and Votes.’

Hence, the above interconnected relative items of consumers or customers, retail industries, producers or manufacturers are split and designed into two halves. Adapting to the circular economy model, showing ‘reverse shopping.’ Beginning with the first half is identified as ‘P to C’ where ‘P’ represents producers, ‘to’ represents the transition between which customised business lodges and facilitates, and ‘C’ represents consumers.

The producers or manufacturers start manufacturing brand ‘plastic packaging products’ tailored to request and demand with an ‘international serial business number’ given before selling such products to customised businesses (retail industries) and prospective clients.

The retail industries buy their brand ‘plastic packaging products,’ tagged with ‘international serial business number’ and incorporate them into their marketable goods system (stocks). When ready for sale, they are offered to sell the brand plastic packaged goods tracked via ‘international serial business number’ confirmation at the point of purchase.

The consumer or customers enter at the other end of the transaction with the retail industries at the point of the earlier transaction when purchasing brand ‘plastic packaging products’ via ‘international serial business number’ in scanning. Lastly, the consumer or customers interact with the brand plastic packaging and content through ownership and usage, thus signalling the full chain of the first half – ‘P to C’ also expressed diagrammatically below:

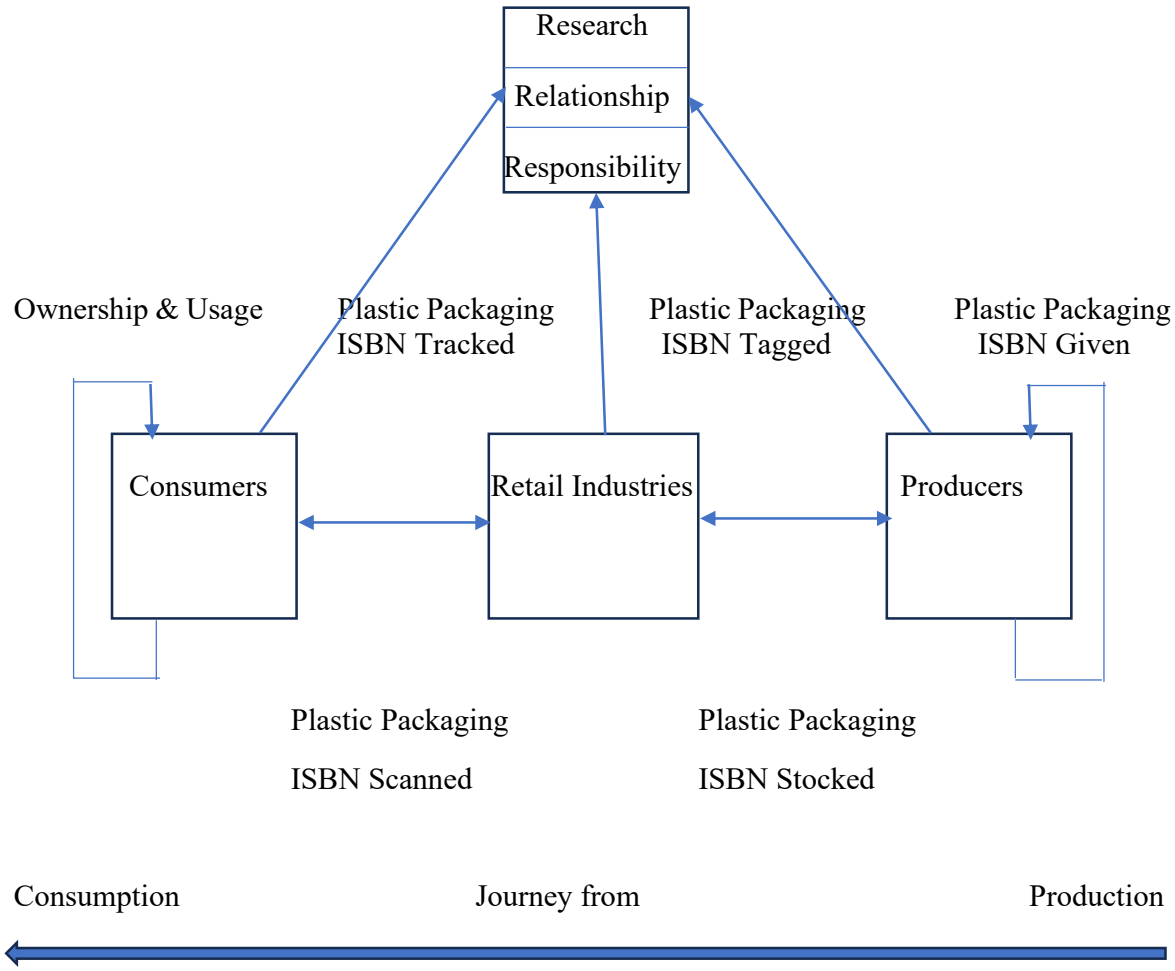


Figure 9: DESIGN DETAILS OF FIRST HALF – 'P to C' SHOWING CONSUMPTION JOURNEY FROM PRODUCTION

Moving onto the second half, identified as 'C to P' where 'C' represents the consumer, 'to' describes the transition between which customised business lodges and facilitates while 'P' represents producers.

Here, consumers or customers offer incentives to encourage decisive action by returning owned and used brand 'plastic packaging products' for accounted or stated benefits. Yielding a return transaction by scanning the 'international serial business number' of the brand plastic packaging product at the respective retail industries channel(s).

Retail Industries, obviously at the end of the former consumer or customer transaction during return, verify the brand plastic packaging received via the

‘international serial business number’ system check tallies. After tallied system checks of returned and collected brand plastic packaging goods, they are redirected to their respective producers and manufacturers with their respective ‘international serial business number’ recorded for appropriate segregation.

The producers or manufacturers then enter at the other end of the transaction with the retail industries at the point of the former transaction when received brand plastic packaging products are validated via matching ‘international serial business number’ and acceptance is established. Lastly, the producers or manufacturers begin by themselves or further collaborate with destroying plastic packaging to recycle it and reissue the ‘international serial business number.’ Thereby signalling the entire chain of the second half – ‘C to P’ also expressed diagrammatically below:

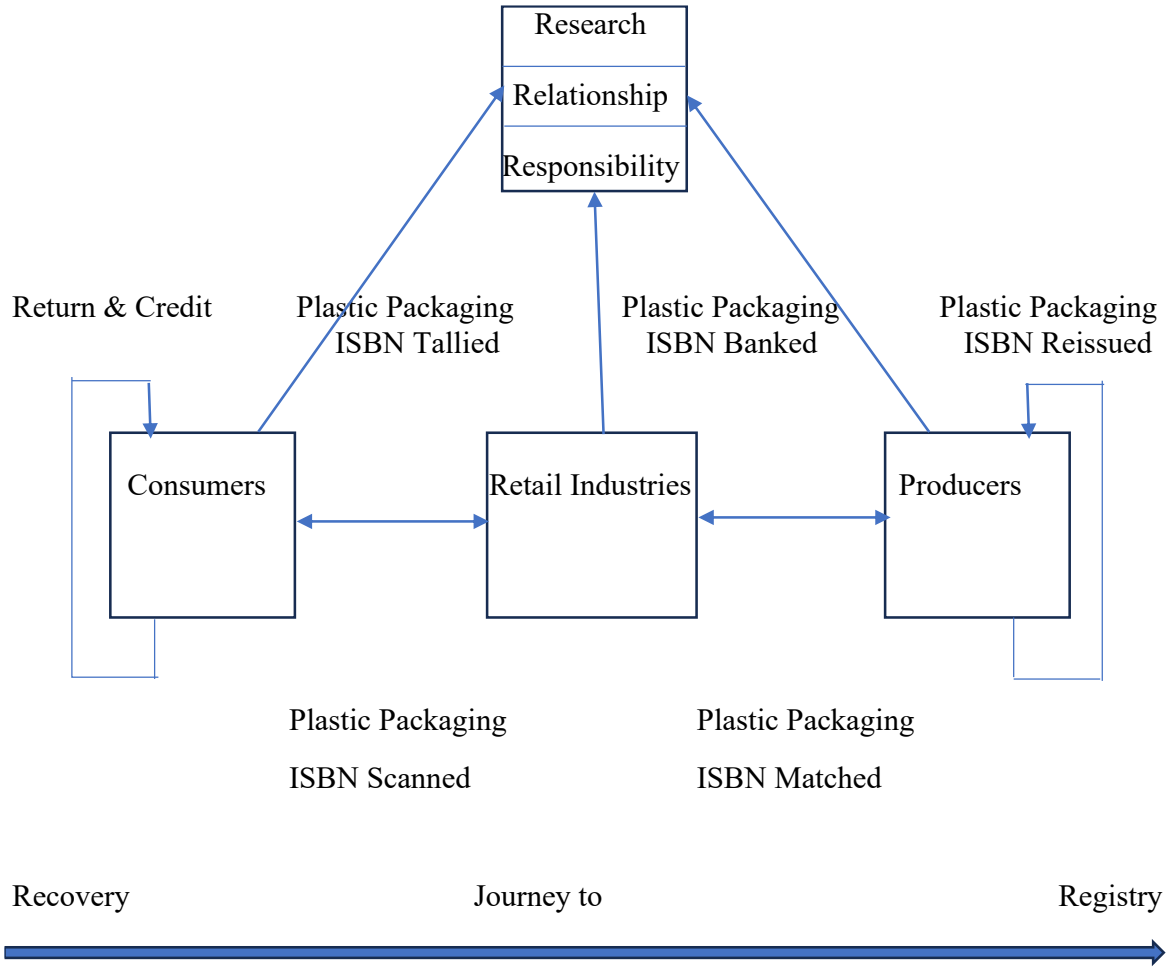


Figure 10: DESIGN DETAILS OF SECOND HALF – 'C to P' SHOWING REGISTERED RECOVERY JOURNEY TO RECYCLABLE RELEASE

The captured stakeholders (customers, retailers, and producers) in the methodology requirements (stage 1) are connected relationally through their respective items, forming an interactive partnership where critical factors are responsibly shared as follows:

- ISBN: used by consumers, tracked by retail industries, and matched by producers.
- ROLE: consumers (contribute by returning), retail industries (resolve to revolve), and producers (accountability in recycling).
- TARGET: shopped plastic packaging brand shared by all stakeholders.

- MOTIVE: value purchase for consumers, brand standard for retail industries, and ethical product for producers.
- FIRST DYNAMICS: culture hinges more on consumers, while tourism is on retail industries and producers.
- SECOND DYNAMICS: producers embrace science most, while consumers and retail industries use technology.
- THIRD DYNAMICS: retail industries will advocate using 'diplomacy,' while consumers and producers will use 'vote.'

Matched against the average industrial design courtesy of Gupta and Bedi (2018), the electronic waste management proposal captures the following stakeholders (producer, retailer, consumer, receiving point, recycling point) as understood in the drawing below:

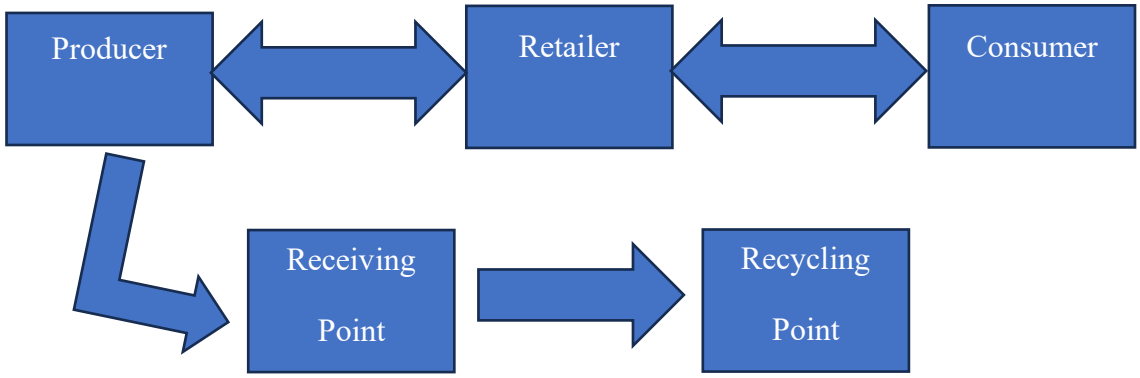


Figure 11: DIAGRAM OF THE RESEARCH UNDERSTANDING IN APPROACH INSTANCE A (PROPOSED SYSTEM FOR E-WASTE MANAGEMENT).

The interpretation concerns an electronic product produced by the producer, who then supplies it to the retailer. The retailer then trades the supplied electronic product from the producer to the consumer. The consumer then uses the bought electronic product and returns it to the retailer as electronic waste. As expected, the retailer continues the 'return' by returning the electronic waste to the producer. At this, the producer is tasked with diverting the electronic waste to the receiving point

(collection centre). It ends at the receiving point (collection centre), where the electronic waste is delivered to the recycling point. A critical analysis of the above-average relative matching by and to the research is as follows:

- As the research aims to reduce or eliminate third-party involvement where possible, including a ‘receiving point’ (collection centre) and recycling point is a disagreement. There is no deterministic clue as to the electronic waste being recycled. With notice of possible split from the ‘receiving point’ towards landfills.
- As the research aims to combine the recovery theme (‘reverse shopping’) of retail brand plastic packaging and the model (circular economy), a second disagreement is that there is only one communication pathway between [producer and receiving point (collection centre)], [receiving point (collection centre) and recycling unit]. Where inappropriate or surplus electronic waste may be channelled from the ‘receiving point’ to the recycling point without going through the circularity of (producer to retailer to consumer, back to the retailer to and to producer).
- Closely following reverse logic, the third disagreement is that there is also a denial of circular economy at [producer and receiving point (collection centre)], [receiving point (collection centre) and recycling unit] stations, and their respective transits. For which potential recycled electronic waste could be re-inducted back to the producer in various parts for utility purposes. Helping to spare and reduce the need for such item(s) production.
- In fairness and agreement, this proposal also incorporated a Government Agency), which performs the role of regulator as a node on the Ethereum blockchain and will manage those points.
- The second agreement is the acknowledgement of the proposal’s circular economy model observance at (producer and retailer), (retailer and

consumer) stations, and transits. If not, this can factor in the maintenance and or repair of electronic products returned (not yet necessarily as waste).

3.1.2 DESIGN

From the requirements to the methodology, second stage sees the design concept of the research theme model system to underpin and partner in operation(s) with the above theme model expressed in Figure 9 and Figure 10 of the methodology requirements (stage 1). Hence, this research design is represented diagrammatically below:

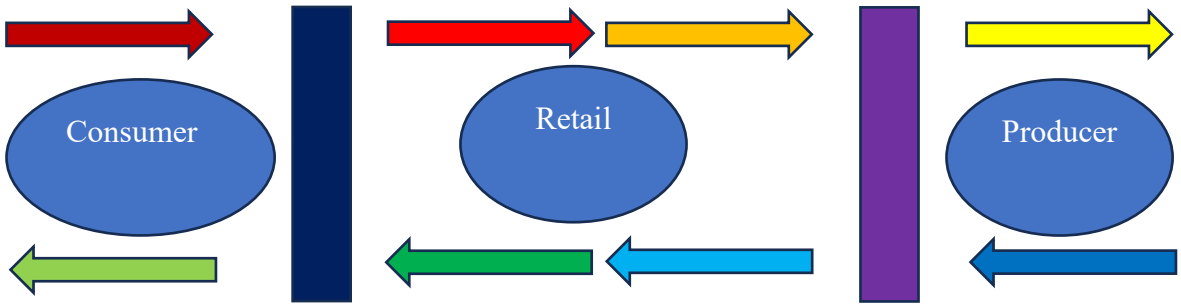


Figure 12: THEME MODEL SYSTEM DESIGN OF THE RESEARCH

Where the:

- Dark Red Arrow implies the transaction of ‘reverse shopping’ returned retail branded plastic packaging undertaken by consumers.
- Dark Blue Rectangle implies a public blockchain, storing retail brand plastic packaging registered.
- Red Arrow implies the matching and execution of ‘reverse shopping’ received retail branded plastic packaging by the retail industry's smart contract (transaction and address).
- Orange Arrow implies the matching and execution of ‘reverse shopping’ recovered retail branded plastic packaging by the smart contract (brand update) in the retail industry to the respective producers.

- Purple Rectangle implies a consortium blockchain storing retail brand plastic packaging updates (orders, recovered, reordered). Participants are retail industries and producers (partnering in brand plastic packaging).
- Yellow Arrow implies a reverse shopping transaction for returned retail branded plastic packaging. Undertaken by the retail industry back to respective producers, completing the research model (circular economy).
- Blue Arrow implies transaction of potential or probable ‘reverse shopping’ reordered retail branded plastic packaging. It can also mean a particular supply of retail brand plastic packaging to the retail industry. Both cases utilise transaction production logs. Undertaken by the respective producers.
- Light Blue Arrow implies the matching and executing ordered and/or reordered retail branded plastic packaging by the smart contract (address of production logs) in the retail industry.
- Green Arrow implies the matching and execution of sold-ordered or reordered retail branded plastic packaging by the smart contract (brand update) in the retail industry to consumers.
- Light Green Arrow implies purchasing ordered and/or reordered retail brand plastic packaging from the retail industry by consumers.
- The consumer is a captured stakeholder participating in the research theme model and aware of courtesy transparency reporting on the dedicated website(s), updated and drawn from the public blockchain.
- Retail is a captured stakeholder participating in the research theme model. The centrepiece facilitates the research system.

- The producer is a captured stakeholder participating in the research theme model. Included for their partnering in the production of plastic packaging tailored to retail industries with their image tag for brand boost. Plus, indirect market capture and protection.

3.1.3 IMPLEMENTATION

From the design to the methodology, third stage sees the implementation steps of the above research design (stage 2) in delivering a working prototype of the research theme model. However, due to technical expertise, the implementation only covers the design areas within the black rectangle box as represented diagrammatically below:

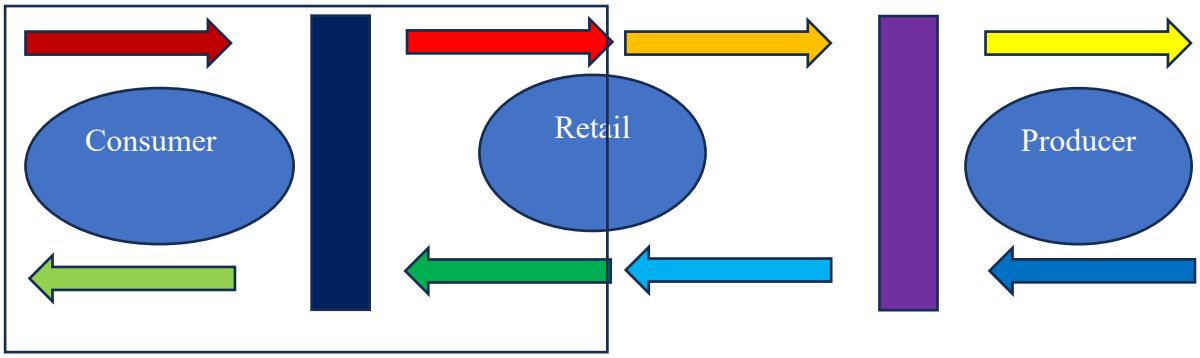


Figure 13: DEMARCATION OF RESEARCH THEME MODEL SYSTEM DESIGN

This also further reflects the research aim succinctly and satisfactorily. Hence, the research implementation partition is further represented diagrammatically below:

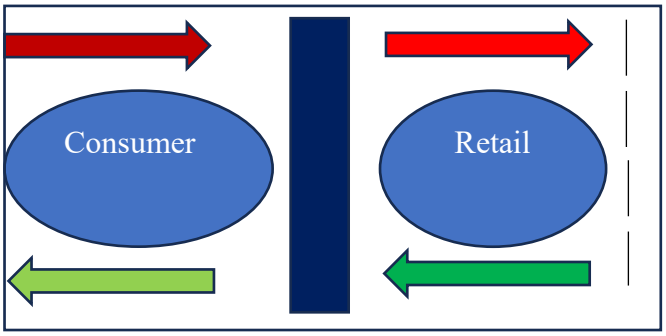


Figure 14: IMPLEMENTABLE PARTITION OF RESEARCH THEME MODEL SYSTEM

Working locally, plus use of created virtual environments through the ‘Anaconda Navigator,’ where the needed third-party packages are imported from, including cryptocurrency enablers like ‘Pycryptodrome’ or ‘Pycrypto.’ Activating intended coin via command line (REPL) and local directory linkage by the following instructions below:

- conda info –envs
- activate ‘name of cryptocurrency’
- python
- exit()
- conda info

The respective implementation begins with the blockchain, which is implemented via Microsoft Visual Studio Code and Python. The blockchain functions consist of the following:

- The Prototype – developed structure to complement the research design.
- The Blocks developed a structure for validated and stored transacted plastic packaging records.
- The Hashing – the developed structure of security.
- The Output – the developed structure of required and understandable prompts.
- The Prove – developed structure of verification (conditional checks).
- The Transaction – the developed structure of processing exchanges.

- The Nodes – developed structure of identified stakeholders with their respective interactions.
- The Wallets – the developed structure of handling stakeholders' pre- and post-exchanges.
- The Port is the developed structure for evaluating the above-combined functions.
- The Graphical User Interface Port is the developed structure of transparency reporting via a webpage connection.
- The Graphical User Interface Network is the developed structure that links other nodes (participants) to the webpage connection (corroborating sustainable transparency reporting).

To be judged using parameters of a blockchain tabulated in Table 7 below:

Table 7: TABLE OF BLOCKCHAIN PARAMETERS AND THEIR RESPECTIVE DESCRIPTIONS

PARAMETERS	DESCRIPTIONS
Transaction Volume	The set period in the total amount of transactions processed.
Network Hash-rate	The combined (mining and transactional) processing power needed to compute.
Decentralization Metrics	The tally of participants in the network.
Block Time	The average period needed in block creation via mining.

Transaction Throughput	The tally of transactions processed per second on the network.
Transaction Fees	The expense incurred via processing transactions on the blockchain.

Where Microsoft Artificial Intelligence – Copilot (2025) highlights some steps for each of the metrics as follows:

- **Transaction Volume:** Define the timeframe, Collect Transaction Data, Calculate Total Value, Use Blockchain Analytics Tools, Analyse and Interpret.
- **Network hash-rate:** Understand hash rate, Use Mining Software, Run Mining Algorithms, Check Online Calculators, and Monitor Network hash rate.
- **Decentralisation Metrics:** Node Distribution, Stakeholder Distribution, Hash-rate Distribution, Governance Participation, Software Diversity.
- **Block Time:** Understand Block Time, Record Block Timestamps, Calculate Time Differences, Average the Differences, and Use Monitoring Tools.
- **Transaction Throughput:** Define the time frame, Collect Transaction Data, Calculate Throughput, Monitor Over Time, and Use Performance Testing Tools.
- **Transaction Fees:** Collect Transaction Data, Sum of Fees, Number of Transactions, Calculate Average Fee, Monitor Over Time.

Then, ‘Smart Contract’ can be achieved through ‘Remix’ and ‘Solidity.’ The ‘Smart Contract’ functions accordingly:

- Maximum Saleable: communicates total inventory coin for reward mechanism.

- Monetary Exchange: communicates the international market value of the coin to encourage participation and investment opportunities.
- Mapping: Solidity command helps to communicate the security of coin and currency accounts by matching public addresses correspondingly.
- Purchasing Power - communicates verification (acquiring stated amounts).
- Investors: communicates validation (holdings of 'interested buyers' in coin and currency amounts).
- Purchase: communicates buying the coin.
- Trading: communicates selling the coin.

The successfully built and compiled smart contract code is deployed (via Byte code and ABI) to 'MYETHERWALLET', a browser extension website where Ethereum allows for local use, deployment, interaction, and testing of smart contracts in tandem with 'Ganache', an application which houses mock apparatus for verification and validation of private or local Ethereum blockchain.

Further judged using parameters of a smart contract tabulated in Table 8 below:

Table 8: TABLE OF SMART CONTRACT PARAMETERS AND THEIR RESPECTIVE DESCRIPTIONS

PARAMETERS	DESCRIPTIONS
Gas Usage	The amount of computing power needed in executing a smart contract.
Execution Time	The measurement of smart contract execution period-wise.
Smart Contract Interactions	The tally of execution and interaction of a smart contract and with other smart contracts respectively.

Code Complexity	The measurement of complexity concerning the smart contract written code.
Security Vulnerabilities	The identification of potential threats, and weaknesses of the smart contract code.

Where Microsoft Artificial Intelligence – Copilot (2025) highlights some steps for each of the metrics as follows:

- **Gas Usage:** Deploy the Smart Contract, Use a Blockchain Explorer, Monitor Transactions, Calculate Average Gas Usage, Use Gas Estimation Tools, and Optimize Gas Usage.
- **Execution Time:** Deploy the Smart Contract, Use a Local Blockchain Development Environment, Run Tests, Use Time Measurement Functions and Analyse Results.
- **Smart Contract Interactions:** Deploy the Smart Contract, Use Blockchain Development Tools, Record Transaction Data, Analyse Event Logs, Use Blockchain Explorers, and Generate Reports.
- **Code Complexity:** Lines of Code, Cyclomatic Complexity, Function Complexity, Depth of Nested Constructs, Code of Readability, Use of Libraries, Automated Analysis Tools, Maintainability Index.
- **Security Vulnerabilities:** Code Review, Static Analysis Tools, Formal Verification, Security Audits, Penetration Testing, Bug Bounty Programs, Continuous Monitoring.

3.1.4 INTEGRATION AND TESTING

Tailored to match the returned plastic packaging during ‘reverse shopping’ with the stored blockchain record of sold plastic packaging during shopping. The ‘Smart Contract’ deployed via (Byte code and ABI) to ‘MYETHERWALLET,’ a browser extension website where Ethereum allows for local use, deployment, interaction, and testing of smart contract in tandem with ‘Ganache,’ an application that houses mock apparatus for verification and validation of private or local Ethereum blockchain. A choice with which Franca and Neto et al. (2020) concur, Where Ethereum has a foundation uniquely showcasing a system of integrated contract automation – ‘smart contract’ for chronological and distributed order generation system uses, citing (Ethereum Foundation)”. Hence, the seven functions of the smart contract are integrated and tested. The list of steps conducting the integration and testing of the system are as follows below:

- OPEN (REMIX IDE, GANACHE, MYETHERWALLET).
- SET NETWORK TO CUSTOM NETWORK/NODE IN MYETHERWALLET.
- GET LOCALHOST AND PORT INFO FROM GANACHE INTO THE MYETHERWALLET CUSTOM NODE.
- IN MYETHERWALLET, GO TO THE CONTRACT TAB AND CLICK ‘DEPLOY CONTRACT.’
- GO TO REMIX IDE, CLICK TAB SOLIDITY COMPILER, COPY BYTE CODE (ENSURE ALONE) INTO MYETHERWALLET.
- SET ACCESS TO WALLET TO PRIVATE KEY.
- GO TO GANACHE, CHOOSE ONE ADDRESS, AND CLICK ON THE CORRESPONDING KEY TAB TO OBTAIN THE KEY (COPY KEY).
- GO TO MYETHERWALLET, PASTE THE OBTAINED COPY KEY INTO THE ‘PASTE YOUR PRIVATE KEY’ BOX; THEN CLICK ‘UNLOCK,’ ‘SIGN TRANSACTION’ AND FURTHER ‘DEPLOY CONTRACT.’

- GO TO GANACHE, CHECK (TX, BLOCK).
- GO BACK TO MYETHERWALLET, CLICK ‘INTERACT WITH CONTRACT,’
- OBTAIN THAT FROM GANACHE VIA ‘CREATED CONTRACT ADDRESS,’
- COPY BACK TO MYETHERWALLET AND PASTE IT IN THE ‘CONTRACT ADDRESS’ BOX.
- GO TO REMIX IDE, CLICK TAB SOLIDITY COMPILER, COPY ABI INTO MYETHERWALLET.
- BACK TO MYETHERWALLET, PASTE IT IN THE ‘ABI’ BOX, CLICK ACCESS.
- THEN BEGIN TO INTERACT WITH THE CONTRACT COURTESY OF THE ‘READ OR WRITE CONTRACT’ TAB.
- WHICH HOLDS PROGRAMMED-ENABLED FUNCTIONS TO IMPLEMENT EXECUTABLE COMMANDS.
- CULMINATING IN ACTIVITIES (TESTING, GENERATION, SIGNING TRANSACTION, RESPECTIVE BLOCK CREATION, RESPECTIVE BLOCK UPDATE.
- ALL SAVED, STORED, AND SHOWN ALONGSIDE GASES (COST) OF EACH OPERATION EXECUTED.

3.1.5 DEPLOYMENT

This stage was not reached but would be of great interest for execution, so it is detailed in Chapter 6 for recommendation.

3.1.6 MAINTENANCE

This stage cannot be addressed yet as it depends on the deployment stage, which must be completed.

CHAPTER 4 – FINDINGS

This chapter outlays the informed issues courtesy of the above research method, which aided in guiding the research system's technical development and consisted of two sub-parts – assets and limitations. Assets where the beneficiary understanding is moulded from the research system via research methodology and limitations where the hindrances are enumerated with description on how (capacity) and what (depth) disturbance is currently borne.

4.1 ASSETS

The first asset concerning the research direction is ‘Cemented Potential’ through ‘reverse shopping’ (same parties) and ‘circular economy’ (encouraging recovery). An investment in using blockchain and smart contracts to recover plastic packaging in the retail industry via reverse shopping in the circular model theme among stakeholders and shareholders within the public domain. Where the same parties in ‘reverse shopping’ tackle the usability mode of plastic packaging, the ‘circular economy’ tackles the reusability mode. Aligning with Peshkam Michael (2019, p.1), “… blockchain technology has the potential for addressing the challenges of plastic waste in our environment. Specifically, distributed ledgers, combined with global positioning and micro tagging, provide a mechanism for tracking plastic through the supply chain and support incentive systems for recycling or reusing it and choosing biodegradable options.” Potential boosting technologies emerged pliably and flexibly in applications, allowing them to absorb issues with high concentration and saturated depth. Servicing the recovery theme of retail branded plastic packaging by prompting reservations of infrastructure allocation towards increased recovery also echoed in a slightly different focal theme (recycling), where industries are crisscrossed in its enablement as Allison Ian (2022) cites Lisa Zafferani (Recycling Technologies marketing manager) verbatim, “I think what is interesting for the waste

and recycling industry is how you can use technology like blockchain to trace plastic waste in those processes of recycling and the output from them".

The second asset concerning the research direction is 'Concerted Consolidation,' where the innate profit drive is tasked to coincide with the stemming control in active and reactive efforts of raising respective collaborative responsibility.

- Respective: regarding all captured stakeholders.
- Collaborative: regarding their fused efforts.
- Responsibility: regarding the necessary readjustments.

It also implied the coordinated, cooperative target of plastic packaging regarding sector (retail), which bridges other sectors. Type (branded), significant status and role, and mode (physical), locale of typical proximity. Exemplified in a different scenario, Athumani (2019) states, "They are collecting plastic bottles around, but the polythene bags are being left. Yet they are the most dangerous for the environment." Poorly disposed, unsanctioned burning, and even dumps in gardens hinder ethical agriculture practices. Despite counter efforts in ironing fifteen compiled plastic bags and making a strong backpack with designs to customers' preference (Athumani, 2019). There, our research through 'concerted consolidation' would help to:

- Raise affinity in identified stakeholders' willingness to be attached to the above scenario.
- Craft collaborative, participatory efforts in fusion to combat allowed and increasing environmental pollution and agricultural malpractice.
- Readjusting the responsibility to the necessities of sustaining the counter efforts in the above scenario thriving.

Agreeing, Ventures Africa (2020) states, “We are one of the top polluters of the ocean in the world, and it is sad because there is an unexplored opportunity here, going to waste, but we can solve many issues by tapping into this sector”. Citing WeCyclers Partnership(s) founder, Bilkiss Adebiyi Abiola. This highlights an example from a manual approach, where a school received plastic bottles as student tuition payments. Thanks to the principal’s influence in diversifying and including children whose guardians’ inability to pay financially had a pending dismissal—liaised with the African Clean-Up Initiative (ACI) and WeCyclers to introduce the ‘Recycles Pay Education’ project (Egbedi, 2019b).

The third asset concerning the research direction is ‘Market Examination.’ The merchandise of plastic packaging is of colossal magnitude, so also the myriad means of addressing its enormous far and wide reach (Allison Ian, 2022) showing Circulor CEO Doug Johnson-Poensgen’s happiness concerning plastic waste, stating, “In many European countries, governments are proposing taxes on retailers who sell plastics which does not contain a minimum of 30 per cent recycled. The obvious thing required is a way to prove it, which is what blockchains can do.” For us, our means through records obtained in technologies (blockchain and smart contract) applied via circular economy model, using ‘reverse shopping’ is used with an appendage on the web. The webpage(s) facilitation entails transparent, sustainable reporting checks on branded plastic packaging in the retail industry, covering all parties. The records indicating (ordered, produced, stocked, sold, received, and returned) for retailers’ courtesy:

- Place orders on brand plastic packaging to be produced.
- Stock brand plastic packaging on reception.
- Sell brand plastic packaging as part of the trade.

- Receive brand plastic packaging upon recovery from customer(s).
- Return brand plastic packaging to ‘original product producers’ (OPP).

For producers or manufacturers courtesy:

- Produce tailored retail brand plastic packaging on order.
- Issue and tag (ISBN) on produced retail brand plastic packaging for identification.
- Sell produced and identified retail brand plastic packaging.
- Check identification of retail brand plastic packaging upon return.

For customer(s) or consumer(s) courtesy:

- Purchase retail brand plastic packaging as part of the trade.
- Return retail brand plastic packaging as part of the trade.

This constitutes a combination incorporated into a digital coin offering for possible association with the relative organisation of the same pulse. Remembering Smith, N. and Soonieus (2019) study, “Of the 234 business leaders polled (across ranks and company sizes), three quarters believe that ignoring sustainability will affect their company’s ability to create long-term value and almost a third indicated that their organisations aim to be market leaders in sustainability and a further 30 per cent aim to be seen as strong performers”. Such insight peered through supersedes an impression of market examination but to an actual market examination with informed clues. As (Amogunla, 2021) states, “In Nigeria, (“wastepreneurs” are providing an answer to this by taking waste straight from the dump, transforming it and redefining its purpose. These innovators work with varied materials – water sachets, scrap metal, bottles, plastic, tyres, and more – with many learning how to manipulate these objects to make “beauty out of ashes.” These entrepreneurs ask:

“If you can recycle it, why waste it?”).” Our research raises the question: “If you can recover it, why dump it?”

Lastly, the fourth asset concerning the research direction is ‘Galvanized Sectors.’ Galvanized will be adept at explaining the impact on retail-associated sectors. As the catalyst(s) of technology used (blockchain and smart contract) in plastic packaging recovery, it has an overall impact courtesy of shareholders and stakeholders. The impact was measured through accurately accrued detailed information of shopped plastic packaging brands against recovered ‘reverse shopped’ plastic packaging brands in the retail industry. Statistically inferred to produce a threshold on which other sectors in an association can base decisions and gauge progress. Thereby answering the Director of Research, African Tax Administration Forum (ATAF), Dr Nara Monkam’s recommendation of “Exploring the potential of environmental taxes, feeding into sustainability and economic resilience” cited by Osaji-Ugo (2021). The difference between retail branded plastic packaging in ‘shopped’ and ‘reverse shopped’ is scrutinised.

On the other hand, tying a reward system (digital coin offering) brings monetary incentivisation to the recovery theme with particular emphasis on participatory consumers. Differing from the existing focus on recycling encouraged monetary practices as W Chan Kim, Mauborgne, and Ji (2021) report of a European start-up engaging in blockchain tokens for encouraging gift-oriented recycling where money donated by people and enterprises are equated in the same weight proportion of plastic waste guaranteed to be cleaned up by the European brand; mathematically 10 euros matching 10kg of plastic waste as an example, increasing the realisation of statements usually credited towards the recycling theme also inherited by recovering branded plastic packaging situated in the retail industry. Such statements include Misha Hanin (2020), CEO of DeepDive Technology Group, who is confident in blockchain technology providing concrete proof of beneficial environmental

impact for every agent in the supply chain recycling wise with monetisation, incentivisation, and integrity intact in mind Group (2020) cites. Bound together (associated sectors) by the threshold (an intersection point), that can propel the system into a vehicle for further analysis from the respective sectors' agents as (Kessler, 2021) opines with a note in reducing waste in mass and substantially impactful globally, comes from using a systems perspective where academia, sectors, legalities, clients, suppliers, and non-governmental officers (NGO's) work in unison of the same beat, pace, and goals.

4.2 LIMITATIONS

In close observation, the first limitation concerning the research direction is 'Plastic Politics.' With government(s) not specifically captured among the stakeholders in design, development, and implementation, the political will of enacting ownership and penalties in respective countries cannot be deduced. Nielsen *et al.* (2020) state, "Global demand and production for conventional plastic is expected to increase as petrochemical companies realise large-scale investments in new production facilities and infrastructure, especially in the United States, Middle East, and South-East Asia". Issues of losses can scupper the embrace of our research in favour of current and or planned profitable ventures, though exceptions abound. As is the testimony of the Kenyan government and legal sectors with world-class success in a decided action against plastic carrier bags with which they carry their shopped commodities like groceries, etc in the capital Nairobi which Ventures Africa, (2021) states, "The Kenyan government would enact the ban on production, sale and use of plastics carrier bags which is considered one of the sternest in the world and whose success rate is now recorded at approximately 80%". Hopefully, this research can gain the support of governmental policies without the interference of politics, where actionable first-line responders can achieve recovery of retail branded plastic packaging with a wide reach. As Athumani (2019) states, "So, those solutions are

something that is not just for urban people, but also those people out there who need to have something like that and eco-friendly, and it's an action towards our health right now, for who are suffering from plastic".

The second limitation encountered concerning the research direction is the 'Themed Model.' The theme (recovery) that the research is centred on is overlooked, and a fair amount is needed to garner the attention it deserves. The model (circular economy) that the research adapts to is not without fissures. The theme, an example, was the European Commission Strategy for Plastics in a Circular Economy, covering (reuse, repair, and recycling needs) with no mention of 'recovery' Mah, (2021). The model, despite its recorded successes, has underlying fissures in the bedrock of its foundational solidity and stability as Palm *et al.* (2022) write, "However, surface agreement on the need for 'circularity' hides deeper-lying ideological divisions over what exactly the circular economy means and the different directions this implies for plastic governance". Plus, companies incurring losses attempting to embrace a circular economy plastic-wise further strengthen their current linear economy; as a result, Palm et al. (2022). This is certainly outside the prospective feasibility of retailers' readjusting or acquiring the necessary infrastructures for 'reverse shopping.' Hence, the recovery theme and the circular economy model are paired for their advantages in implementing 'reverse shopping,' which concurrently adds the twin limits, where such advantages highlight a technocentric circular economy employing technology (blockchain and smart contract) but not a holistic circularity consisting of a deep reform touching (social, political, economic, and environmental considerations).

With further insight, the third limitation concerning the research direction is the 'Attitudinal Fix.' Attitudinal is about traits of captured stakeholders and 'Fix' is about expected researched tendencies. As the research does not answer challenges in general consumer behaviour and consumption patterns, the retailers' brands cannot

be guaranteed an automatic rise in patronage though promotion is upscaled. Further encumbrances such as Mah (2021, p.127) hint at a wider scope of actors listing ‘institutional power’, ‘corporate provider’, and ‘operator’. In detail:

- ‘Institutional power’: Ponte (2019) states, “arenas where powerful actors jockey for the inclusion of terms that are especially favourable to them, for example, when lead firms can shape the definition of minimum standards on environmental impact as a way to lower the costs of compliance”. Noticing a link between ‘institutional power’ and ‘cost of compliance’ is respectively mirrored in retail industries and the technological implied ‘reverse shopping.’ The prototype (system) was implemented locally with the use of text (.txt) files for storage but will require a database (as used in retail industries). The reason is capacity and high memory usage bringing to bear the above-mentioned hinderance mirroring.

- ‘Corporate provider’: Bartley (2018) states, “are not pushing for or against intergovernmental agreements but rather pushing private standards for safety, sustainability, technical specifications, and human rights through their global supply chains”. Noticing a link between ‘corporate provider’ and ‘private standards’ is respectively mirrored in retail industries and the technological implied ‘reverse shopping.’ The ‘Prove’ function in the prototype (system) implemented locally, responsible for verifying and validating the internal programmed commands in conjunction with conditions, was executed in the calculative difficulty against energy consumption. For industrial deployment, the calculative difficulty will be higher in tandem with huge energy consumption. Likewise, the ‘Transaction’ function using the ‘proof of work’ algorithm executed singularly is counter effective as industrial deployment will require bulk transaction execution such as the ‘Merkle Tree’ technique. Therefore, with the implemented system tailored to no specific

retail industry stakeholder, the system must pass through the scrutiny of their various private standards (technical specifications, sustainability template, and shopping network infrastructure).

- ‘Operators’: Eckert (2019) states, “have detailed technical knowledge about important infrastructure, which is difficult for nonexperts to challenge, and thus they can use informational asymmetries to become direct providers of global governance”. Noticing a link between ‘operators’ and ‘infrastructure’ is respectively mirrored in expertise and used technological infrastructure. The ‘Port and Graphical User Interface Port’ achieved using the ‘POSTMAN’ application and webpage(s) connective display for more transparent sustainable reporting was executed in isolation without much-anticipated web traffic. Also, the ‘Nodes and Graphical User Interface Network’ was tested via simulation, which pales against the asynchronous scheduling needed for industrial deployment. Additionally, the ‘Blocks and Hashing’ implemented using (‘SHA-256’) asymmetrical encryption needs to undergo an industrial hacking stress test. All these need adjustments performed by experts against indicated pointers for a much better ‘reverse shopping’ contributory measurement of recovering retail branded plastic packaging in a circular economy.

The fourth limitation encountered concerning the research direction is ‘Local Build.’ The basic blockchain application with a cryptocurrency format via Python programming language was developed with the tutored assistance of Schwarzmuller (2019). Built-in ‘object-oriented programming’ format utilising techniques (classes and objects, attributes and methods, inheritance), detailing:

- The implemented ‘Dark Blue Rectangle’ (in Figure 8) implies a public blockchain, storing retail brand plastic packaging registered. Being a

permission-less blockchain with the potential to expand industrially when more nodes (users) join, feasibility will be of great concern given the integrated testing of smart contracts costing 1ether per transaction. This note is without the costing of the unimplemented ‘Purple Rectangle’ (in Figure 7), a consortium blockchain storing retail brand plastic packaging updates (orders, recovered, reordered) where participants are retail industries and producers (partnering in brand plastic packaging); feasibility will be of greater concern.

- The Prototype – Text (.txt) files as storage (limited capacity) for contents (the chain, open transactions, and corresponding methods) must be upscaled to a database (higher capacity), accommodating the expected high memory usage. As in industrial deployment, the bigger the blockchain results in more memory usage and subsequent consequences like longer chain record retrieval requiring a database with higher capacity towards scalability efficiency.

- Mining Difficulty: The blockchain application uses the ‘proof of work’ mechanism, which has set the generating of a block to just ‘00’ as this matches and simplifies the smart contract ‘ICO’ – initial coin offering at the cryptocurrency start but will need complexity (more zeroes) as the system grows in industrial deployment.

- The Blocks and Hashing – Simplicity alongside asymmetrical encryption using ‘SHA-256’. This is due to the understanding of potential nodes (users) increase by and when joining the above implemented ‘local build’ public blockchain when industrially deployed. As ‘Practical Byzantine Fault Tolerance’ (PBFT) algorithm is and would be helpful.

- The Output – Error handling measures are basic because the blockchain application implemented a basic error handling measure but would need improvement for industrial deployment in means of more and required elaborative feedback, and additions of such logs to storage.

- The Prove – represents the verification and validation of the internal programmed commands in conjunction with the programmed conditions used via calculative difficulty over and against energy consumption.

- The Transaction and Prove – Algorithm ('proof of work') used for (transactions, last_hash, proof) with a test done singularly as against the bulk test requiring techniques such as the 'Merkle Tree.'

- The Port and Graphical User Interface Port – Achieved using the 'POSTMAN' application and webpage(s) connection and display for more transparent, sustainable reporting, but web traffic was ignored.

- The Nodes and Graphical User Interface Network – A tested simulation (conflict resolution and consensus algorithm) that pales against asynchronous scheduling.

Understood from the implementation format of Liu, Zhang, and Medda (2021) and Koscina, Lombard-Plates (2019) in conjunction with the assistive tutoring of (De Ponteves, Eremenko, Team (2023), the 'Smart Contract' lacks functions enabling trade with other cryptocurrencies (especially like-minded eco-friendly). Implementation could only achieve tested stand-alone but not linked to the blockchain as the methodology design conceptualised evidenced below:

- REMIX IDE – Smart contract programmed and compiled using Solidity with 'ByteCode' and 'ABI' extracted.

- MYETHERWALLET – Ethereum nodes network operation set-up with smart contract deployed.
- GANACHE – Smart contract executed via simulated test.

Critically, an analytical review of the implemented smart contract confirms an incentivisation or reward mechanism thrust alone, more incorporated features like conversion of existing consumer respective retail brand coupons to stakes (mirroring the ‘proof of stake’ algorithm). This can help negate the high feasibility cost of the ‘proof of work’ algorithm used instead, plus even considering the modularity (many, assigned, and specific) of smart contracts for simplicity. Tried by (H. Damadi and M. Namjoo, 2021) for a waste management system underpinned by the combination of blockchain using smart contract and fog computing, where generated waste is drawn from city services to the respective end nodes responsible for their generation (companies, individual households). Then, they are collected by authorised municipal waste collectors who, in turn, have a network of nodes stationed within the city for wider coverage, which host an array of smart contracts for execution when triggered. Worthy of note is that one of the essential functions of these smart contracts is for incentives where the waste collectors (authorised companies) pay a cryptocurrency amount for sorting generated wastes from the end nodes. In addition, the combination of fog computing and blockchain (executing smart contracts) is interesting as the taxing blockchains can be mitigated courtesy of fog computing. However, the strength of such depends on the number of nodes each company acquires in conjunction with the size of the city.

Nevertheless, the negation is that the transactional data is derived through the payment of sorted waste as it only lends credence to the ‘commercialisation of waste’ disguised under the cloak of incentives. Not without disapprovals, due to the nature of following such types of perspectives, where the underpinning intent and or

motivation stirring such proposals and subsequent implementations is the worth of given to waste through the corresponding monetary attachment (Steenmans, Taylor and Steenmans, 2021) asserted. Which differs from this research's aim, focus, and drive.

4.3 METRICS

The metrics are measured indices from the developed prototype of the research proposed system. Relaying the indicated parameter values of the research system (blockchain and smart contract) metrics. Regarding the 'local build' blockchain application, the results are as follows:

- **Transaction Volume:** The time frame was daily, with transactional data collected via a text file (.txt) displaying the wallet holdings. The total value could be calculated via analysis and interpretation, arriving at **22.** That value in proper context is due to a very low computation hash threshold of "00" via a laptop, a mock simulation as industrial deployment was not achieved, and other less standard techniques as admitted by concession in the immediate above 'Limitations' section of the research findings. Hence, based on the admission, when compared against contemporary blockchains, including Bitcoin and Ethereum, with industrial deployment, higher (far higher in comparison) computation hash threshold, high (far higher in comparison) specification of electronic systems, and top-tier standard techniques; this research 'local build' blockchain application pales in performance. As Medium (2023) states, "According to data from Statista, the daily number of confirmed Bitcoin transactions reached over 383,000 in December 2021. Meanwhile, the Ethereum network peaked at over 1.7 million daily transactions in September 2020. This growth can be attributed to several factors, including increased awareness, adoption of cryptocurrencies, and the emergence of new use cases".

- **Network Hash Rate:** From understanding the hash rate and using the application software – 'POSTMAN', the hash rate is **74 hashes per second**. The reason is that the blockchain at the start mines at **20 hashes per second**, while the **first batch transaction was at 54 hashes per second.** Adding mine and transaction hash rates together results in 74 hashes per second. Before and the growth sets in. Again, the value in proper context is due to a very low computation hash threshold of "00" via a laptop, a mock simulation as industrial deployment was not achieved, and other less standard techniques as admitted by concession in the immediate above 'Limitations' section of the research findings. Hence, based on the admission, when compared against contemporary blockchains, including Bitcoin and Ethereum, with industrial deployment, higher (far higher in comparison) computation hash threshold, high (far higher in comparison) specification of electronic systems, and top-tier standard techniques; this research 'local build' blockchain application pales in performance. As Jacob Wade (2024) states, "Hash rates change daily for all cryptocurrencies, but on August 30, 2024, Bitcoin's was 692.14 EH/s, Bitcoin Cash's was 3.58 EH/s, Litecoin's was 998.15 TH/s, and Dogecoin's was 1 PH/s".
- **Decentralisation Metrics:** Decentralisation (no single authority) is often defined as the opposite of centralisation (single authority) in a blockchain. **Only two main nodes were implemented and tested with a third as fringe.** Given the research 'local build' blockchain via a laptop, a mock simulation as industrial deployment was not achieved, and other less standard techniques as admitted by concession in the immediate above 'Limitations' section of the research findings. Hence, based on the admission, when compared against contemporary blockchains, including Bitcoin and Ethereum, with industrial deployment, higher (far higher in comparison)

computation hash threshold, high (far higher in comparison) specification of electronic systems, and top-tier standard techniques; this research 'local build' blockchain application pales in performance. However, (Jaeseung Lee et al., 2021) further elaborated on decentralisation in blockchain to include geographical diversity and censorship resistance, especially for the post-evaluation of decentralisation in blockchain as opposed to the prior assessment including this research.

- **Block Time:** From the understanding of block time and the use of the application software – 'POSTMAN', and a text file as log records of timestamps, the block time averaged **1.6327 seconds, with** a reminder that the research 'local build' blockchain via a laptop, a mock simulation as industrial deployment was not achieved, and other less standard techniques as admitted by concession in the immediate above 'Limitations' section of the research findings. Hence, based on the admission, when compared against contemporary blockchains, including Bitcoin and Ethereum, with industrial deployment, higher (far higher in comparison) computation hash threshold, high (far higher in comparison) specification of electronic systems, and top-tier standard techniques; this research 'local build' blockchain application pales in performance. Coinmetro (2025) states, "For instance, Bitcoin has an average block time of around 10 minutes, while Ethereum aims for about 12-15 seconds".
- **Transaction Throughput:** The transaction throughput stood at **one transaction per second**. The research blockchain application pales in performance as the 'local build' approach via a laptop, a mock simulation as industrial deployment was not achieved, and other less standard techniques as admitted by concession in the immediate above 'Limitations' section of the research findings. Hence, based on the admission, when compared against

the contemporary blockchains with industrial deployment, higher (far higher in comparison) computation hash threshold, high (far higher in comparison) specification of electronic systems, and top-tier standard techniques (Cointracker, 2025) relays of Bitcoin at seven transactions per second, Ethereum at 15-30 transactions per second, Solana at 65,000 transactions per second, and Polygon at 7,000 transactions per second. A view which (Frank Corva, 2023) states, “Bitcoin, though widely considered the most secure blockchain, doesn't settle transactions as quickly as other blockchains like Ethereum or Solana. The Bitcoin blockchain only settles about seven transactions per second on average. Ethereum settles 15 TPS on average, more than double that of Bitcoin, but it's less secure than Bitcoin. Meanwhile, the outage-prone Solana, the least secure of the bunch, settles an average of almost 4,000 TPS”.

- **Transaction Fees:** Based on the above concessions, the research blockchain application did not incorporate transactional fees into the simulation. Consequently, there is no basis for a comparison.

Regarding the smart contract, the results are as follows:

- **Gas Usage: G**iven ‘wei’ is the smallest divisible unit of the ether used in Ethereum. The smart contract transactions used gases, as tabulated below in Table 9:

Table 9: SMART CONTRACT TRANSACTIONS WITH THEIR RESPECTIVE GAS USAGE AND GAS COST

TRANSACTIONS	GAS USED	GAS COST
Transaction 1	370712	7414240000000000wei/0.00741424ether
Transaction 2	87897	1757940000000000wei/0.00175794ether
Transaction 3	42897	857940000000000wei/0.00085794ether
Transaction 4	39610	79220000000000wei/0.00007922ether

Hence, the **average gas used was 135279 while the average gas cost was 2705580000000000wei/0.00270558ether.** Altogether higher in gas usage and gas cost to Sen Gupta et al. (2022), contemporary smart contract measurements tabulation is displayed in Figure 15 below:

Table 5 Estimated gas cost of deploying smart contracts

Smart contract (proof of concept)	Smart contract (algorithm)	Gas used	Gas cost (wei)	Gas cost (ETH)
SGB.sol	SC_{SGB}	2402448	480489600000000000	0.04804896
Vehicle.sol	$SC_{Vehicle}$	4513662	902732400000000000	0.09027324
Token.sol	SC_{Token}	1659442	331888400000000000	0.03318884

Table 6 Gas cost of procedures in smart contracts

Smart contract	Function name (proof of concept)	Algorithm	Gas used	Gas cost (wei)	Gas cost (ETH)
Token.sol	transferIncentive	$Transfer_{Incentive}$	53527	10705400000000000	0.00107054
SGB.sol	SGBStatus	SGB_{Status}	53599	10719800000000000	0.00107198
	registerSGB	None	112672	22534400000000000	0.00225344
Vehicle.sol	SGBNotification	$SGB_{Notification}$	109470	21894000000000000	0.0021894
	vehicleStatus	$Vehicle_{Status}$	48786	9757200000000000	0.00097572
	SGBNotificationResponse	$SGB^{Response}_{Notification}$	97843	19568600000000000	0.00195686
	optimalRouteCollect	$OptimalRoute_{Collect}$	96078	19215600000000000	0.00192156
	optimalRouteDispose	$OptimalRoute_{Dispose}$	85185	17037000000000000	0.0017037
	registerVehicle	None	92079	18415800000000000	0.00184158

Figure 15: DISPLAY OF SEN GUPTA'S ET. AL., SMART CONTRACT GAS USAGE AND GAS COST MEASUREMENT

- **Execution Time:** The execution time courtesy of the application software, 'Ganache', is the average of the chain blocks consisting of the deployed smart contract and executed transactions. Table 10 below tabulates accordingly:

Table 10: SMART CONTRACT EXECUTION TIME COURTESY BLOCKS OF CHAIN DIFFERENTIAL

BLOCKS	TIME	DIFFERENTIAL
Block 0	11:41:12	00:00:00
Block 1	11:44:40	00:03:28
Block 2	12:07:09	00:23:29
Block 3	12:20:09	00:13:00
Block 4	12:24:26	00:04:17

Hence, the average execution time was **8 minutes and 8 seconds**. However, because the simulation of smart contract deployment and execution encountered difficulties and delays, the reason for the spike in 'Block 2' and subsequent drop in 'Block 3' showed problem-solving. Preferably, 'Blocks (1 and 4)' are further separated in consideration due to the similarity of the interval with 'Block 0' the origin. Therefore, a more accurate average execution time would be **3 minutes and 7 seconds**. In the context of no industrial deployment and fewer standard computing tools, this serves as only a pointer for a recommended retest, including the highlighted factors.

- **Smart Contract Interactions:** The smart contract interactions are divided into two categories (interaction with other smart contracts and the interactions within a smart contract). The first category (interaction with other smart contracts is non-existent, as only one smart contract was written and

deployed. A major drawback is that industrial deployment will certainly have other smart contracts for interaction. Reason it is admitted in the above, 'Limitation' section of the findings, and a recommendation in the conclusion. The second category (interaction within the smart contract) yielded **four interactions courtesy of the four transactions.** All seven functions were tested and verified by their respective arguments and outcomes.

- **Code Complexity:** Through the indices below in Table 11, the code complexity of the smart contract is low. A quicker execution time is a plus for further expansion and industrial deployment.

Table 11: CODE COMPLEXITY TABLE OF RESEARCH SMART CONTRACT

INDICES	VALUE	INFERENCE
Lines of Code	29	Less complex
Cyclomatic Complexity	5	Low – linearly independent.
Function Complexity	2	Low – only two functions with more than two lines of code.
Code Readability	Good	Documented via simple comments ahead of each function explaining the role.

- **Security Vulnerabilities:** Another big drawback of the research smart contract is that no industrial deployment gives an opaque understanding of the smart contract security rating. Especially when the code complexity is low.

CHAPTER 5 - PRODUCT

Beginning with the product implemented diagram represented below:

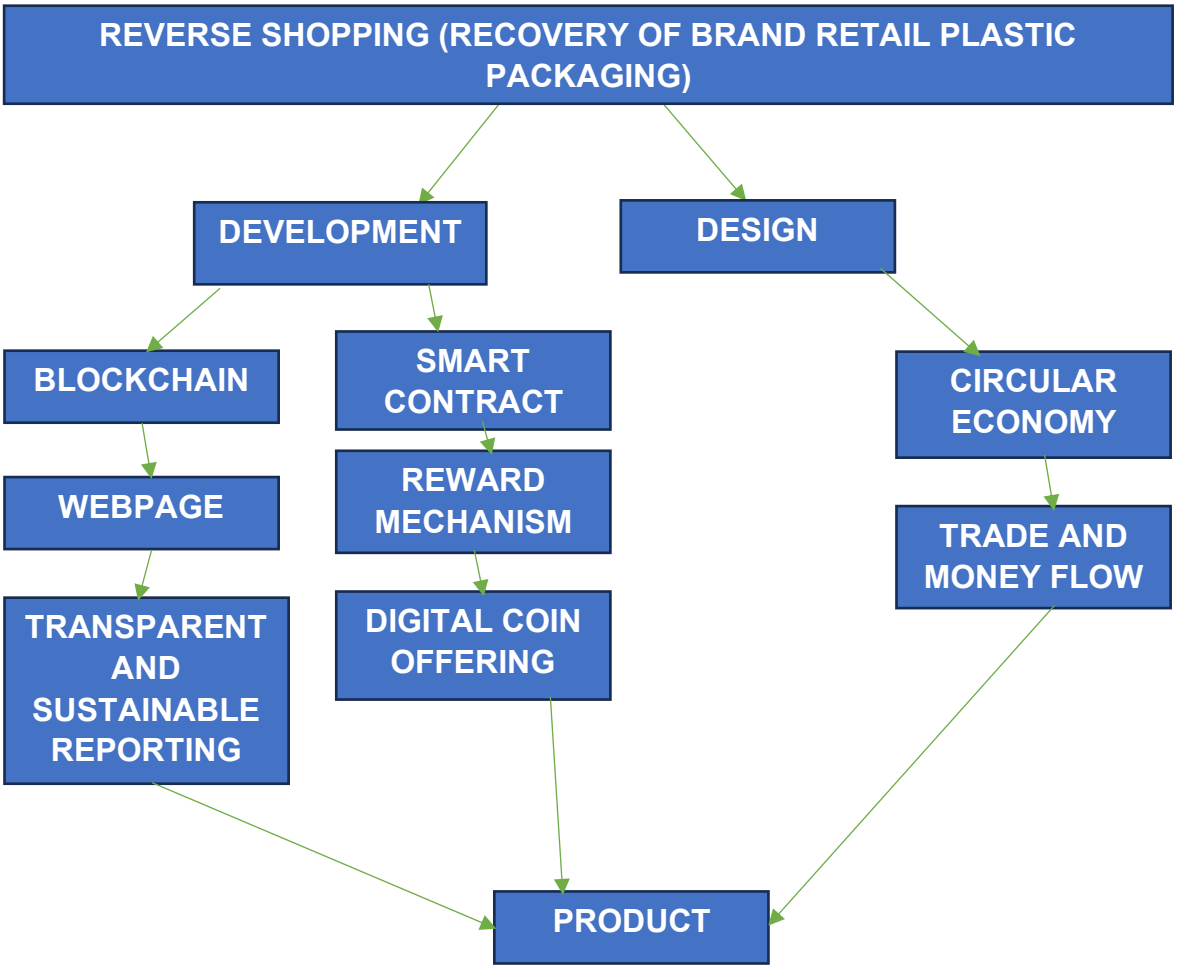


Figure 16: DIAGRAM OF RESEARCH PRODUCT IMPLEMENTATION

The following notes must be addressed when critically appraising the product within the research aim. The notes refer to industries''' decision-makers constitutions towards niches (referenced talking arenas, points, and operational approaches). With relativity, the niche of sustainability can be related to the research where Smith, C., Soonieus, R. (2019) informs of directors and boardroom behaviour towards sustainability is of a similar Likert scale measurement in which some are 'deniers', 'hard-headed', 'superficial', 'complacent', and 'true believer'. Incorporated into the product implementation for the beneficial active participation of maintaining

sustainability as increasingly a ‘force of presence’ though the ‘force’ and the ‘presence’ are often seen and separated. Due to ‘force,’ perceived as dictatorial running of business organisations from outside entities mostly without understanding the unyielding ironic complexities of operating their business aside. The ‘presence’ they can point to in referencing a representation of existing sustainability approaches. Unpacking further:

- ‘Deniers,’ dealing with sustainability just for an ethical brand appendage in retail industries concerning brand plastic packaging recovery, will contend with the transparent reporting courtesy of the connected webpage(s) display. A yield of working output nodes (respective users) engaging in transactions via a webpage with an underlying blockchain principle as captured below:

UNABLE TO GAIN PERMISSION FROM THE COPYRIGHT HOLDER

Text Redacted

UNABLE TO GAIN PERMISSION FROM THE COPYRIGHT HOLDER

Text Redacted

- ‘Hard-headed,’ dealing with sustainability just for profitability, as Kessler (2021) cautions with assertion concerning outfits imperative in recording profits, that is their underlying essence, not in a stance of rescuing or salvaging the sustainable problems in effect globally, only when such stances of sustainability affecting the world is in sync or aligns with their profitability driven ambitions. Also, deals with customer preference where they will be compelled in retail industries concerning brand plastic packaging recovery. As the digital coin offering reward mechanism courtesy, the smart contract ensures stakeholder(s) preference shown below:

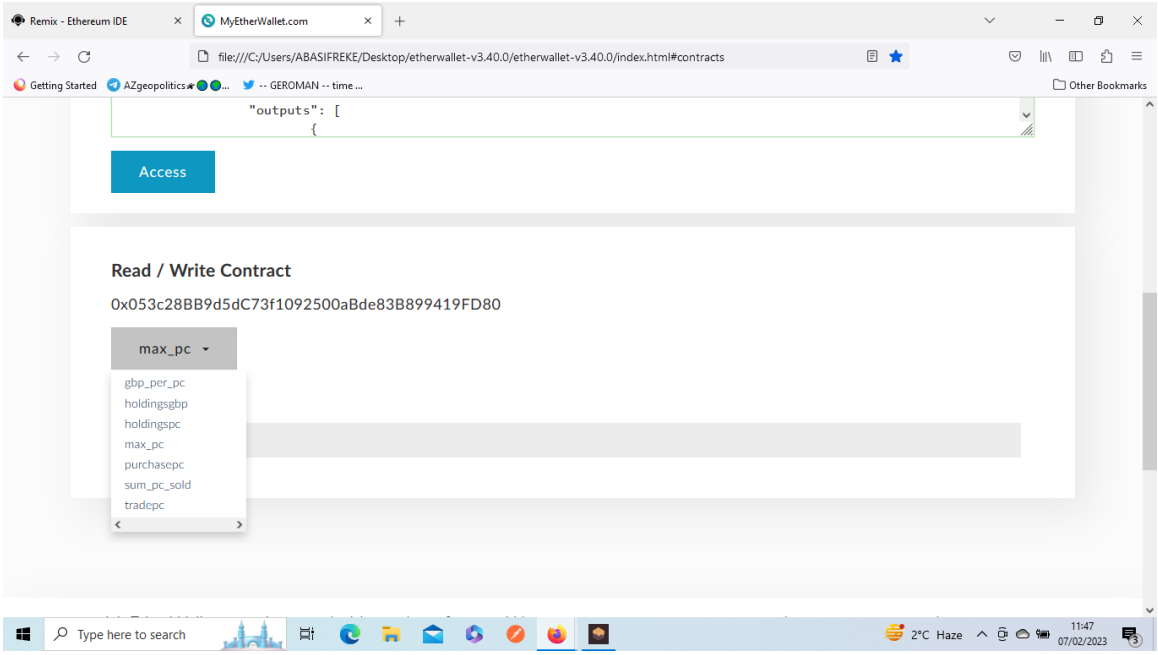


Figure 17: DISPLAY OF DEPLOYED SMART CONTRACT FUNCTIONS ON MYETHERWALLET

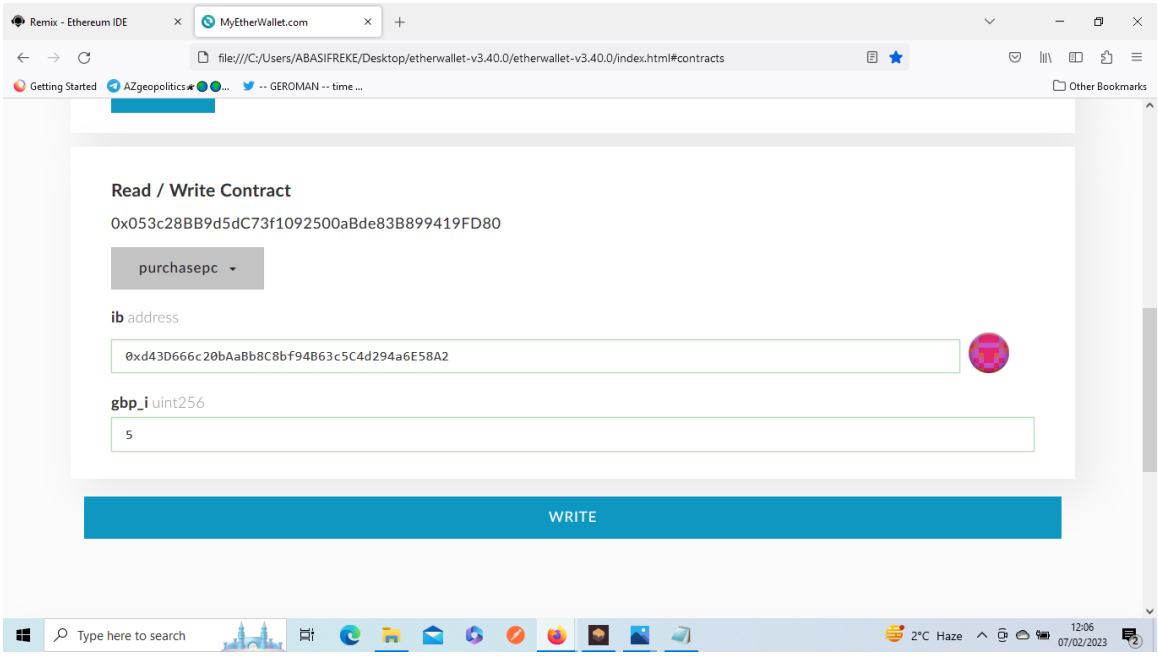


Figure 18: INTERACTION OF DEPLOYED REMIX IDE SMART CONTRACT FUNCTION (PURCHASE PC) ON MYETHERWALLET

- 'Superficial' deals with sustainability just for importance but without an operational framework. In the retail industries concerning brand plastic packaging recovery, considering the product is necessary due to operative

frameworks. Such as further successive testing, generation, signing of transactions, respective block creation, and logs presented below:

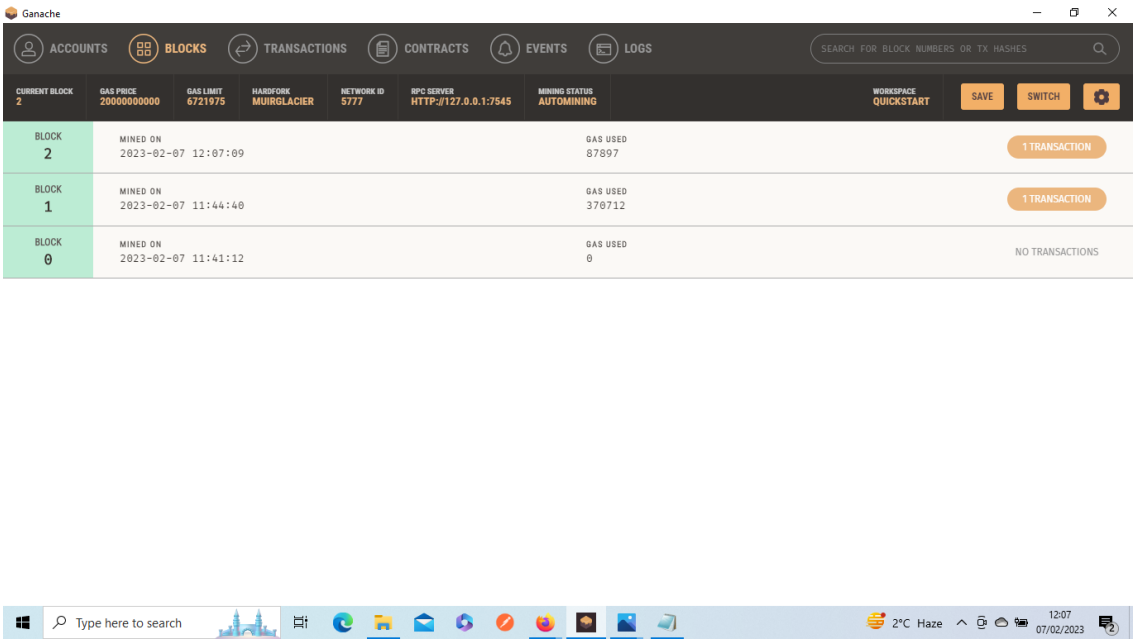


Figure 19: LIST OF BLOCKS

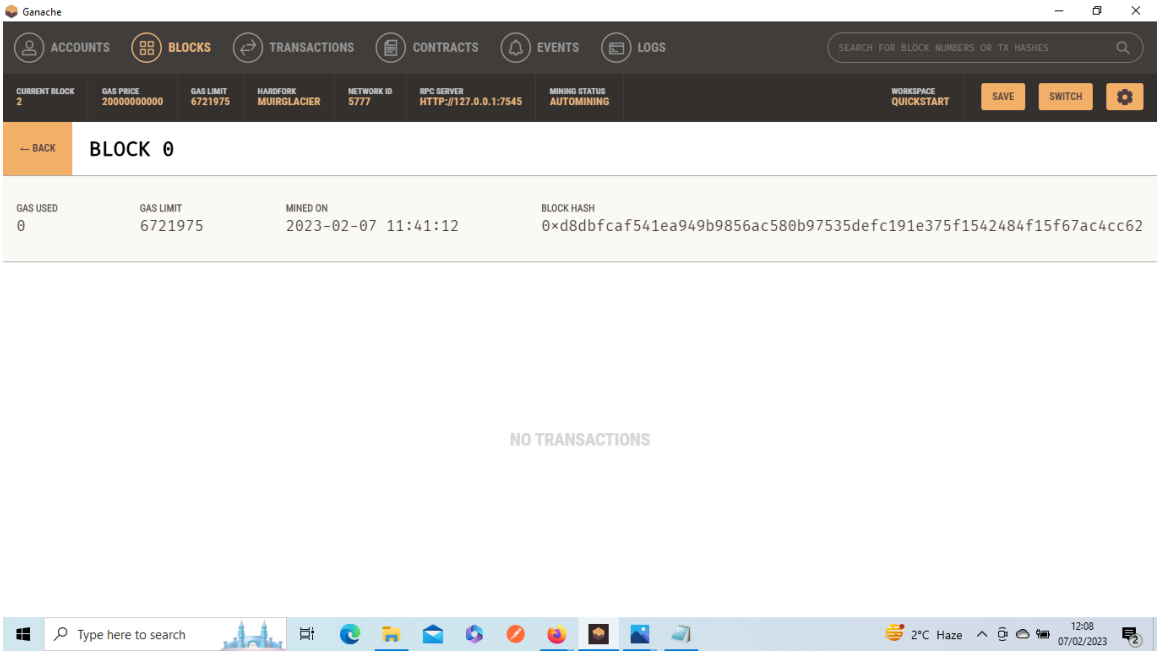


Figure 20: LOG DETAILS ON ‘BLOCK 0’

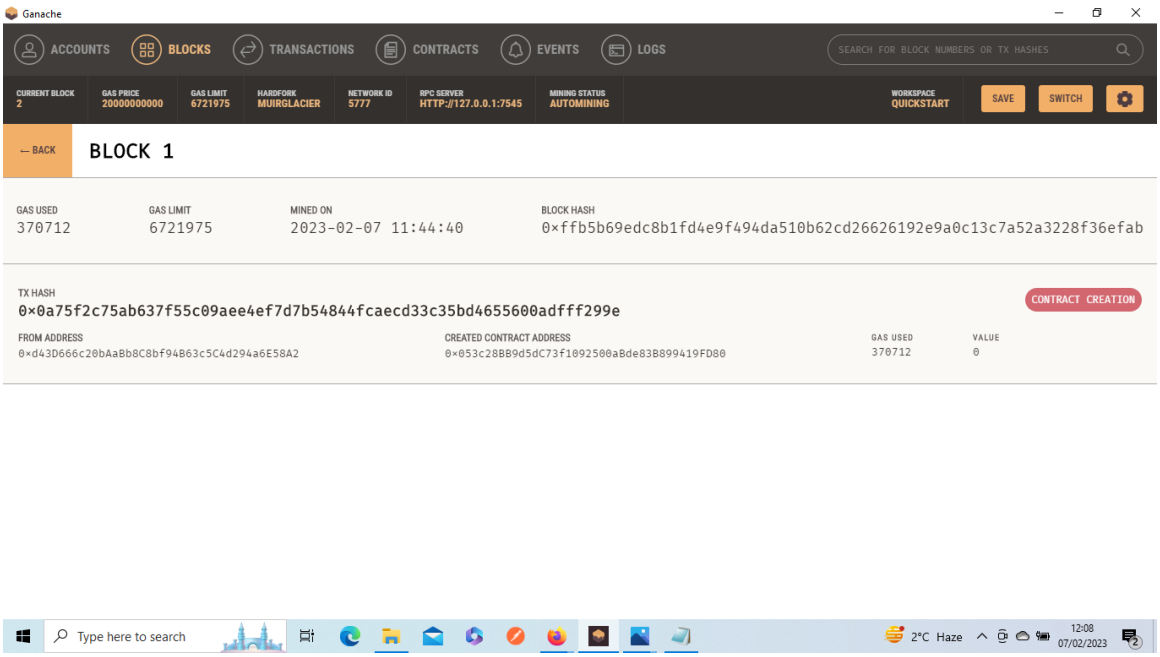


Figure 21: LOG DETAILS ON ‘BLOCK 1’

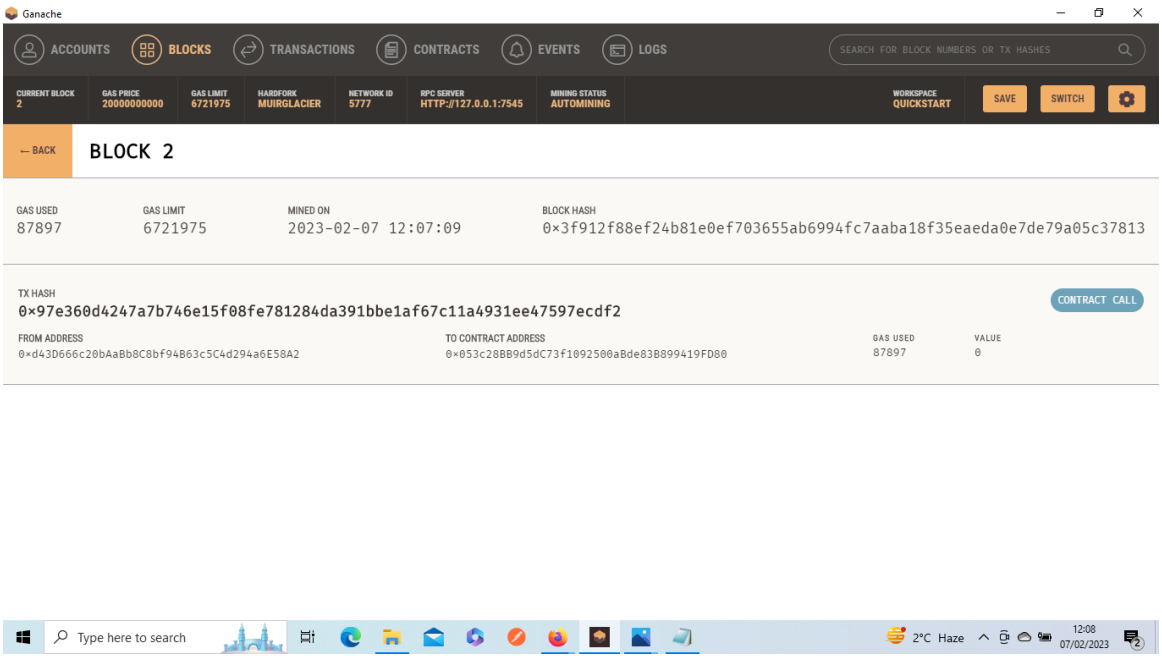


Figure 22: LOG DETAILS ON ‘BLOCK 2’

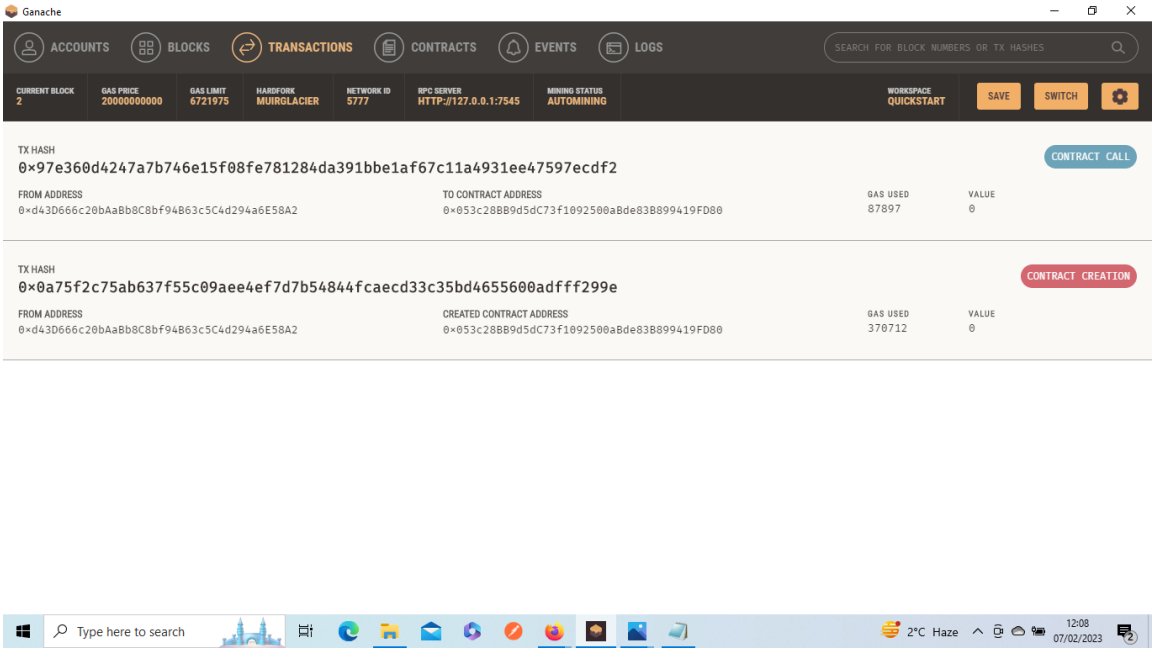


Figure 23: LOGS OF TRASANCTION

- ‘Complacent’ deals with sustainability from previous operational models, which may or may not be necessarily recent as far as ‘success(es)’ was achieved. In retail industries concerning brand plastic packaging recovery, the ‘reverse shopping’ motto is surprising; and the combination of motto and model (circular economy) courtesy of programmable instructions. Obtained in the technologies (blockchain and smart contract) developed. Plus, the recovery perspective is the sustainability focus. Screenshots of some implementation stages are below:

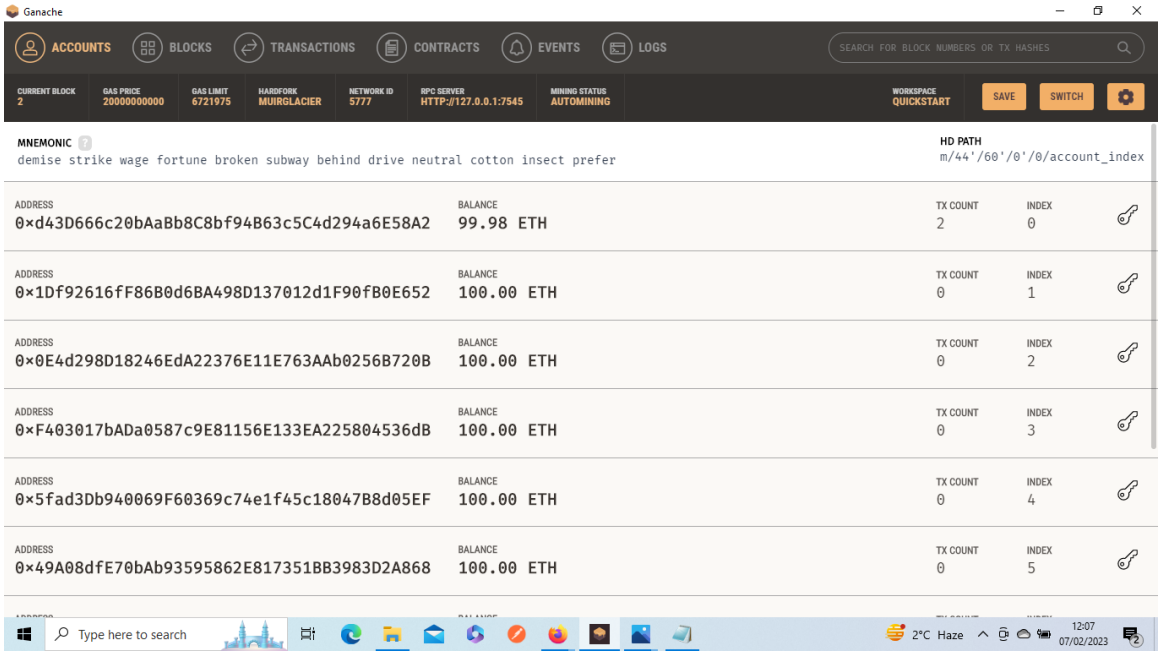


Figure 24: TEST REGISTRATION OF SIGNED, GENERATED TRANSACTION AND BLOCK ON GANACHE

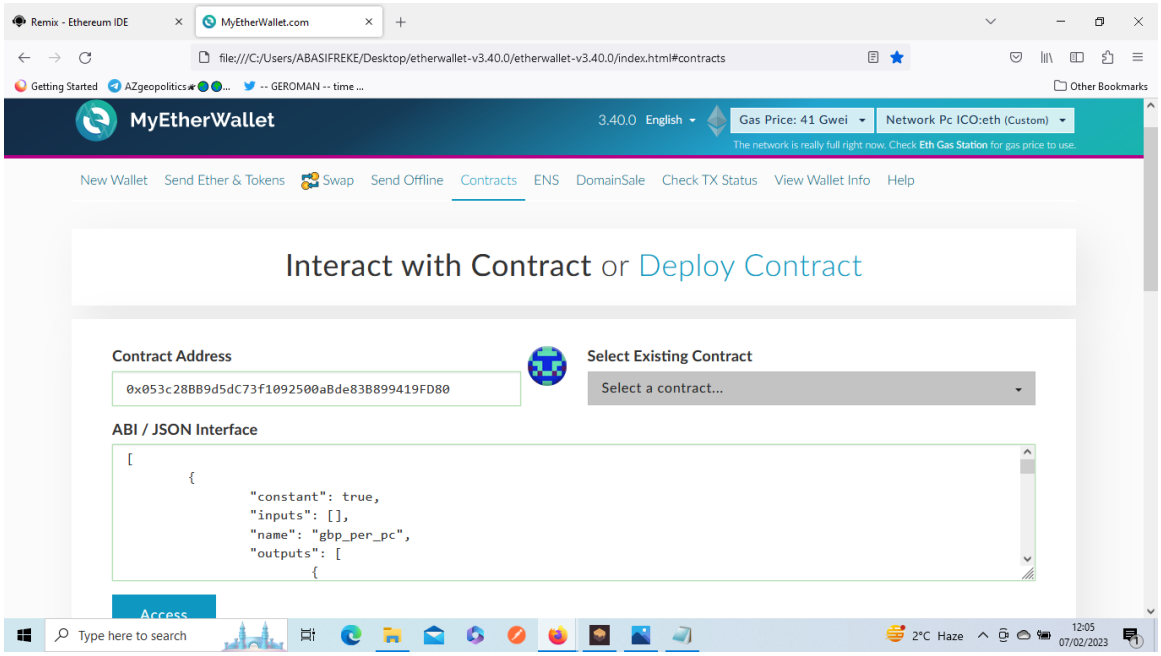


Figure 25: SET UP FOR INTERACTION OF DEPLOYED SMART CONTRACT FROM REMIX ON MYETHERWALLET

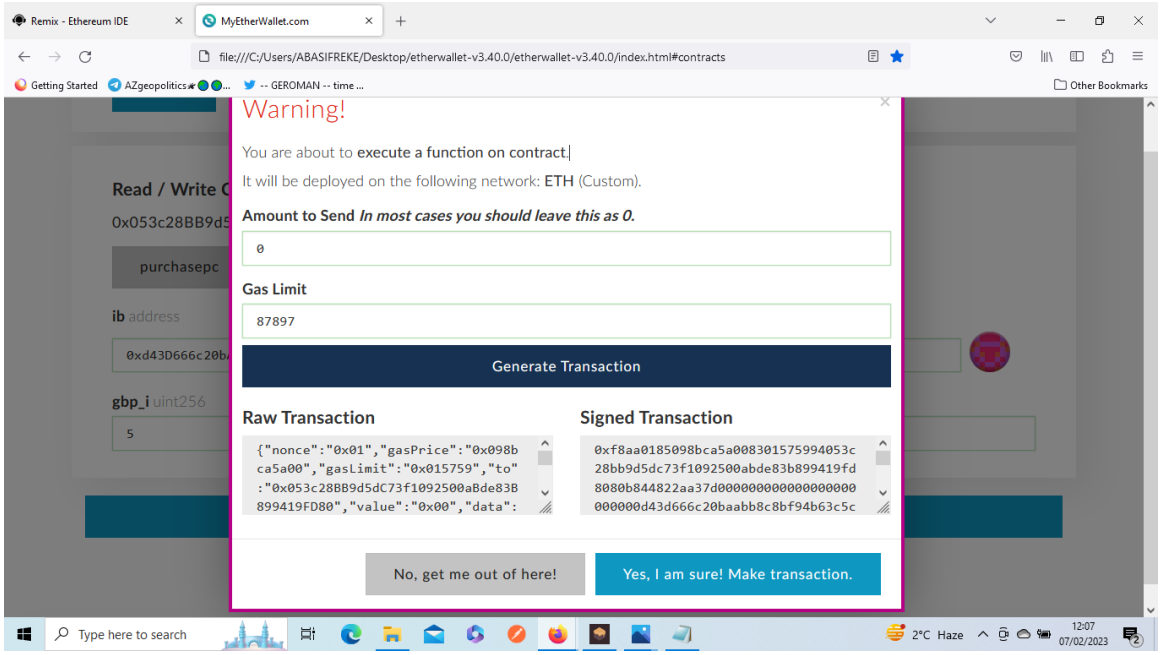


Figure 26: TEST GENERATION AND SIGNING OF DEPLOYED SMART CONTRACT ON MYETHERWALLET

- ‘True Believers’ deals with sustainability just as the research methodology (waterfall) fused with business set-up. For retail industries concerning brand plastic packaging recovery, the research thesis and upscaling of products with acknowledged limits are proposed for further business and industrial scrutiny. As the behaviour of customers can be problematic, Kessler (2021) states, “We did some research where we asked people, ‘suppose you can buy a washing machine, or you can lease a washing machine that is used but looks like new and has been completely refurbished’ to which 30 to 40 per cent of people who would never want to lease. Pride of ownership is a strong behavioural thing. No matter the price, they want to own their washing machine. It is like they are in love with their washing machine.”

However, when measuring industrial modalities of engaging each category of decision-makers, we find the following:

- When up against deniers, meeting them on their terms and with great patience is important. Approach sustainability indirectly, if necessary, through

specific, concrete concepts like risk exposure or cost reduction. Wisely judging the moment by never raising sustainability in times of crisis, instead opt to engage individuals among the board members in rational conversation and get support before taking the issue before the board proffered by Smith, C., Soonieus, R., (2019). Here, the research product offered the issue of sustainability indirectly through the recovery theme. They did not reduce costs but sought appropriate costs to tackle their retail brand plastic packaging. However, including sustainable reporting could see tax reprieve earned in offsetting some incurred costs.

- Introduce hard-headed board members to sustainable ideas that are not too far from existing practices by pushing sustainability as good management practice and focusing on the 'low-hanging fruit' beginning with areas where the business case is strong and the results are tangible proffered by Smith, C., Soonieus, R., (2019). Here, the research product offered the implemented concept of 'reverse shopping' that is not distant from their existing practice of 'shopping.' Focused on the 'low-hanging fruit' of their retail brand plastic packaging recovery. Strengthening a business case of an ethical brand standard.
- Refer superficial board members to implementable sustainability routes, including a resolute sustainability committee (encouraging a safe and transitional space) that ensures sustainability advocacy via matching discussion with concrete actions proffered by Smith, C., Soonieus, R., (2019). Here, the research product offered a digital coin offering a reward mechanism courtesy smart contract. Capturing stakeholders' revenue loyalty for their contribution and participation. Chun and Ovchinnikov (2019) advocate using more 'revenue-based' loyalty programs, which raise profit more than the

traditional ‘quantity-based’ programs, ensuring that even though revenues stay the same, operating costs are reduced while profit rises.

- Motivate complacent board members by shifting their focus unto small actions rather than a wholesale strategic review through the balancing act of acknowledging past successes when pointing to shortcomings of current practices and employing coalitions through like-mindedness proffered by (Smith, C., Soonieus, R., 2019). Here, the research product offered the implemented recovery proposal and potential reordering. Recovery in retail industries ‘reverse shopping’ their brand plastic packaging from consumers (s). Reordering in retail industries opting for reproduced brand plastic packaging from identified recovered.

Further critical appraisal of the product within the research aim is emergencies. With recent example is the ‘COVID-19’ pandemic, which guaranteed a surge in plastic commodities globally. Previously seen and cast in a negative light becoming the preferred material option in hard-hit locations worldwide. To shore up personal hygiene and maintain medical and/or front-line personnel safety when encountering and treating ‘COVID-19 patients. Plus, the shortage of plastic material commodities courtesy of panic-buying, where customers purchased goods for storage beyond their normal measured consumption forcing pressure on the respective retail brands to compromise the production of plastic material commodities without prioritising sustainability. The research product is neutral, like W Chan’s (Kim, Mauborgne, and Ji, 2021) observation of the consequential effects of the immediate past global pandemic (Covid-19) was tremendous in measurement against operations of businesses and the overall economy coefficient. Rendering an unplanned business interruption, courtesy of the impromptu termination of opportunities to some. Services used technological platforms and software increasingly exemplified by the high use of the ‘Zoom app.’ Lending credence to the technologies (blockchain and

smart contract), the research product incorporated towards retail brand plastic packaging recovery. Which may help position the research and product better in emergencies. Nevertheless, such positioning must consider questions revised by W Chan Kim, Mauborgne, and Ji (2021) below:

- Which indices in the sector are lightly rated and could be discarded?
- Which indices in the industry must be lowered to the existing standard?
- Which indices in the industry must be lifted above the existing standard?
- Which indices in the industry are missing but need to be addressed?

Judging each question: the retail industry supply line engagement in brand plastic packaging production. Without recovery line engagement in their brand, plastic packaging should be eliminated is the research response to the first question as the product initiates a reduction effort. Through which, in an emergency setting, they can fare better. Addressing the second question, the retail industry cascades its brand plastic packaging cost onto the consumer(s). Whereas the profits are huge, such is tackled by the research product. Appending a portion of such profits as cost in incorporating recovery measures. In an emergency, the template though differing but not neglecting. The third question, the opposite of the second, concerns transparency. Retail industries report with transparency regarding their brand plastic packaging. The perspective of recovery (after sales against presales) as the research product (technologies) implements. Whereby emergency can be factored in but not an opaque or muddy ‘reset.’ Finally, the fourth question mandates critical, purposeful attention to beneficial novelty. Particularly research products opting for digital coin reward mechanisms (cryptocurrency) over existing coupons or club cards. Possibly linking the retail industry's brand plastic packaging to existing sustainable ‘coins’ of relative desire, reaching impactfully in emergencies by catering to the actionable periods of occasioned sustainability ‘disregard.’

The basic blockchain application with a cryptocurrency format via Python programming language was developed with the tutored assistance of Schwarzmuller (2019). Therefore, the first phase of product development is organised in a government cabinet administration style as listed below:

- The Government
- The Section of the Blocks
- The Section of the Hashing
- The Section of the Output
- The Section of the Prove
- The Section of the Transaction
- The Section of the Nodes
- The Section of the Wallets
- The Section of the Port
- The Section of the Graphical User Interface Port
- The Section of the Graphical User Interface Network

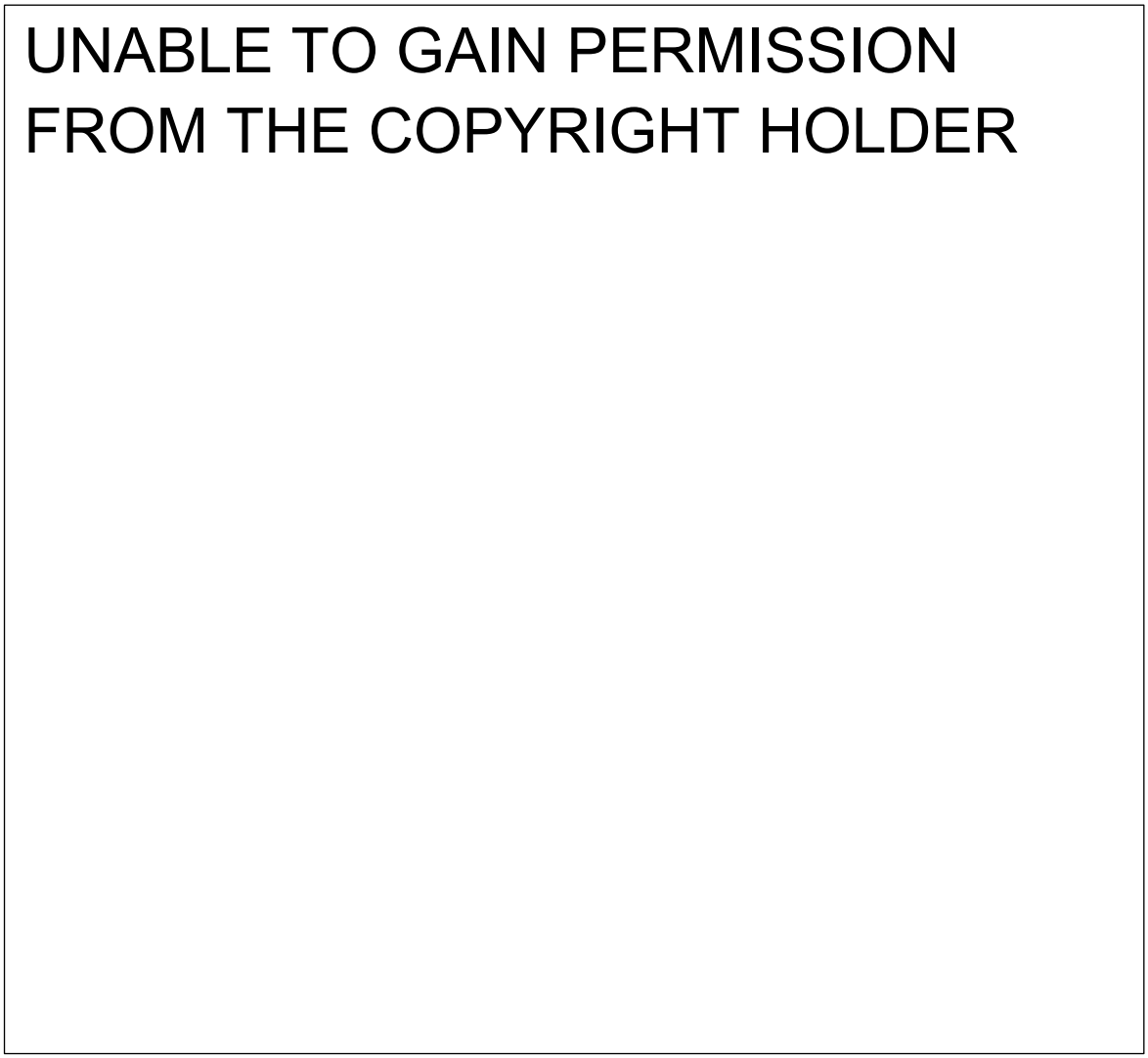
Therefore, with the matching presentation of evidence correlating the above-enumerated structure:

The Government - the main body of the program which generates the blockchain. Starting with libraries and functions from other associated ‘class’ object programming.

The block generation reward is set at 10 coins, and the Super Class (Prototype) entails: (the Genesis block of blockchain, Initialising of blockchain, and Transactions in queue) functions.

The ‘node’ functions are programmed to implement added, cancelled, and displayed user(s).

The ‘load’ function is programmed to address queued transactions in the blockchain.



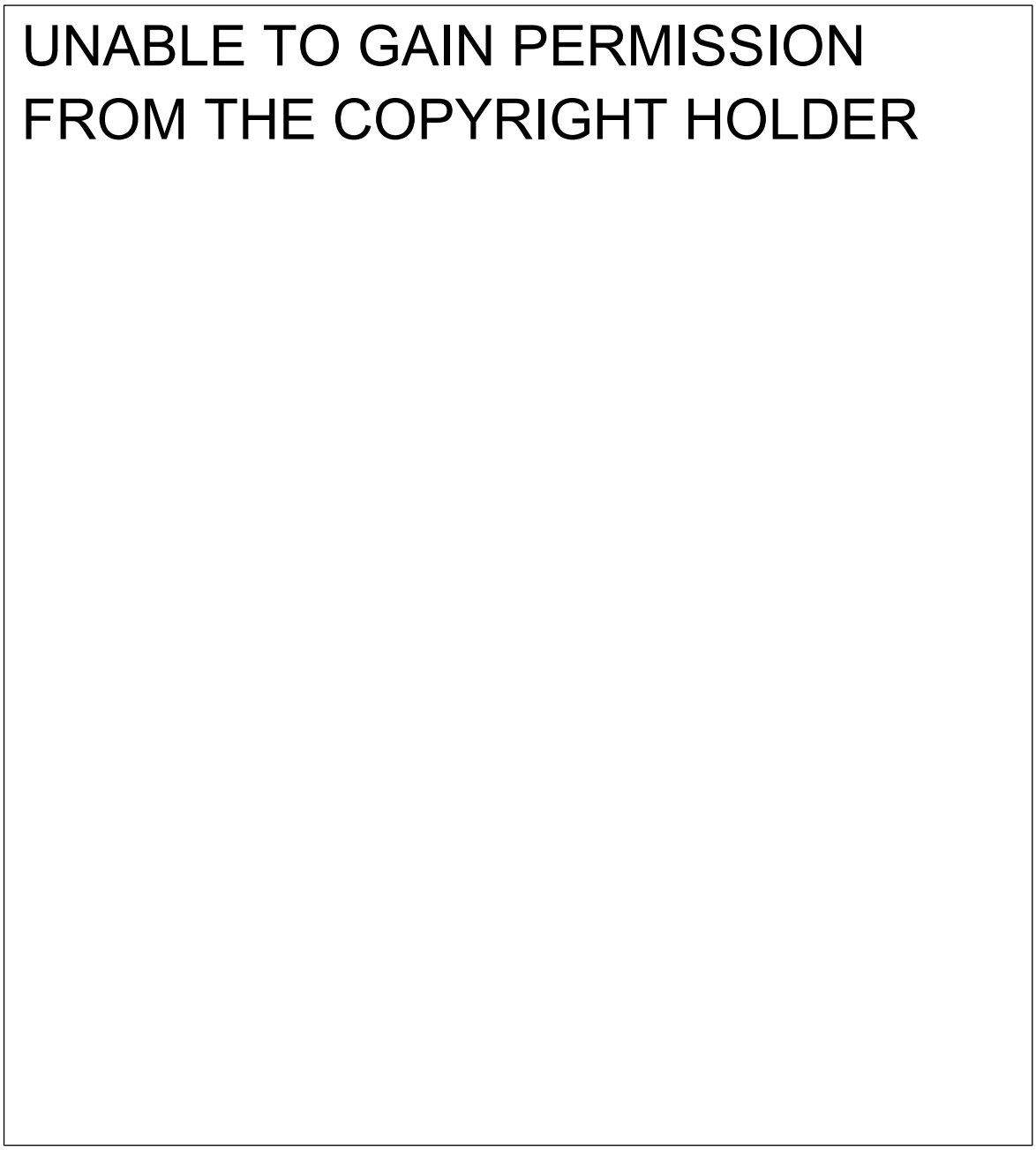
The ‘save’ function is programmed to implement storing of addressed queued transactions on the blockchain.

The function and algorithm, ‘proof of work’, which matches the generating algorithm) to the corresponding hash (SHA-256 asymmetric encryption) of the queued transaction.

The ‘get balance’ function, is programmed to implement balance information and checks to user(s). Entails (coin sent, open transactions, coins received, and total balance).

The ‘get last prototype value’ function is programmed to implement the rearrest block value in the existing blockchain. Entails two arguments (transaction amount and last transaction).

The ‘add transaction’ function is programmed to implement the addition of transactions to the blockchain queue.



The ‘mine block’ function, is programmed to implement the generation of new blocks.

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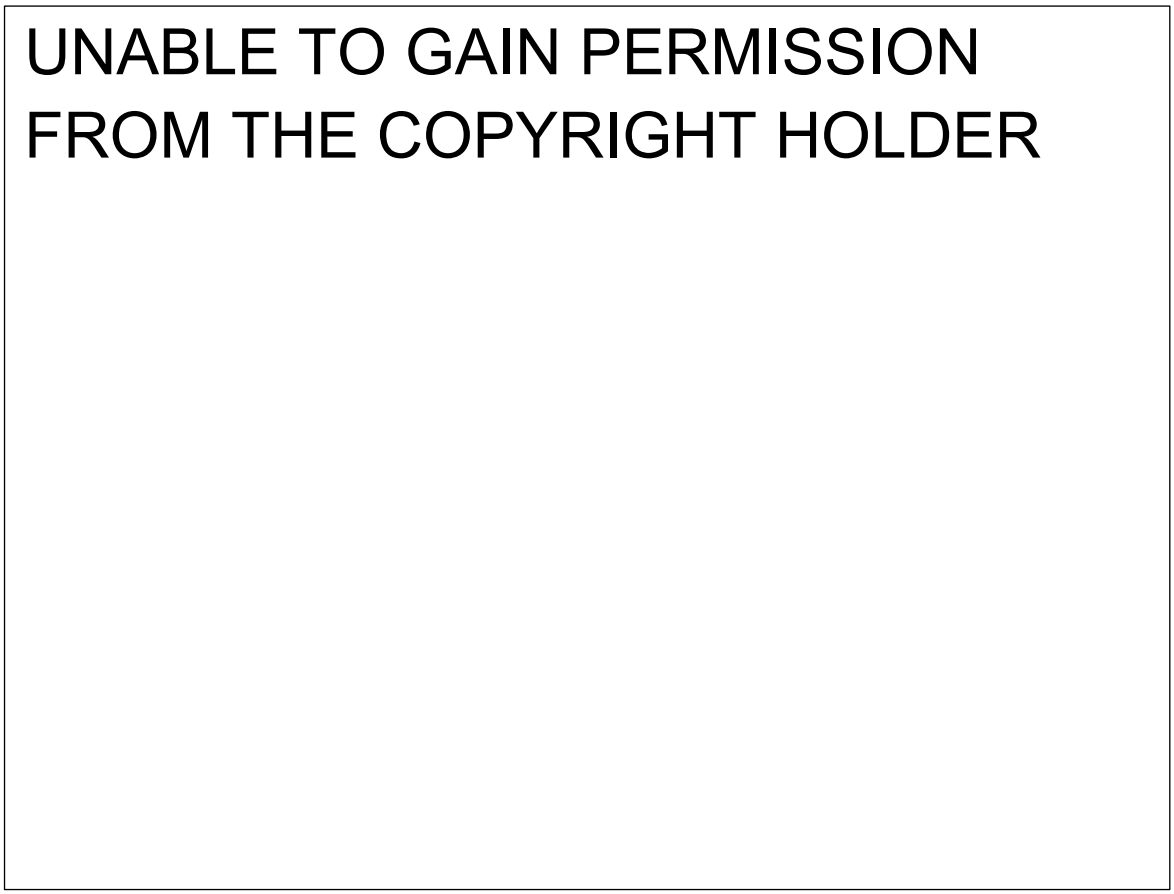
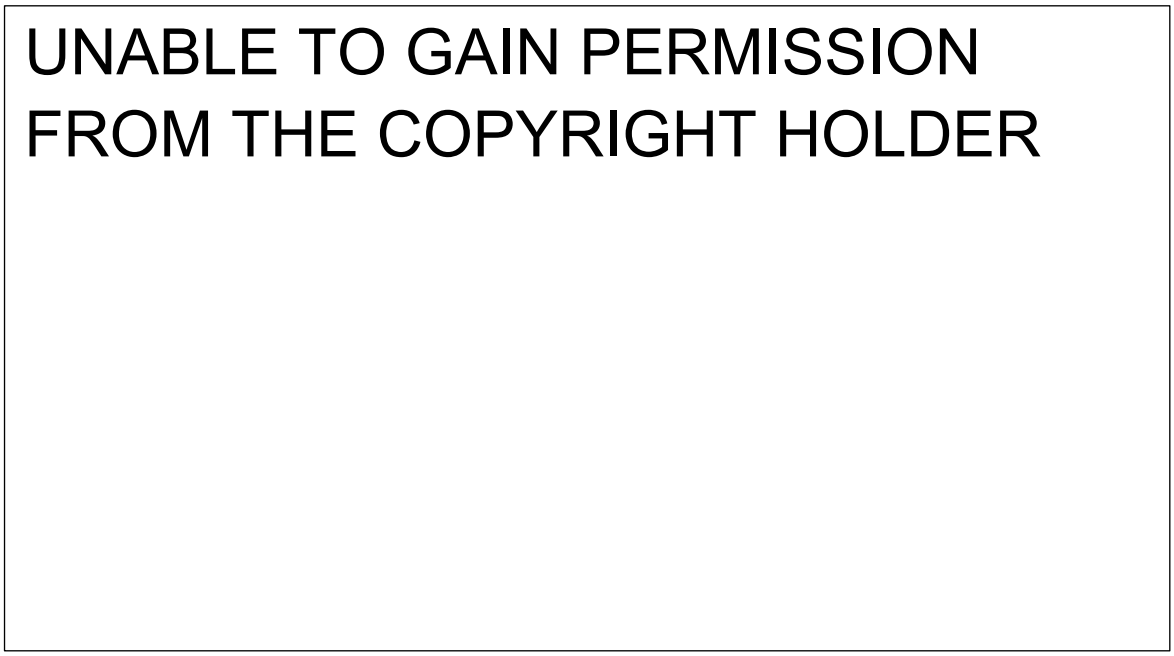
The ‘add block’ function is programmed to introduce block generation to the blockchain with accompanied contents and identifications.



The ‘resolve’ function is programmed to implement conflict resolution in chains.

Next are the remaining composite sections that function in tandem with the government:

The ‘class block’ caters to the block creation of the blockchain, with the ‘init’ function requiring arguments (index, last hash, transactions, proof, and time).



The hashing caters to the secure encryption (asymmetrically using SHA-256) of the block function of the blockchain. Characterised by the ‘hash string 256’ function for string conversion. Also, the ‘hash block’ function is used for the encryption operation of the blocks.

The ‘class Output’ caters to the printing out of output as resultants of programmed inputs.

The ‘class Prove’ caters to verifying and validating the internal programmed commands in conjunction with the programmed conditions. Characterised by:

- ‘valid proof’ function: programmed to implement the operation of the above class.
- ‘verify chain’ function: programmed to implement the operation of verifying chain in resolving conflicts.
- ‘verify transaction(s)’ function: programmed to implement the operation of assisting in verifying transactions.
- ‘verify transaction’ function: programmed to implement the operation of helping in verifying transactions.
- ‘verify transactions’ function: programmed to implement the operation of assisting in verifying the open transactions.

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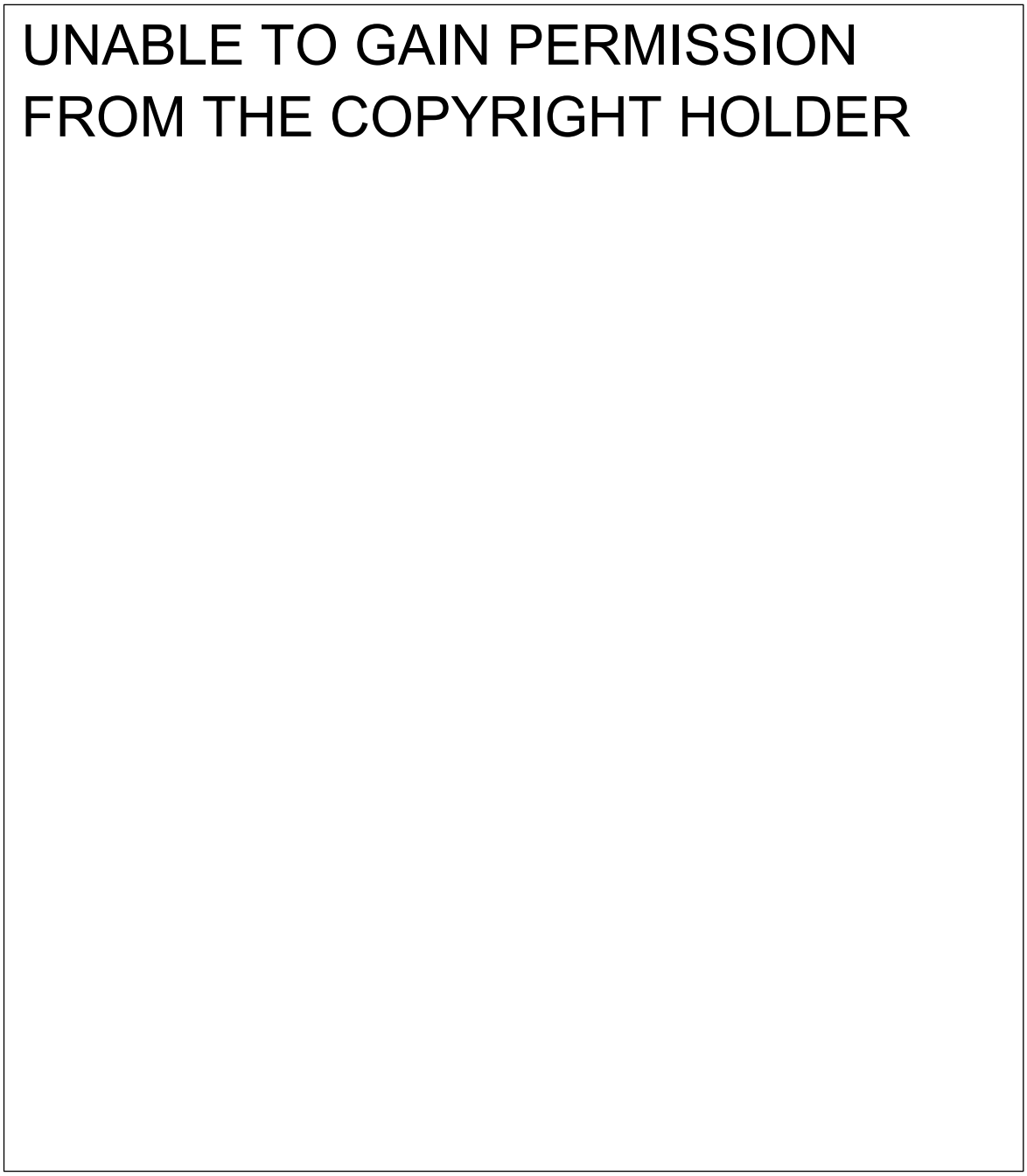
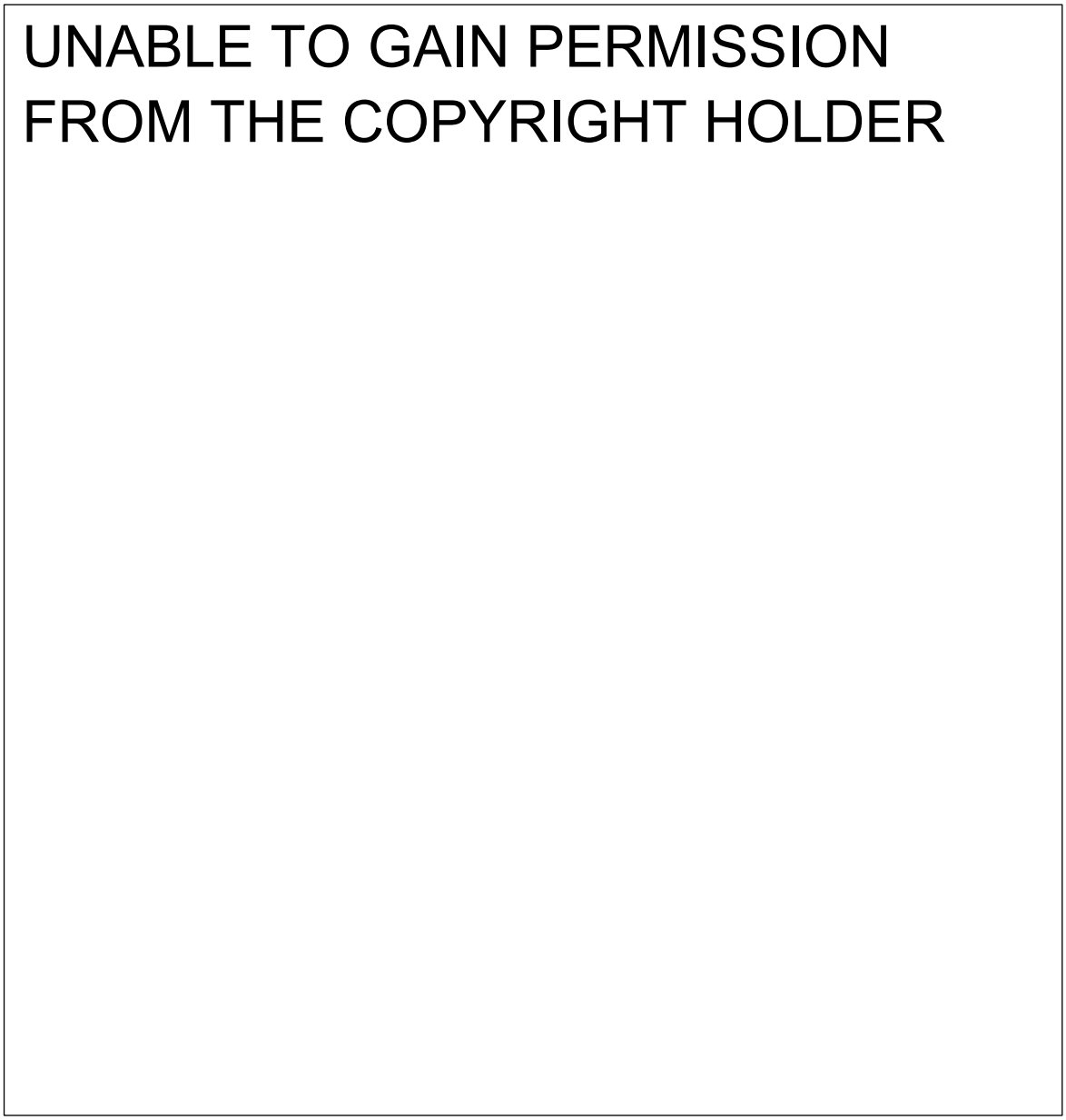


The ‘class Transaction’ caters to the internal and external complementary services of transactions between interested, secure, and authorised parties. Characterised by the ‘to ordered dict’ function, programmed to implement the conversion and preparation of transaction hashable in an orderly dictionary format.

The class ‘Node’ caters to the representation of the external user(s) subscribed in usage of the blockchain. Characterised by functions responsible for user representation, user transaction interaction, resultant blockchain, and interface).



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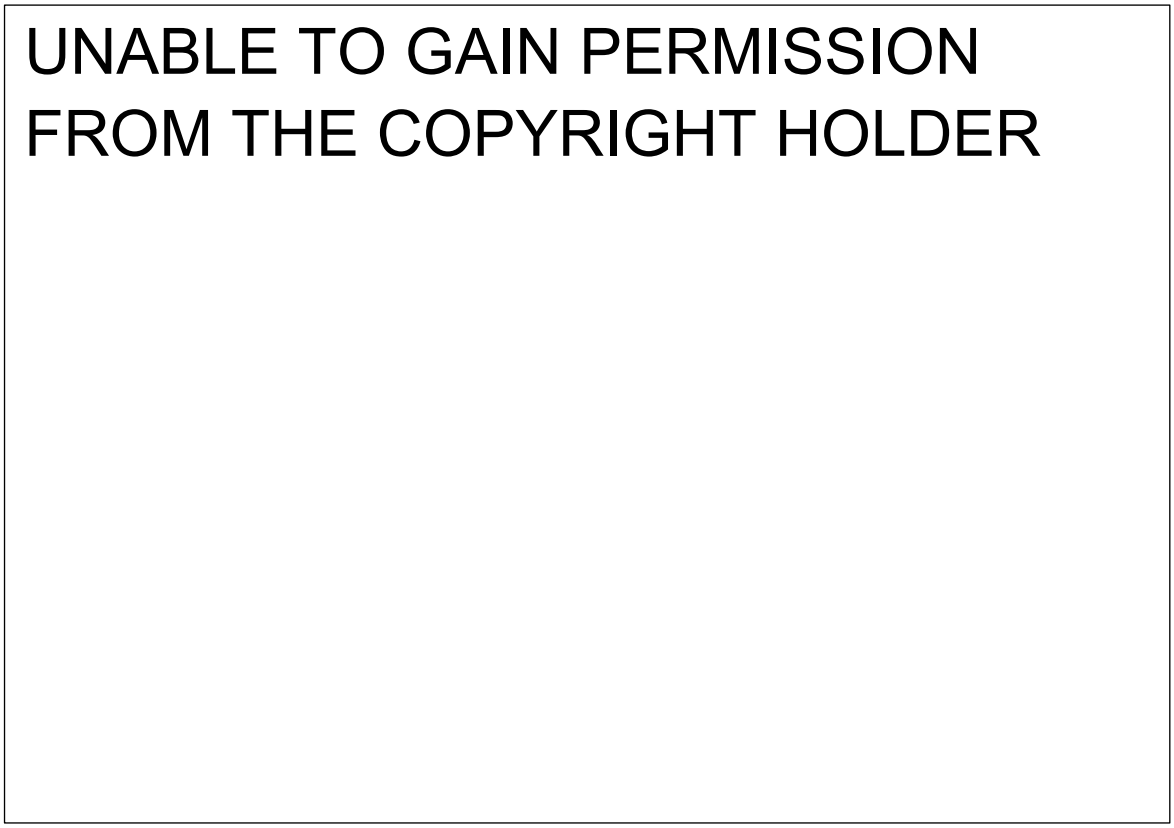
The ‘class Wallet’ represents the digital account(s) of the respective user(s) and their holdings. For checked transactions via various secure enabling imported libraries and packages. Courtesy Python and Anaconda virtual environment, respectively. Characterised by functions programmed to implement (initialisation, keys creation, saving keys, loading keys, generating keys, signing the transaction, and verifying transaction).



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The local ports enabled the successful connection and communicative interaction of the respective user (s) 's digital account (s) to the internet. Characterised by imported ‘Flask’ library and its third-party packages. Internet output (message, protocol, and broadcast), especially the status of the ‘chain’ in resolving conflicts.

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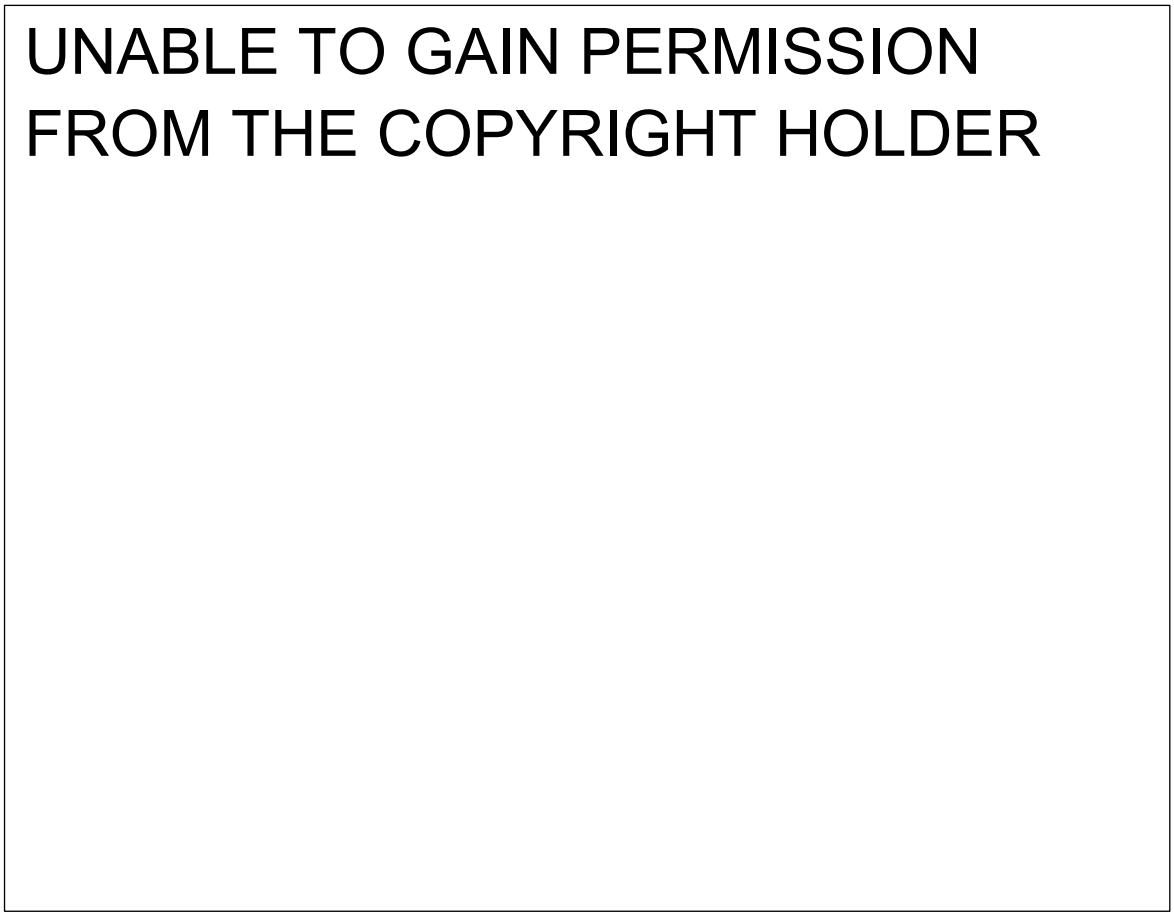


The ‘graphical user interface port’ embedded courtesy of Schwarzmuller (2019) is in the appendix. An ‘html’ code ensuring successful graphical user interface connection. Plus, the communicative interaction of the respective user (s) 's digital account (s) to the internet on a webpage.

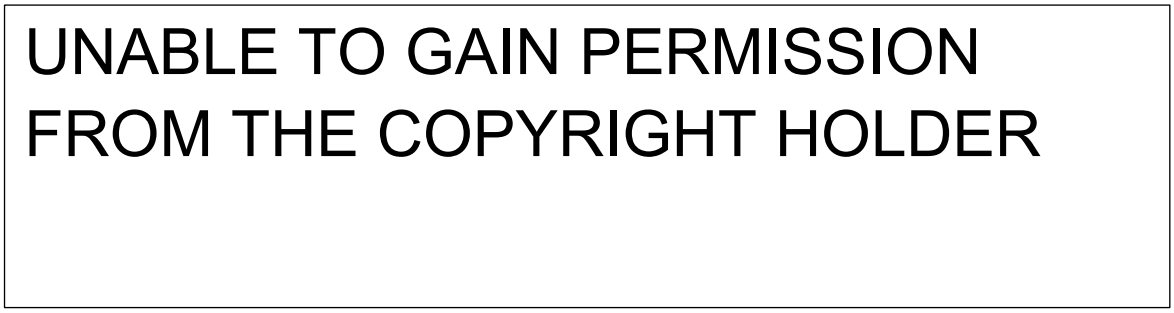
The ‘graphical user interface network’ embedded courtesy of Schwarzmuller (2019) is available in the appendix. An ‘HTML’ code ensures a successful graphical user interface connection. Plus, communicative interaction of digital account(s) of respective user(s) on the internet. On a webpage, in collaboration and or consolidation with other nodes (digital account(s) of respective user(s)). On the internet, on a webpage, enclosed in secure transactions and privacy.

Still on product development but with a shift towards the second phase (‘smart contract’ via solidity programming language). Understood by (Koscina, Lombard-Platet, and Cluchet, 2019) and (Liu, Zhang, and Medda, 2021) works in conjunction

with the assistive tutoring of (De Ponteves, H., Eremenko, K., Team, L., 2023). Adaptive programmed implementation to research aim (retail industry-tailored, circular economy model, and ‘reverse shopping’ proposal) of recovering branded plastic packaging. Below is a succinct detail and capture:

Programmed to implement recovery reward mechanism tagged ‘plastic coin’ in a cryptocurrency format. With an ‘initial coin offering’ set to “5000000” (a random value). Made available for subscription via recovered brand plastic packaging. Through the lifecycle (produced to stock, traded in business, and returned after consumption).

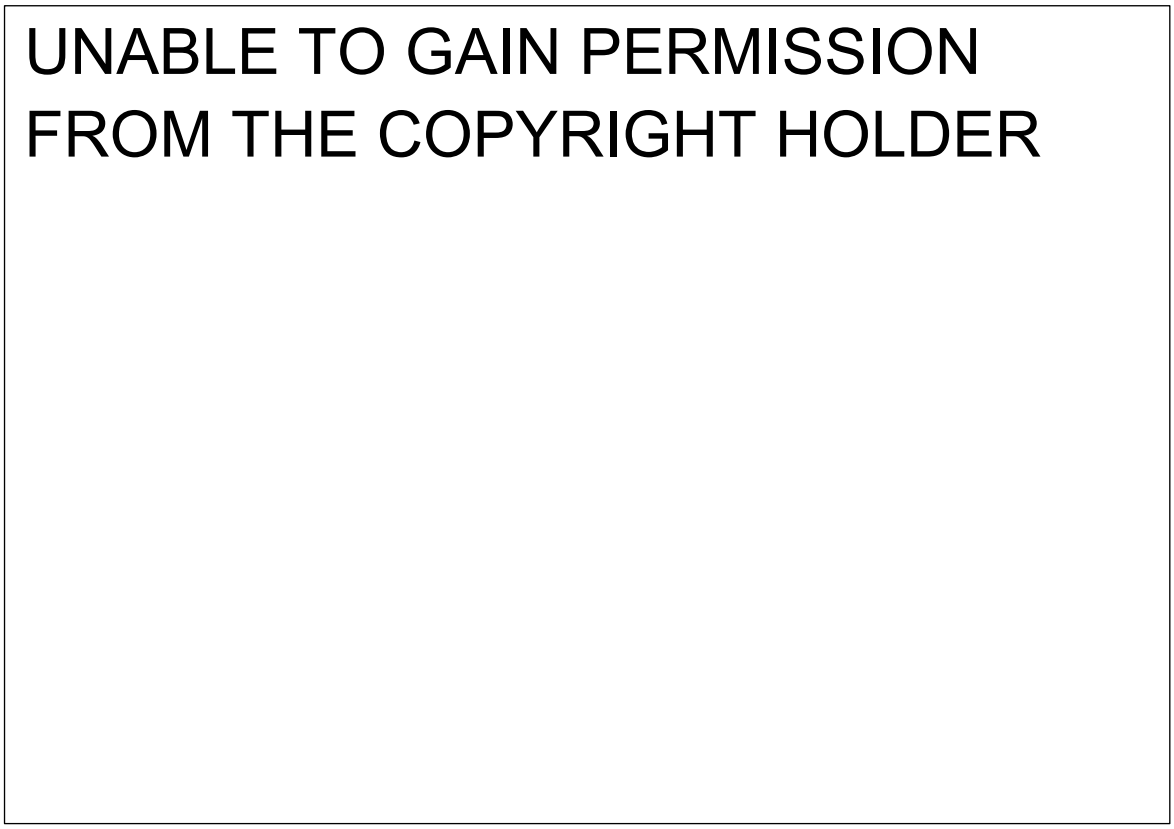
Programmed to implement the ‘plastic coin’ exchange rate as against fiat currency. Set to “50” (a random value), denoting the average unit price of all brand plastic packaging recovered alongside total ‘plastic coin’ in public possession via trading set to ‘0’ (at the start).



Programmed to implement enabling functions when deploying traded equities (holdings) of ‘plastic coin.’ Both in ‘plastic coin’ and currency equivalent (courtesy above random exchange rate) via secure cryptic addresses. In addition, the check on financial capacity (pp = purchasing power) to buy ‘plastic coin.’

Programmed to implement the enabling functions when tallying the cache amount of each ‘plastic coin’ investor (ib = interested buyer) in ‘plastic coin’ and currency equivalent. Along with calculated notes of equities (holdings) in ‘plastic coin’ and equivalent currency.

Programmed to implement the enabling function when an investor (ib = interested buyer) buys (purchases) and sells (trades) ‘plastic coin.’



CHAPTER 6 - CONCLUSION

Selecting the research's forekeys (technologies, plastics, retail industry, consumer) was the first step in tackling the problem. Such selections underwent reviewed systematic evidence presented in blockchain as one of the main technological applicative contributors, plastic though a beneficial substance but not without its issues of wastage, the retail industry being a prominent sector in the embrace of technology and use of plastics, and consumer through consumption which is a derivative of supply.

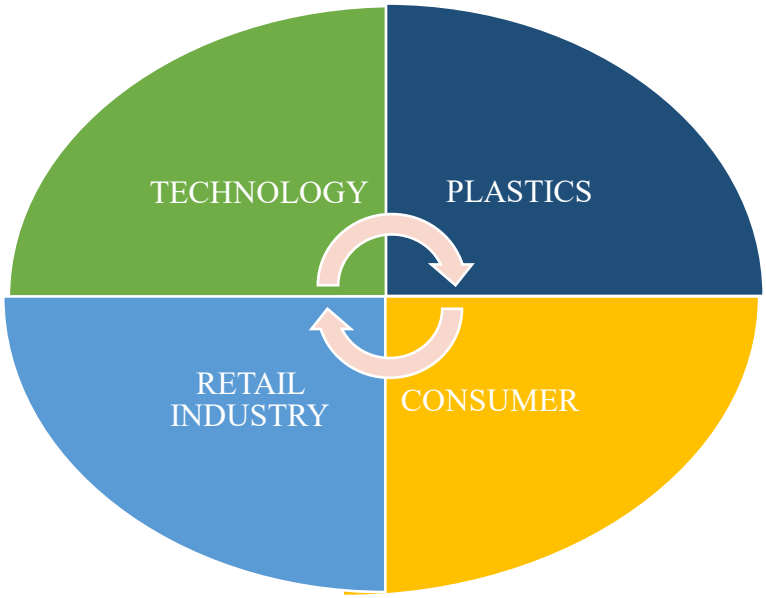


Figure 27: DIAGRAM OF FORE KEYS OF THE RESEARCH

The second course of action was the connection of the above fore keys to the research theme of improvement via conjunction with their respective secondary keys, where the fore key of technology is composed of blockchain with smart contract utilisation, the fore key of plastics is narrowed onto packaging, the fore key of retail industry incorporating the research model of circular economy, and lastly consumer through the research theme of ‘reverse shopping’. The reason is that the ‘technologies’ secondary keys of smart contracts are a tried, tested, and trusted

partnership of joint implementation with blockchain technology, bringing the digital auto-rewarding mechanism (ICO – initial coin offering) that complements the blockchain cryptocurrency format. The plastic secondary key of packaging in Figure 4 is the highest lifetime distribution of plastics and, together with its forms (active, intelligent, and smart), justified the pairing. The retail industry's secondary key of the circular economy brings the responsibility of the retail industries who source, fund and market their product unto profitability to step up and inquire about the cost of sustainability associated with improving the sectors to the fore. The consumer secondary key of 'reverse shopping' regards the consumers' combination of their impact and role encouraged in the participatory circular economy model for the research recovery theme. When all the secondary keys are pieced, the diagrammatical expression arrives below:

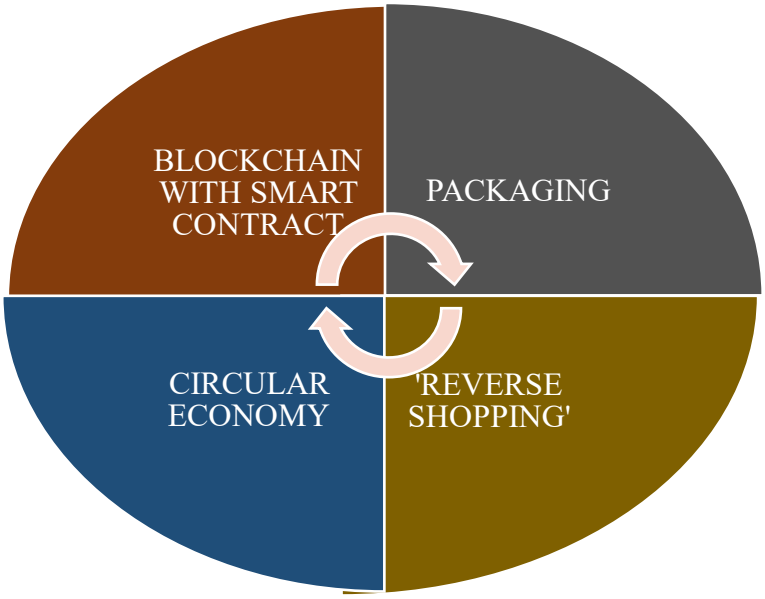


Figure 28: DIAGRAM OF SECONDARY KEYS OF THE RESEARCH

Hence the use of certain technological interventions (blockchain with smart contract) for a specific material substance and style (plastic packaging) in a particular industry (retail) to corresponding societal action (consumption) for achieving more

effectiveness (recovery) adapted from (Kitchenham, 2007) 'Five Stages Research Conduct', listed as follows: Study Identification, Study Selection, Quality Assessment, Data Extraction, Study Synthesis; yielded, 'reverse shopping' aligns with blockchain by transparent reporting, the smart contract which facilitates reward, plastic packaging on brand focus, the retail industry in product and trade flow, and sustainability using circular economy. Represented diagrammatically below:

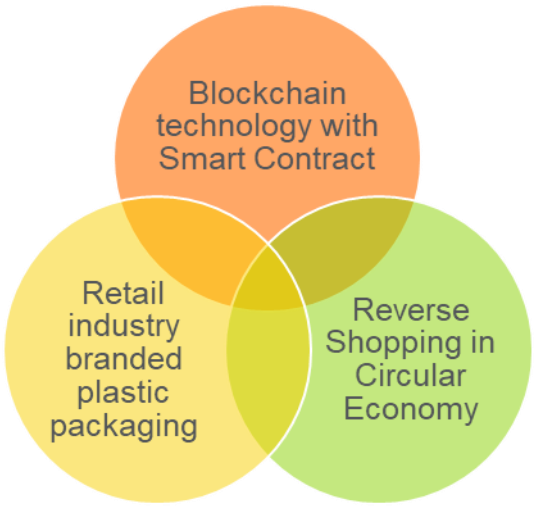


Figure 29: DIAGRAM OF RESEARCH CONCLUSION TOWARDS CLEANER AND RESPONSIBLE CONSUMPTION

6.1 ASSESSMENT

Rehearsing the objectives of the research for assessment starting with, 'To investigate the lifecycle of plastic packaging in the retail industry, especially in areas needing improvement regarding recovery':

- It is safe to say that recovery of plastic packaging was, still is, and will continue to be a necessity given that it has mostly been in a passive capture behind other frontal issues such as recycling. Through this research comprehending journey, the influential factors of driving its momentum and

exerting its pressure were discovered (quantity, quintessential, queue, quality, and quest) from which their power (quantity – massive tonnage from production to waste, quintessential – myriad forms of distributive needs, queue – the mounting rate of pace often in tandem to meet market targets in the past, present and future trends, quality – perspective, and significance attached by different groups from varying angles examples being some viewing its waste stage as a means of commercialisation while another is some others examining the number and ratio of it recycled, quest – extraction of the issue outside politics where and when possible for suitably bridging profit with sustainability) briefly surmised is correspondingly addressed and will only emphasise the situational urgency. Hence, this research has especially brought an active focus on recovery in the retail brand plastic packaging, with the notice that, where possible, applicable third-party points (collection points, recycling points, and so on) can be sidelined to achieve a tighter and less 'relinquished outsourcing' of lifecycle recovery improvement.

To, 'To explore the incorporation of 'reverse shopping' into the circular economy model regarding aiding plastic packaging recovery in the retail industry:

- Critically understood from the concept of supply chain feeding shopping, an analytical appraisal informed that for reverse supply models of and in supply chains, 'reverse shopping' can be the counterbalance. Fitting into the above recovery theme as an active focus, circular economy model incorporation ensured the afore counterbalance is connected and synchronised courtesy 'relationship responsibilities' of the captured stakeholders' (consumers, retail, and producers). Highlighting the design 'flow' (of product and money), showcasing the retail industry as the facilitator, with the consumer participation tied with a reward mechanism (digital coin), and the producer in

potential ‘reordering’ as a hopeful yield from the recovery theme via ‘reverse shopping’, with channelled the incorporation towards the retail industry brand wise, concerning their brand plastic packaging in bringing sustainability on the relative cut on their respective profitability in the zeal of recovery.

Then lastly, ‘To develop a system based on objective two, which implements objective 1 for the research aim: Blockchain with a smart contract for reverse shopping of retail industry branded plastic packaging’:

- As written earlier, when tackling the problem that the intervention of technology was used, two imperatives were utmost, being the crucial ‘modus operandi’ of such technological interventions and adaptation to the circular model. Judging from industry and institutional initiatives, which formed the template for compiling measures for investigation, a brief list included bureaucracy, stakeholders, reports, logistics, and disposal, among others. Circular economy was characterised by reform, technology, transformative, and fortress, implying and applied to wholescale progression, technocentric focus, sustainability dictating, and equilibrium maintenance, respectively. From which the technology circularity was the most suitable to the research given the implementation of two technologies which are better in contrast to the traditional approach, which is more lengthy, more intensive, and more error-prone when conducting checks by the bureaucracy, subject to sustainable reports manipulative bias, more logistical expenses, and a more strictly defined stakeholders role play. Hence, this objective was achieved firstly by conceptualising a system that encapsulates recovery and cryptocurrency. As such, relative concepts of proposals were studied where attributes of recovery and assistive technologies identified stakeholders were prominent. Moving onto the development, where the system requirements of

a blockchain and smart contract required a blueprint whereby the above two objectives' results are incorporated, resulting in the decision to pair the blockchain development to a web server for more transparent public sustainable reporting and the smart contract development to offer 'initial coin offerings' (ICO) utilised in the blockchain courtesy of the cryptocurrency format as a reward. Culminating in the testing of the developed blockchain via local simulation and the developed smart contract via 'MyEtherWallet' (an Ethereum browser-based platform for smart contract deployment and interaction mock testing) and Ganache (an Ethereum application of nodes with wallets for smart contract mock testing). A yield of corroborative evidence that the technology was characterised by shorter bureaucracy due to automation, more tamper-proof sustainable reports despite bias, and a more flexible interplay of stakeholders' roles.

Reviewing the research questions for assessment commencing with research question 1, 'How is the lifecycle of plastic packaging addressed in retail industries?':

- With the assessment of the first objective, 'To investigate the lifecycle of plastic packaging in the retail industry, especially in areas needing improvement regarding recovery', it is right to say that the essence of plastic packaging recovery still needs much adherence through the 'much' needs realignment, as first, a geographical ratio with much emphasis on certain locality with the vast amount of accumulated plastic packaging waste. Then scaling adjustment of the committed workforce to fit accordingly to the ratioed geography before honing onto specific slacking stages (models, brands, relationships, responsibility, and stakeholders). With further observance of the lack within those stages in need of boosting like much more priority given to retail brand plastic packaging use of 'loyalties' (like coupons), infrastructure

(plus digital). Also, retail business or industry plan permits allocated higher attention to adept personnel of the workforce, gauged against the policies, reports, and penalties to ascertain what settings need to be reconfigured in the working model to uplift the dragging aspect and or introduction of new elements to further progression like ‘reproduce’. This means that retail brand plastic packaging variants of the same products can be restrained to fewer brand iterations, and by extension, the retail sector and organisations based on contribution levels and profit turnovers take responsibility in a parallel match of sustainability activities like instances of decoupling where, when, and how necessary.

To research question 2, ‘How should retail industries’ operations be designed in a circular economy that encourages ‘reverse shopping?’:

- From the assessment of the second objective, ‘To explore the incorporation of ‘reverse shopping’ into the circular economy model, regarding aiding plastic packaging recovery in the retail industry’, it is safe to say that the approaches (‘reverse shopping’ and technology circularity) of retail brand plastic packaging have both served very well in the research recovery focus. As servicing the research bid of plastic packaging recovery against the former linear economy (cradle to grave) to a circular economy (cradle to cradle), anticipated hiccups factored in the above objective and research question as Ritzén and Sandström (2017) state, “Attitudinal, financial, structural, technological are equated as operational challenges of circular economy”. By bringing in combination, first, the novelty in counterbalancing shopping and equally matching reverse supply chains facilitated in and through the retail industry majorly. Secondly, the methodology (requirements, design, implementation, and integration with testing), along with the leverage of

catalysts (application of technologies for a technocentric circularity), raised options to other captured stakeholders (consumers and producers) for increased participation. While disagreeing and negating some encountered obstacles, for example, social and economic targets, though tenuous, can be ignored. (Crane *et al.,* 2014).

Then, lastly, research question 3, ‘To what extent does the system of objective 3 satisfy the research title?’:

- In tandem with the assessment of the third objective, ‘To develop a system based on objective two which implements objective 1 for the research aim: Blockchain with smart contract for reverse shopping of retail industry branded plastic packaging’, further entails the question, ‘Why the choices: of blockchain technology, utilisation of smart contract, and focus on the retail industry sector?’; it is fair to say regarding the research methodology outlined earlier; achieving four out of the six stages following the ‘waterfall’ method helped raise the implemented system extent of satisfying the research. The first two paired objectives and their respective research questions were highly addressed, yielding an avenue of transparent, sustainable reporting, a novel approach in waste management (plastic packaging) with recovery as the priority, and streamlining to and within an industry (retail, brand). Also, in concert with the reward mechanism (digital coin) as an appeal consideration, and rooms for improvement including expansion (like potential ‘reordering’), exigency (referee stakeholder like government), extermination (reducing technology applications like the number of blockchains), and enumeration (adding technology application like the number of smart contracts). However, the remaining two stages (deployment and maintenance) are not achieved, though equally important, dull the edges of the extent to which the

implemented system satisfies the research drive as an industrial test would certainly provide a more in-depth stress test. Nevertheless, the research system, in a small effort, aids and assists in contributing to the broader notion of recovering plastic packaging separately yields more results (Plastic-The-Fact, 2022) highlighted that in 2020, out of 17.9 million tonnes of after-use plastic waste collected in joint material mode, 7.9 million tonnes was the amount of plastic waste resulting in 1% recycling, 62% energy recovery, and 37% landfill. In contrast, collection in sole material (plastic packaging) mode, 10 million tonnes of plastic waste resulted in 80% recycling, 18% energy recovery, and 2% landfill.

6.2 SHORTCOMINGS AND RECOMMENDATIONS

Recalling the research design (stage 2) of the methodology in Chapter 3, where the implementable steps (stage 3) of the method (also in Chapter 3) delivered a working prototype of the research theme model, sections were omitted and areas assumed. Hence, amalgamating the shortcomings and recommendations of this research starts with the focus redirection toward the omission and assumption (enclosed within the black rectangle) expressed diagrammatically below:

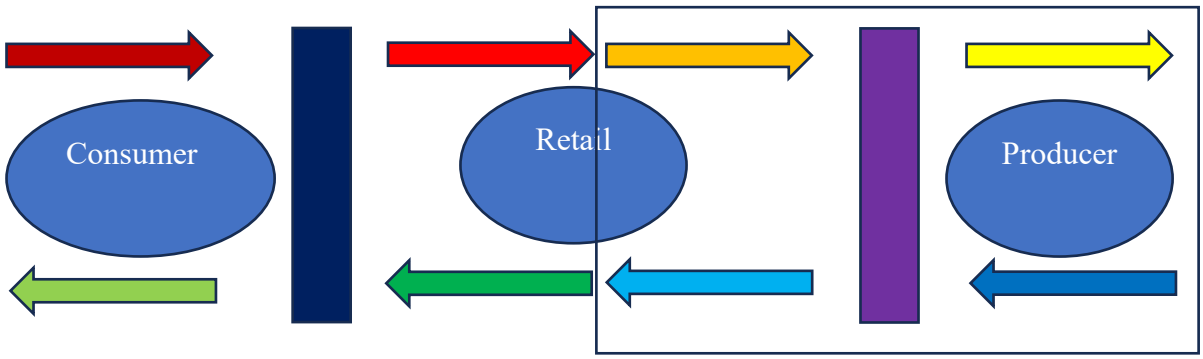


Figure 30: DEMARCATION OF OMITTED SECTION OF RESEARCH THEME MODEL SYSTEM DESIGN

Which in turn will also further bring the research implementation partition to this representation diagrammatically below:

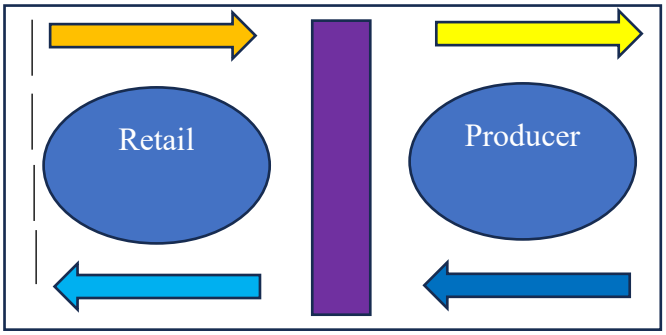


Figure 31: OMITTED RECOMMENDED IMPLEMENTABLE PARTITION OF RESEARCH THEME MODEL SYSTEM

The Purple Rectangle implies a consortium blockchain storing retail brand plastic packaging updates (orders, recovered, reordered). Participants are retail industries and producers (partnering in brand plastic packaging). Like Liu, Zhang, and Medda's (2021) system models where an 'M-InfoChain' is a consortium blockchain for storing manufacturers' document contracts and production information. Noteworthy is that with the above model's emphasis on recovery, the stakeholders (retail and producer) will have no choice but to be stricter on their plastic packaging partnership. Brand indulgence for retail and production for producers to help slow the churning out of plastic products far more that can be judiciously accounted for. Forming a hopeful potential of 'reverse reordering' while matching the consumers' increased participation courtesy through this research 'reverse shopping' novelty. In tandem, as acknowledged in the limitations section of Chapter 4, concerning the modularity (assigned and specific) of the implemented smart contract, so also, in extension, can the digital coin reward mechanism (Plasticcoin) be further integrated beyond the research implemented context? Including relative aspects like 'Big Data', as Gopalakrishnan and Radhakrishnan (2019) account of the Swachhcoin initiative in making a gainful contribution as it has employed a host of technologies ('Big Data', Adaptive Intelligence, 'Internet of Things', 'Smart Bins', Blockchain, 'Smart

Contract', and Tokens) by the platform. Gopalakrishnan and Radhakrishnan (2019) state:

For 'Big Data', Swachhcoin inclusion is SwATA (Swachh Big data): Catering to the transparent management of data in the various means of waste collection and transportation but without neglecting the near or equal vast amount of data generated through a customised application receiving (NoSQL and virtual data filter at reception used in data structuring for processing), storing, and analysing for intelligent feedback in optimisation of routes, maintenance cycles, report generation.

- We recommend this for inclusion as 'Big Data' in the retail industry is not an anomaly. Plus, the use of 'proof of stake' through existing coupons or 'loyalties' (like gift cards) instead of 'proof of work' will certainly raise the amount of transacted data.

- For 'Adaptive Intelligence,' Swachhcoin inclusion is SwATEL (Swachh Adaptive Intelligence): Serving as the co-ordinating anchor of the whole initiative communicating via a tailored application to other components the actionable intelligence from a backlog of past situational instances (deep learning with neural network) physically or digitally.

- For 'Internet of Things,' Swachhcoin inclusion is SwIOT (Swachh Internet of Things): Leveraging the interconnectivity to and of the internet in herding stakeholders, logistics, equipment, and sites in achieving the initiative's waste management targets. We exempted online or e-commerce by the retail industries concerning their brand plastic packaging, further research could explore and investigate this area in conjunction with 'Internet of Things.'

- For 'Smart Bins,' Swachhcoin inclusion is SwBIN (Swachh Bins), Featuring a 'unique identifier' (UID) to waste generating agents for 'QR' matching when

depositing waste before measuring quantity and quality towards a calculated reward point. We recommend for extension in addition to this research where instead of ‘smart bins,’ they could be ‘reverse smart vaults,’ overseeing the processes of ‘reverse shopping’ and ‘reverse reordering.’

- For Blockchain and Smart Contract, Swachhcoin: Uses the Ethereum Blockchain in conjunction with the accompanying smart contract implementable options becoming a ‘decentralised autonomous organisation’ (DAO). We already have a combined implementation in this research. Industrial deployment and maintenance are a recommended upgrade.

- For Tokens, Swachhcoin inclusion is SCX (Swachh Tokens): Rewarding practices of proper waste management like sorting to user(s) with further privileges in consultation roles and voting concerning the platform. We have already implemented this in the research. Industrial deployment and maintenance are a recommended upgrade.

In addition, this research does not answer challenges in consumer behaviour and consumption patterns, nor does it mediate in the ongoing tussle of inclusivity against conflict where inclusivity, like Jones and Comfort (2018) state, “… the desire to separate growth from the consumption of natural resources is growing and that green and inclusive growth is possible” while conflict stands like Daly, (2017) states, “There is an obvious physical conflict between the growth of the economy and the preservation of the physical environment” is the opposing view. Having attempted this research to address the impact of ‘blockchain with a smart contract for reverse shopping of retail industry branded plastic packaging;’ with emphasis on recovery in a leaner or narrower circular economy fashion, including other adjoining issues like politics, future research pathways should include:

- Address shortcomings with recommendations and achieve industrial deployment.
- Potential gulping sectors could be co-opted as (Plastic-The-Fact, 2022) highlighted that in 2020, out of 29.5 million tonnes of after-use plastic waste collected in joint material mode, 15 million tonnes was the amount of plastic waste resulting in 5% recycling, 57% energy recovery, and 38% landfill. While collection in sole material mode, 14.5 million tonnes was the amount of plastic waste, resulting in 65% recycling, 27% energy recovery, and 8% landfill.
- Other environmentally problematic materials could be co-opted.

Choices and or combinations of other technologies could be co-opted.

Where Purple Rectangle implies a consortium blockchain, storing retail brand plastic packaging updates (orders, recovered, reordered). Participants are retail industries and producers (partnering in brand plastic packaging). Like Liu, Zhang, and Medda, (2021) system model's where a 'M-InfoChain' is a consortium blockchain for storing manufacturers' document contracts and production information. Noteworthy is the fact that with the above model emphasis on recovery, the stakeholders (retail and producer) will have no choice but to be stricter on their plastic packaging partnership. Brand indulgence for retail and production for producers to help slow down the churning out of plastic products far more that can be judiciously accounted for. Forming a hopeful potential of 'reverse reordering' while matching the consumers' increased participation courtesy through this research 'reverse shopping' novelty. In tandem, as acknowledged in the limitations section of Chapter 4, concerning the modularity (assigned and specific) of the implemented smart contract, so also in extension can the digital coin reward mechanism (Plasticcoin)

be further integrated beyond the research implemented context? Including relative aspects like ‘Big Data’, as Gopalakrishnan and Radhakrishnan, (2019) account of the Swachhcoin initiative in making a gainful contribution as it has employed a host of technologies (‘Big Data’, Adaptive Intelligence, ‘Internet of Things’, ‘Smart Bins’, Blockchain, ‘Smart Contract’, and Tokens) by the platform. Gopalakrishnan and Radhakrishnan, (2019) state:

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- Other environmentally problematic materials could be co-opted.
- Choices and or combinations of other technologies could be co-opted.

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APPENDIX

ETHICAL APPROVAL (ALSO SUBMITTED AS FILE IN ZIP FOLDER)

DATE 04/10/2023.

Dear Abasifreke Ifreke Otu

RE: "A Study Utilizing Smart Contract via Blockchain Application Investigating Modelling Plastic Packaging in Customized Business on Consumer Relationship Experience."

Thank you for submitting your ethics application form to the Mathematics & Computer Science Subject Ethics Panel for review.

I am pleased to inform you that your project, A Study Utilizing Smart Contract via Blockchain Application Investigating Modelling Plastic Packaging in Customized Business on Consumer Relationship Experience' was discussed by the Panel on 04/10/2023 and approval was granted: REC number **MCSEC/202223/AO/006.**

The Committee wishes you every success in your research project.

Kind regards,

Dr Andrew Gascoyne

Chair of Mathematics & Computer Science

Subject Ethics Panel

School of Engineering, Computing &

Mathematical Sciences Faculty of Science

and Engineering

University of Wolverhampton

Dean: Professor David Proverbs BSc (Hons); PG Cert-Ed; PhD; MBA; PFHEA; FCIOB; FRICS University of Wolverhampton, Faculty of Science and Engineering, Alan Turing Building,

City Campus Wulfruna, Wulfruna Street, Wolverhampton WV1 1LY, United Kingdom

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REVIEWED THESIS CHANGES AND SECOND REVIEWED CHANGES HIGLIGHTED IN YELLOW

TITLE CHANGE (PAGE 1)

The thesis title has been modified to enhance the clarity and reflect the research approach more accurately. (PAGE 1).

ABSTRACT CHANGE (PAGE 4)

The thesis abstract has been revised to encompass generic information, a clear problem statement, well-defined aims, the research methodology, contributions, findings, and potential social impact. (PAGE 4).

CHAPTER 1 CHANGES (PAGES 12 - 16)

BACKGROUND (PAGES 12 - 14):

The thesis background has been moved to the beginning with additional content added to serve as a precursor to the entire work. (PAGES 12 - 14).

PROBLEM STATEMENT (PAGES 14 - 15):

The thesis problem statement has been made clearer via succinct but deep presentation of the problem tackled alongside backed up literature review. (PAGES 14 - 15).

OBJECTIVES (PAGES 16 - 17):

The thesis objectives have been rewritten to be specific with support from governmental policies to enhance its credibility. (PAGES 16 - 17).

RESEARCH QUESTIONS (PAGES 17 - 21):

The thesis research questions have been rewritten, mapped with objectives, and relative literature review to buttress the chosen issues. (PAGES 17 - 21).

THESIS METHODOLOGY (PAGES 21 - 22):

The thesis methodology is included, providing the thesis block diagram. (PAGES 21 - 22).

SIGNIFICANCE AND IMPACT (PAGES 22 - 24):

The thesis significance and impact are included to show the appraisal of the research to institutional policies and stance. (PAGES 22 - 24).

THESIS OUTLINE (PAGES 24 - 26):

The thesis outline is the tabular representation of the overall structure of the submitted reviewed thesis. Showing all chapters, references, and appendix with their respective items, theme, and layers. A further brief description is also written. (PAGES 24 – 26).

CHAPTER 2 CHANGES (PAGES 27 - 54)

LITERATURE REVIEW (PAGES 27 - 28):

The thesis literature review is rewritten to lay a groundwork of critically analysed related literature to the research area systematically. Also, unnecessary contents have been removed alongside most external data and figures. (PAGES 27 - 28).

PLASTICS (PAGES 28 - 30):

The thesis has modified the material of choice (plastics), incorporating the critical reasons for its choice and review. (PAGES 28 - 30).

PACKAGING (PAGES 30 - 37):

The thesis has reviewed adequately the concept of packaging through the lens of relative literature considering the research showing research gaps concerning plastic packing recovery. (PAGES 30 - 37).

CIRCULAR ECONOMY (PAGES 38 - 41):

The thesis has added the review of circular economy showing its critical enablement of the research ‘reverse shopping’ aim in enabling recovery of brand plastic packaging. (PAGES 38 - 41).

BLOCKCHAIN (PAGES 42 - 49):

The thesis has rewritten the critical literature review of blockchain technology detailing its features, proposals, application, and implementation in waste management. Serving as justification for the research technology selection. (PAGES 42 - 49).

SMART CONTRACT (PAGES 49 - 54):

The thesis has rewritten the critical literature review of smart contract relaying its recent average occurrence in waste management including reward mechanism. Serving as justification for the research selection. (PAGES 49 - 54).

CHAPTER 3 CHANGES (PAGES 55 - 77):

RESEARCH METHOD (PAGE 55):

The thesis research method highlights with clarity how the research methodology (WATERFALL) is adapted and the subsequent contribution of the research (PAGE 55).

REQUIREMENTS (PAGES 56 - 67):

The thesis research methodology first stage (requirements) informs of the relative stakeholders captured in the research alongside produced tables and figures for further elaborative context. (PAGES 56 - 67).

DESIGN (PAGES 67 - 69):

The thesis research methodology second stage (design) relays the research system design of technologies selected and explained to be implemented in partnership to the above requirements. (PAGES 67 - 69).

IMPLEMENTATION (PAGES 69 - 75):

The thesis research methodology third stage (implementation) serves an in-depth understanding of the research system in practicality. (PAGES 69 - 75). Pages 71 to page 75 have seen two tables added with their respective details. The tables and details are the identified parameters and their respective description. (PAGES 71 - 75).

INTEGRATION AND TESTING (PAGES 75 - 76):

The thesis research methodology fourth stage (integration and testing) shows the sequential steps in verification and validation of the above practical research system implementation. (PAGES 75 - 76).

CHAPTER 4 CHANGES (PAGES 78 - 97):

FINDINGS (PAGE 78):

The thesis findings portray significant issues from the research system implemented as guided by the research methodology in Chapter 3. Previous

external tables and figures are all removed. (PAGE 78). The findings on pages 78 to 97 have seen a sub-heading, ‘METRICS’, added.

ASSETS (PAGES 78 - 83):

The thesis portrays of this as the benefits derived from the implemented research system courtesy of the research methodology in Chapter 3. (PAGES 78 - 83).

LIMITATIONS (PAGES 83 - 90):

The thesis portrays of this as the drawbacks encountered from the implemented research system courtesy of the research methodology in Chapter 3. (PAGES 83 - 90).

METRICS (PAGES 90 - 97):

It provides the result of the system in conjunction with critical reviews. Plus, tables and figures. (PAGES 90 - 97).

CHAPTER 5 CHANGES (PAGES 98 - 133):

PRODUCT (PAGES 98 - 133):

The thesis product renders the various composition that make up the implemented research system implemented under the guidance of the research methodology in Chapter 3. Furthermore, screenshot evidence of all component results are presented with rhyming correspondence to relative literature review critically added. Thereby, bringing and making sense of the included codes, apportioned with description to justify its inclusion. (PAGES 98 - 133).

CHAPTER 6 CHANGES (PAGES 134 - 149):

CONCLUSION (PAGES 134 - 136):

The thesis conclusion presents the summary of the research providing its contributions and future pointers. (PAGES 134 - 136).

ASSESSMENT (PAGES 136 - 142):

The thesis presents the adjudged research considering the respective objectives, and paired research questions judgement. (PAGES 136 - 142).

SHORTCOMINGS AND RECOMMENDATION (PAGES 142 - 149):

The thesis presents the adjudged research considering the boundaries, competence, omissions, and next directions for inclusion, addition, and rectification. All in serving as a leverage for raising the effective and efficient pursuit of the research aim. (PAGES 142 - 149).

REFERENCES (PAGES 150 - 158):

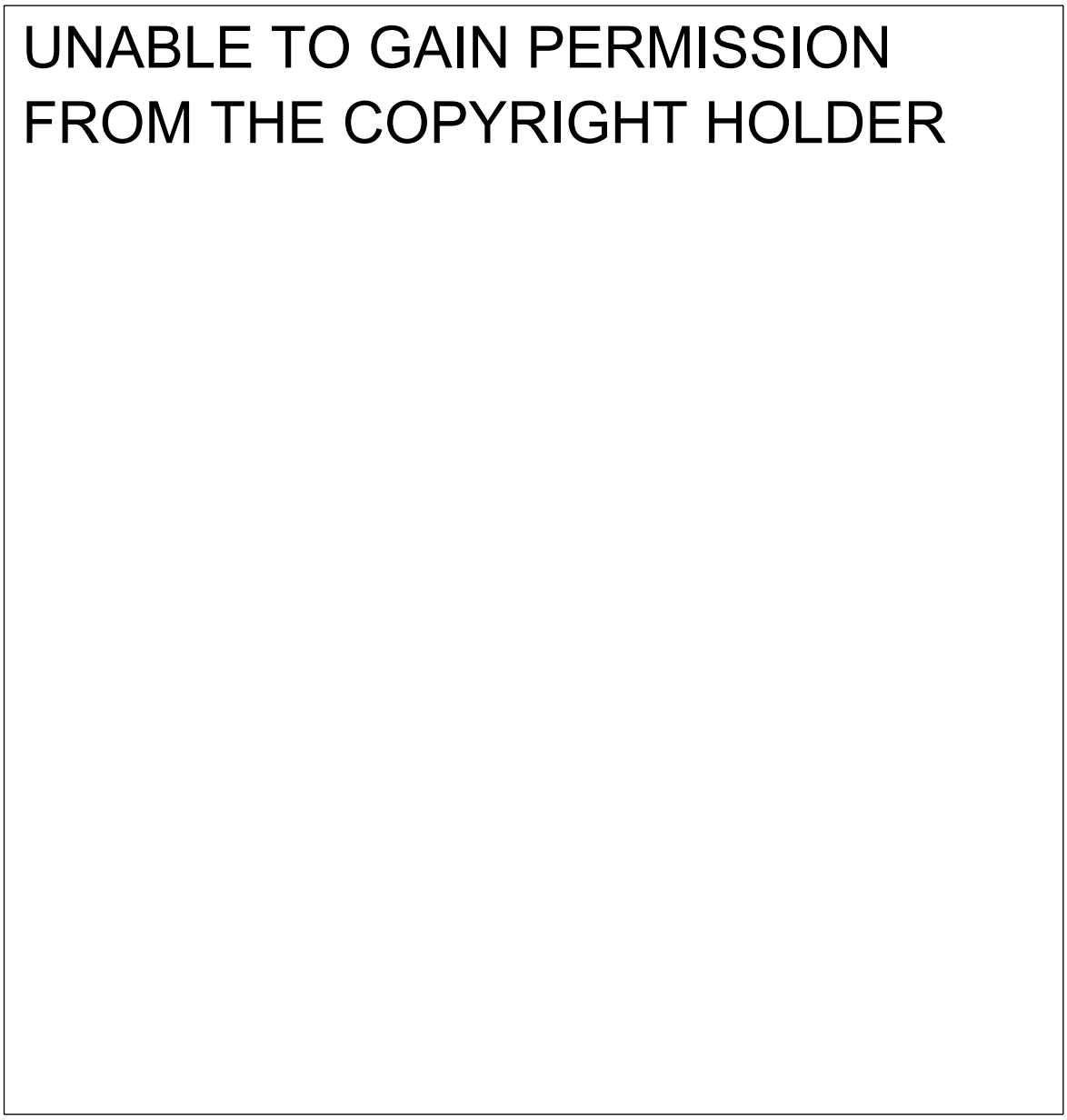
The thesis references have mirrored the removal of unnecessary and archaic cited contents. Hence, the reference list is updated with the removal of unnecessary and archaic sources matching the thesis citations. (PAGES 150 - 158).

APPENDIX (PAGES 159 - 208):

The thesis appendix has been updated to include the ethical approval from the university in consideration of the research. Other existing important and supportive items remain intact. (PAGES 159 - 208)

BLOCKCHAIN LINES OF CODE

The Government - the main body of program which generates the blockchain.



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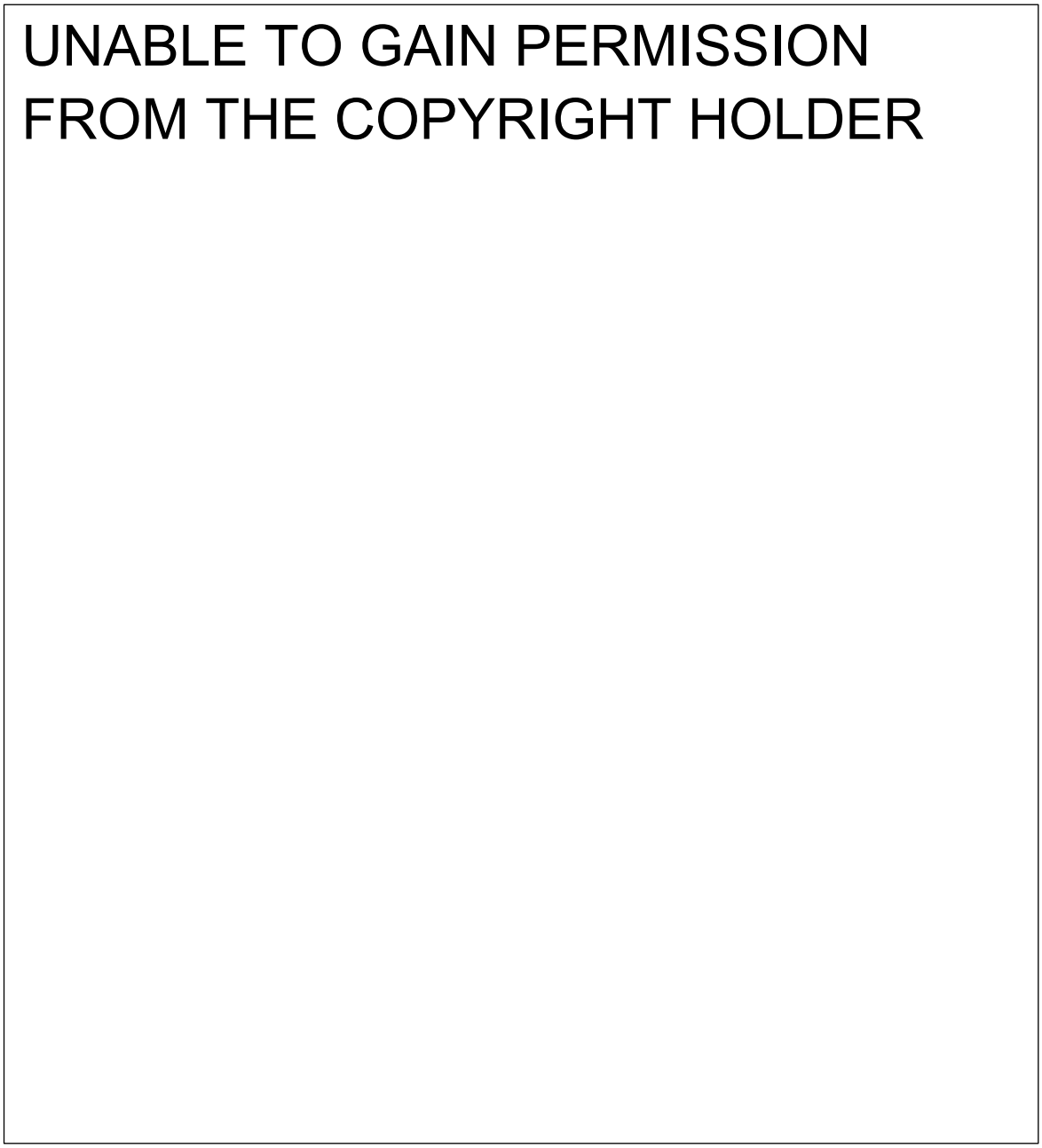
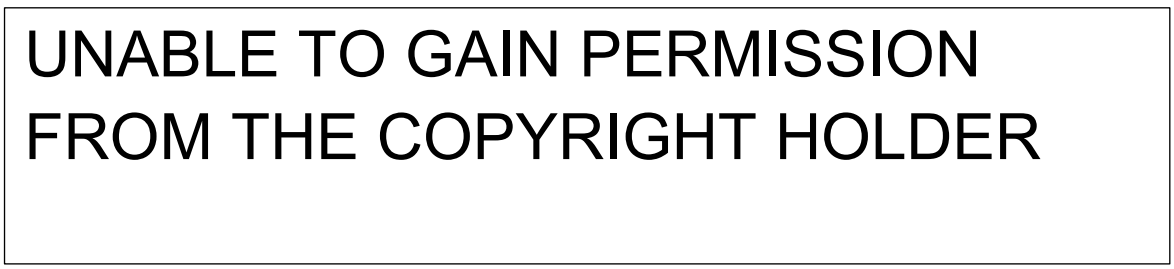


Next are the ministries that function in tandem with the government:

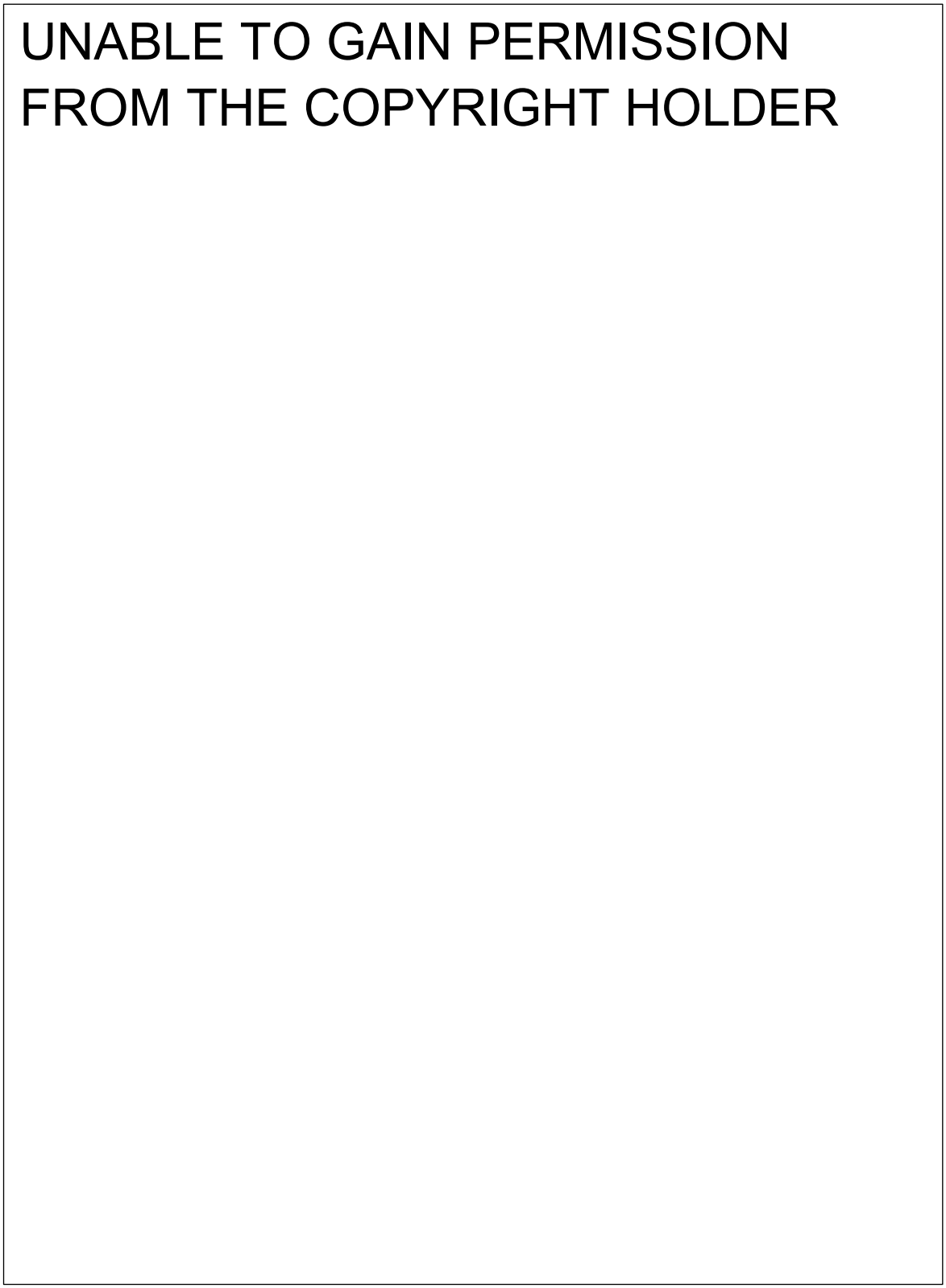
Ministry of blocks, which caters to the block creation of the blockchain.



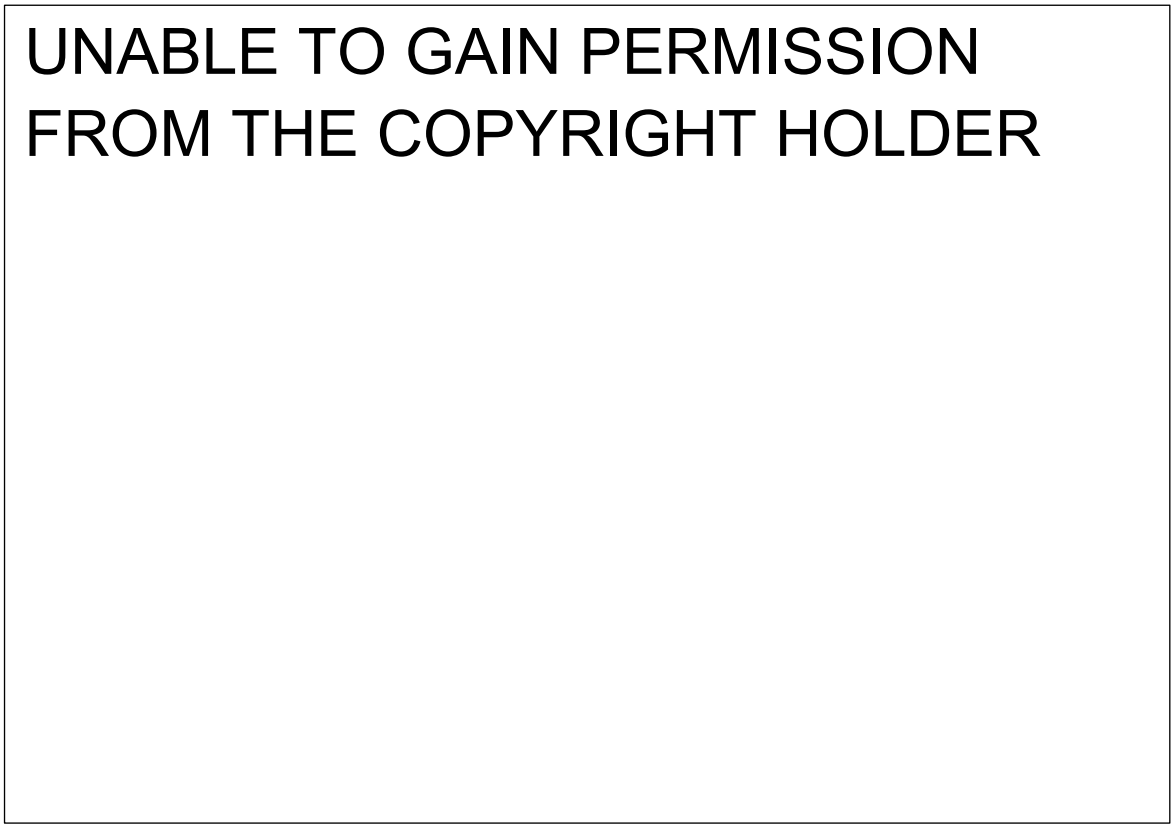
Ministry of hashing, which caters to the secure encryption (asymmetrically using SHA-256) of the block function of the blockchain.

Ministry of output, which caters to the printing out of output as resultants of programmed inputs.

Ministry of prove, which caters to the verification and validation of the internal programmed commands in conjunction with the programmed conditions.



Ministry of transaction which caters to the internal and external complementary services of transaction between interested, secure and authorized parties.



Ministry of nodes which caters to the representation of external user(s) subscribed in usage of the blockchain.

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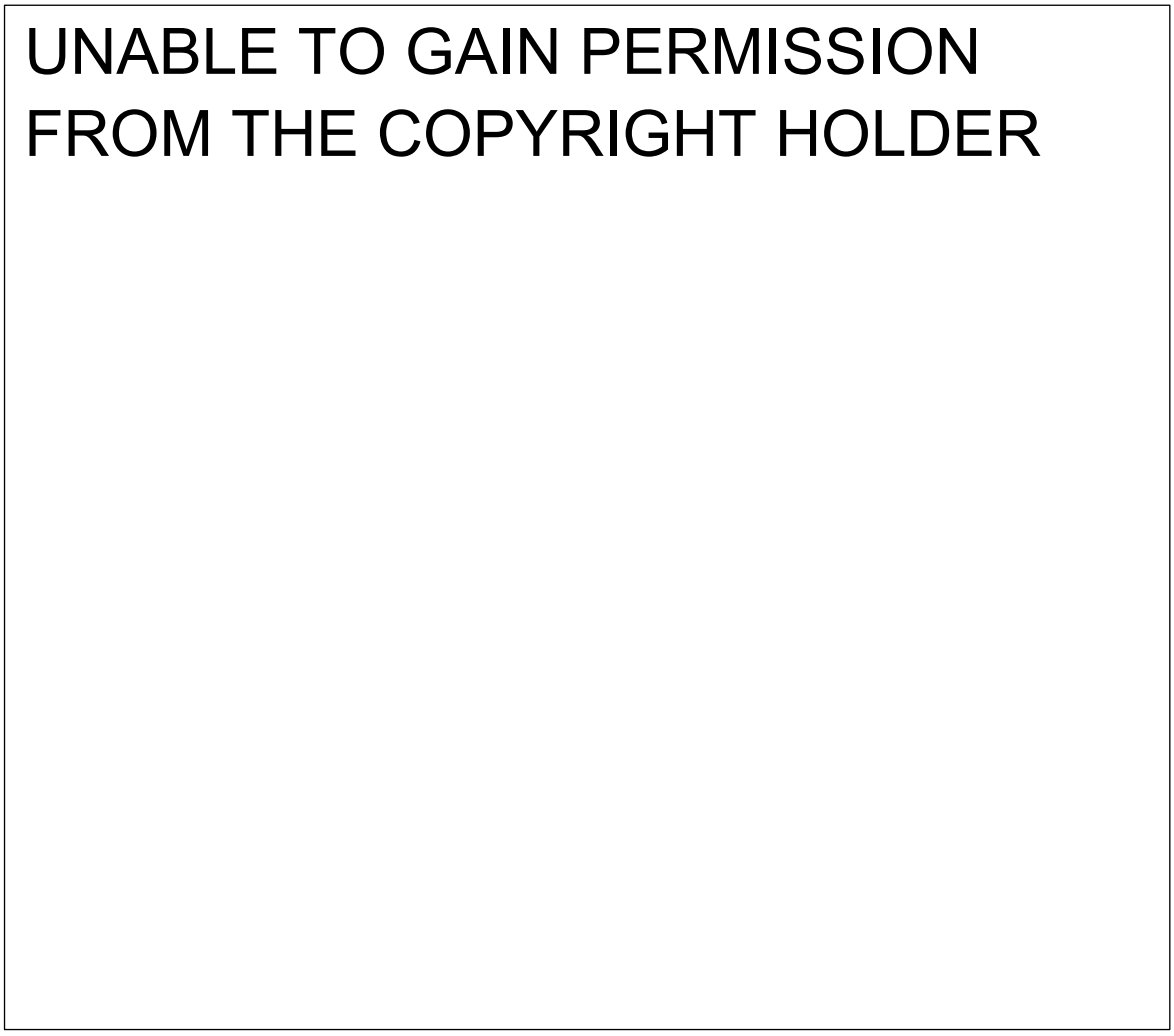

Ministry of wallets which caters to the representation of the digital account(s) of the respective user(s) and their holdings for smooth and checked trading via transactions with various imported libraries and packages courtesy python and Anaconda virtual environment, respectively.

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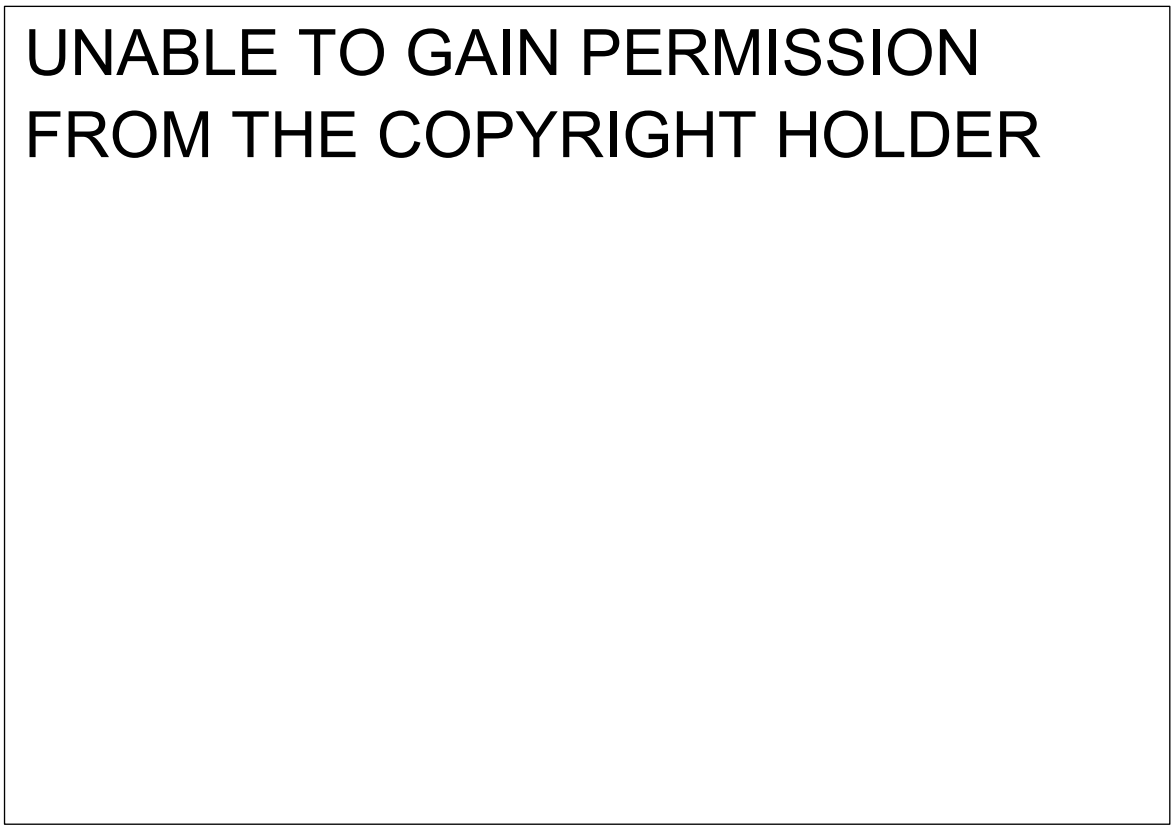
Ministry of ports which oversees to the successful connection and communicative interaction of the digital account(s) of the respective user(s) to the internet.



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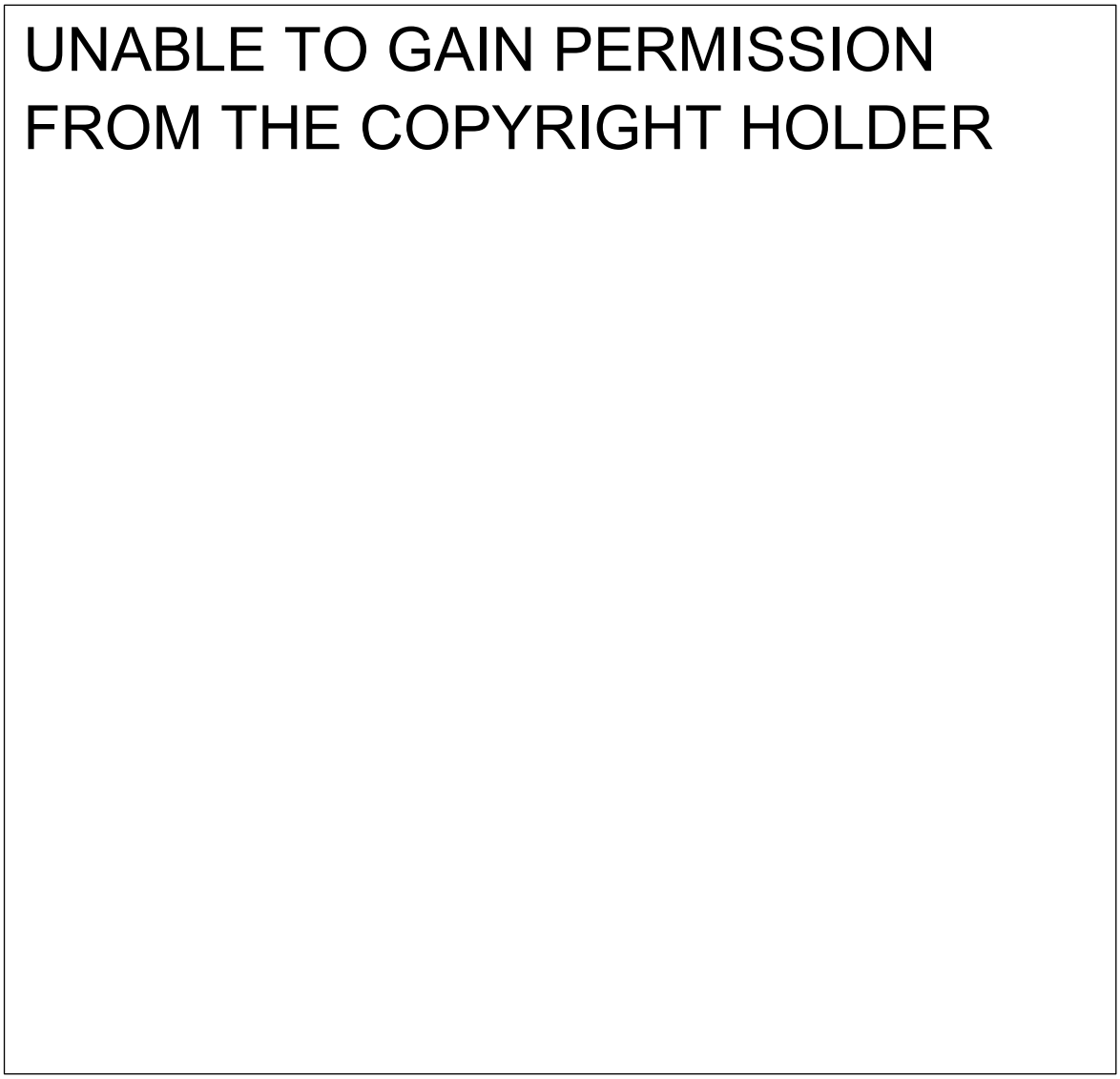
Ministry of 'graphical user interface port' embedded courtesy of (Schwarzmuller, 2019), a 'html' code with capacity to ensure the successful graphical user interface connection and communicative interaction of the digital account(s) of the respective user(s) to the internet on a webpage.



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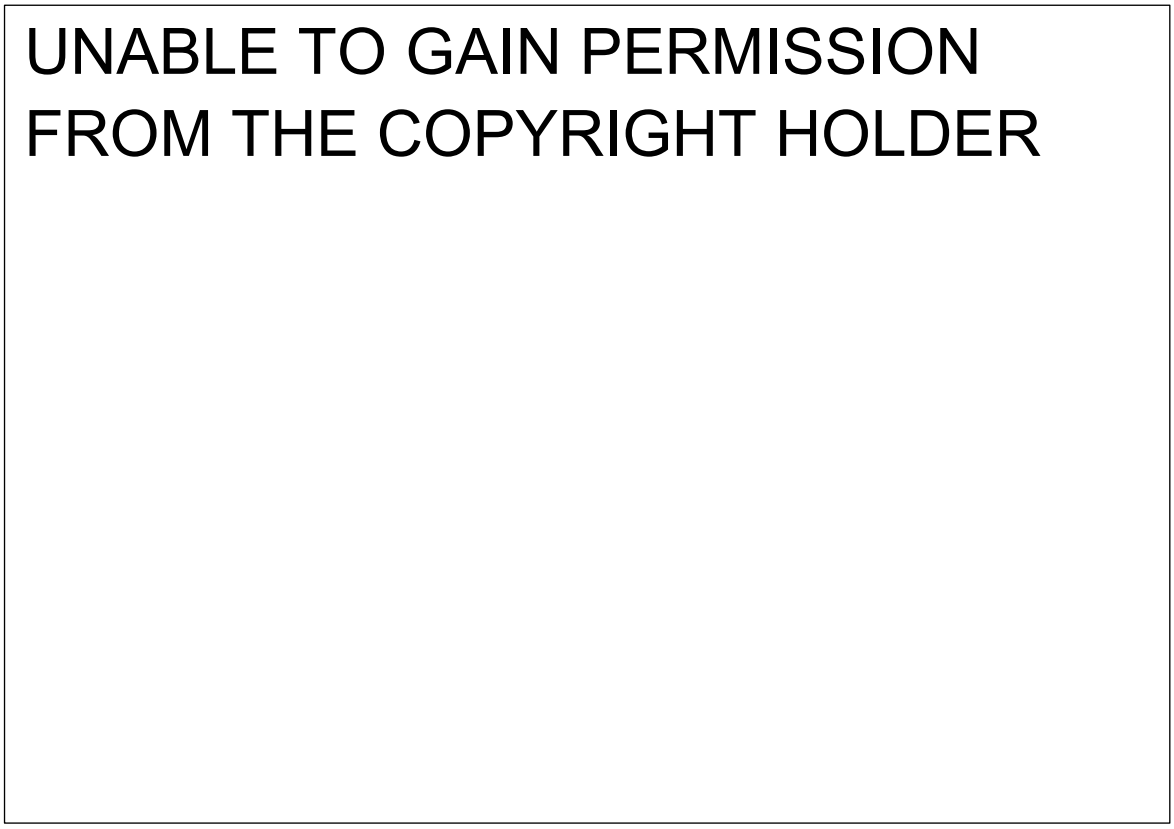

Ministry of 'graphical user interface network' wholly embedded courtesy of (Schwarzmuller, 2019), a 'html' code with capacity to ensure the successful graphical user interface connection and communicative interaction of the digital account(s) of the respective user(s) on the internet on a webpage, in collaboration and or consolidation with other nodes (digital account(s) of the respective user(s) on the internet on a webpage enclosed in secure transactions and of privacy.

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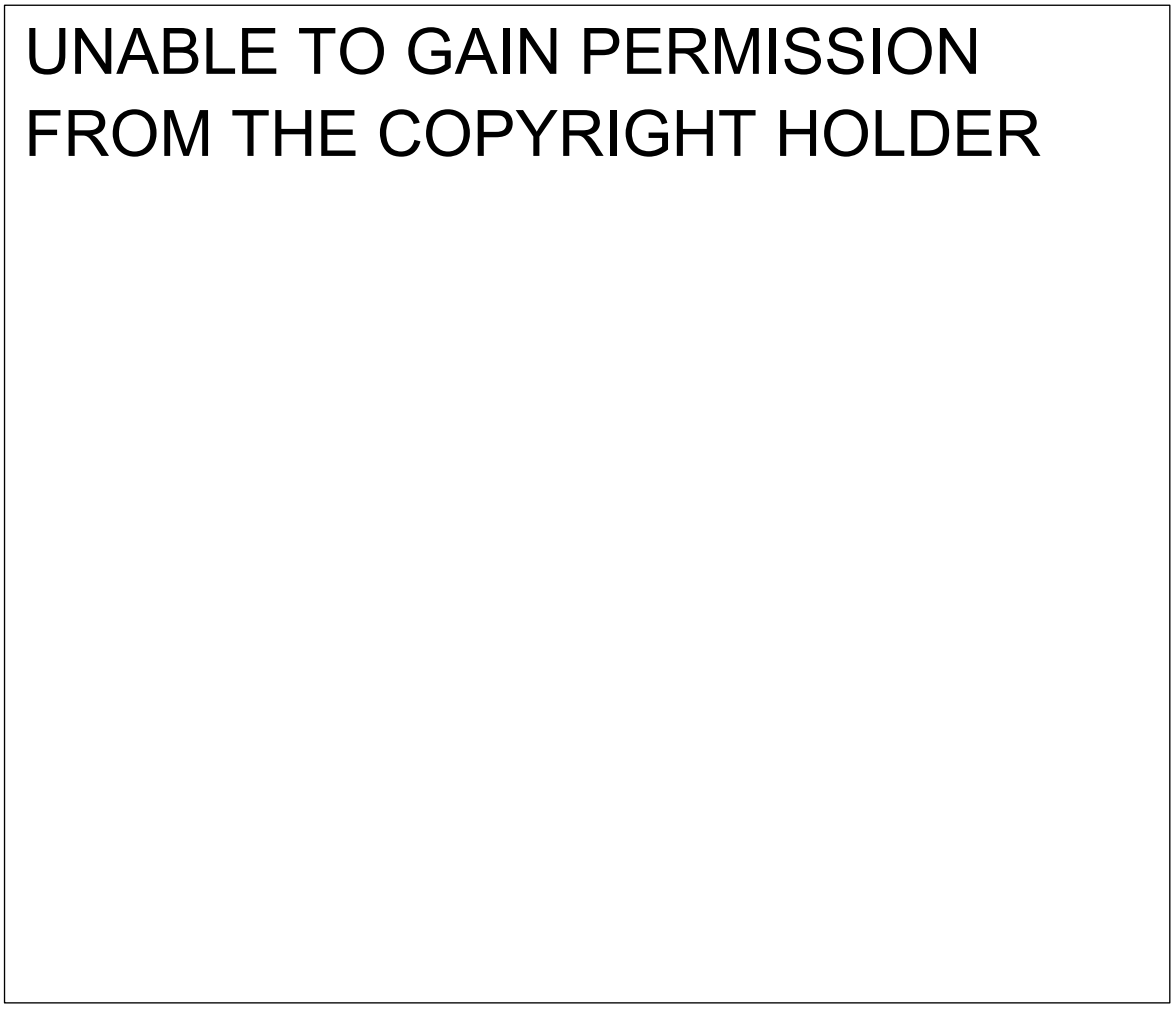

SMART CONTRACT LINES OF CODE

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DESIGN DETAILS OF (CONSUMER OR CUSTOMER, CUSTOMIZED BUSINESS AND MANUFACTURERS OR PRODUCERS) ITEMS INTERCONNECTED RELATIVITY TABLE CODE

```
import java.awt.Graphics;
import java.awt.Color;
import java.awt.Font;
import java.awt.Cursor;
import java.awt.Desktop;
import java.awt.EventQueue;
import java.awt.event.MouseAdapter;
import java.awt.event.MouseEvent;
import java.io.IOException;
import java.net.URI;
import java.net.URISyntaxException;
import javax.swing.JFrame;
import javax.swing.JPanel;
import java.awt.event.*;
import java.applet.*;
import java.awt.*;
import java.net.*;
import java.applet.*;
import java.net.HttpURLConnection;
import java.io.BufferedReader;
import java.io.BufferedWriter;
import java.io.FileWriter;
import java.io.InputStreamReader;
import java.net.URL;
import java.util.Set;

 public class Grade extends java.applet.Applet       // "java.applet.Applet gotten from and referenced to:  (Otu, 2014)//

 {

  public void  paint(Graphics g)

  {
```

```
        g.drawRect(630,50, 130, 75);   // Draws Research //
        g.drawLine(630,100,760,100);   // Draws Lower Line in Research //
        g.drawLine(630,75,760,75);     // Draws Upper Line in Research //
        g.drawLine(690,125,690,200);   // Draws Joining Line //
        g.drawLine(762,86,766,91);         // Draws Lower Arrowhead of UD Between Producers (Child Class) and Research (Super Class) //
        g.drawLine(761,84,766,79);         // Draws Upper Arrowhead of UD Between Producers (Child Class) and Research (Super Class) //
        g.drawLine(689,126,682,131);       // Draws Left Arrowhead of UD Between Customised Business (Child Class) and Research (Super Class) //
        g.drawLine(698,131,691,126);       // Draws Right Arrowhead of UD Between Customised Business (Child Class) and Research (Super Class) //
        g.drawLine(622,91,629,86);         // Draws Lower Arrowhead of UD Between Consumer (Child Class) and Research (Super Class) //
        g.drawLine(629,84,622,79);         // Draws Upper Arrowhead of UD Between Consumer (Child Class) and Research (Super Class) //
        //      SYSTEM      DESIGN      (PRE-REQUISITE)      MIDDLE COLUMN      //
        g.drawRect(440,200,380,430);   // Draws Customised Business //
        g.drawLine(440,270,819,270);    // Draws First Line in Highlight of Customised Business //
        g.drawLine(440,345,819,345);   // Draws Second Line in Highlight of Customised Business //
        g.drawLine(440,450,819,450);    // Draws Third Line in Highlight of Customised Business //
        g.drawLine(440,535,819,535);   // Draws Fourth Line in Highlight of Customised Business //
        //      WHERE      AC      MEANS      ASSOCIATION CLASS      //
        g.drawLine(400,235,440,235);   // Draws Line Between C1 and CB1 //
        g.drawLine(400,307,440,307);   // Draws Line Between C2 and CB2 //
        g.drawLine(400,397,440,397);   // Draws Line Between C3 and CB3 //
        g.drawLine(400,494,440,494);   // Draws Line Between C4 and CB4 //
        g.drawLine(400,578,440,578);   // Draws Line Between C5 and CB5 //
        g.drawLine(820,240,865,240);   // Draws Line Between CB1 and P1 //
        g.drawLine(820,310,865,310);   // Draws Line Between CB2 and P2 //
        g.drawLine(820,395,865,395);   // Draws Line Between CB3 and P3 //
        g.drawLine(820,490,865,490);   // Draws Line Between CB4 and P4 //
        g.drawLine(820,575,865,575);   // Draws Line Between CB5 and P5 //
        //      SYSTEM      DESIGN      (PRE-REQUISITE)      LEFT COLUMN      //
        g.drawLine(240,85,630,85);     // Draws Horizontal Link Line to Consumer //
        g.drawLine(240,85,240,200);    // Draws Vertical Link Line to Consumer //
        g.drawRect(50,200,350,430);    // Draws Consumer //
        g.drawLine(50,266,400,266);    // Draws First Line in Highlight Consumer //
        g.drawLine(50,345,400,345);    // Draws Second Line in Highlight Consumer //
        g.drawLine(50,450,400,450);    // Draws Third Line in Highlight Consumer //
        g.drawLine(50,530,400,530);    // Draws Fourth Line in Highlight Consumer //
        //      SYSTEM      DESIGN      (PRE-REQUISITE)      RIGHT COLUMN      //
        g.drawLine(760,85,1100,85);    // Draws Horizontal Link Line to Producers //
```

```
        g.drawLine(1100,85,1100,200);  // Draws Vertical Link Line to Producers //
        g.drawRect(865,200,400,430);   // Draws Producers //
        g.drawLine(865,270,1265,270);  // Draws First Line in Highlight Producers //
        g.drawLine(865,350,1265,350);  // Draws Second Line in Highlight Producers //
        g.drawLine(865,455,1265,455);  // Draws Third Line in Highlight Producers //
        g.drawLine(865,535,1265,535);  // Draws Fourth Line in Highlight Producers //
        //      SYSTEM                          DESIGN                          LABEL
//
        g.drawString("Research",670,70);         // Writes Research //
        g.drawString("Plastics",670,95);         // Writes Plastics //
        g.drawString("Blockchain",670,120);      // Writes Blockchain //
        g.drawString("Consumer", 300,170);       // Writes Consumer //
        g.drawString("Producers", 900,170);      // Writes Producers //
        g.drawString("Customised Business",500,170);      // Writes Customised Business
//
        g.drawString("Use Of International Serial Business Number", 100,245);    // Writes
Use Of International Serial Business Number //
        g.drawString("To Foster and Aid Recovery", 100,310);          // Writes To Foster
and Aid Recovery //
        g.drawString("For Products of Plastic Packaging", 100,400);       // Writes For
Products of Plastic Packaging //
        g.drawString("Value Purchase", 100,490);                  // Writes Value Purchase
//
        g.drawString("Culture with Technology and Votes", 100,580);     // Writes Culture
with Technology and Votes //
        g.drawString("Tracking Of International Serial Business Number",460,245);   //
Writes Tracking Of International Serial Business Number //
        g.drawString("To Strengthen Resolve Through Revolve",460,315);          // Writes
To Strengthen Resolve Through Revolve //
        g.drawString("For Products Of Plastic Packaging",460,400);                // Writes
Products Of Plastic Packaging //
        g.drawString("Brand Standard",460,490);                  // Writes Brand Standard
//
        g.drawString("Tourism with Technology and Diplomacy",460,580);         // Writes
Tourism with Technology and Diplomacy //
        g.drawString("Matching Of International Serial Business Number",900,245);   //
Writes Matching Of International Serial Business Number //
        g.drawString("To Maintain and Increase Recycling",900,320);       // Writes To
Maintain and Increase Recycling //
        g.drawString("For Plastic Products and Packages",900,405);     // Writes For Plastic
Products and Packages //
        g.drawString("Ethical Product",900,495);      // Ethical Product //
        g.drawString("Tourism with Science and Votes",900,580);          // Tourism with
Science and Votes //
    }
}
```

DESIGN DETAILS OF FIRST HALF – 'P to C' SHOWING CONSUMPTION JOURNEY FROM PRODUCTION FIGURE CODE

```
import java.awt.Graphics;
```

```
import java.awt.Color;
import java.awt.Font;
import java.awt.Cursor;
import java.awt.Desktop;
import java.awt.EventQueue;
import java.awt.event.MouseAdapter;
import java.awt.event.MouseEvent;
import java.io.IOException;
import java.net.URI;
import java.net.URISyntaxException;
import javax.swing.JFrame;
import javax.swing.JPanel;
import java.awt.event.*;
import java.applet.*;
import java.awt.*;
import java.net.*;
import java.applet.*;
import java.net.HttpURLConnection;
import java.io.BufferedReader;
import java.io.BufferedWriter;
import java.io.FileWriter;
import java.io.InputStreamReader;
import java.net.URL;
import java.util.Set;

 public class design extends java.applet.Applet       // "java.applet.Applet gotten from and referenced to:  (Otu, 2014)//

 {

  public void  paint(Graphics g)

  {


          g.drawRect(630,10, 130, 95);   // Draws Relationship //
          g.drawLine(630,60,760,60);     // Draws Lower Line in Relationship //
          g.drawLine(630,35,760,35);     // Draws Upper Line in Relationship //
          g.drawLine(690,105,690,300);   // Draws Joining Line //
          g.drawLine(25,620,1340,620);   // Draws Base Horizontal Directional Line //
          g.drawLine(25,621,31,626);       // Draws Lower Arrowhead of Base Horizontal Directional Line //
          g.drawLine(25,620,31,615);       // Draws Upper Arrowhead of Base Horizontal Directional Line //

          g.drawLine(762,56,766,61);         // Draws Lower Arrowhead of UD Between Producers (Child Class) and Research (Super Class) //
          g.drawLine(761,54,766,49);         // Draws Upper Arrowhead of UD Between Producers (Child Class) and Research (Super Class) //
          g.drawLine(689,106,682,111);       // Draws Left Arrowhead of UD Between Customised Business (Child Class) and Research (Super Class) //
```

```
        g.drawLine(698,111,691,106);      // Draws Right Arrowhead of UD Between Customised Business (Child Class) and Research (Super Class) //
        g.drawLine(622,61,629,56);        // Draws Lower Arrowhead of UD Between Consumer (Child Class) and Research (Super Class) //
        g.drawLine(629,55,622,49);        // Draws Upper Arrowhead of UD Between Consumer (Child Class) and Research (Super Class) //
        // SYSTEM DESIGN (PRE-REQUISITE) MIDDLE COLUMN //
        g.drawRect(465,300,315,130);  // Draws Customised Business //
        // SYSTEM DESIGN (PRE-REQUISITE) LEFT COLUMN //
        g.drawLine(240,55,630,55);    // Draws Horizontal Link Line to Consumer //
        g.drawLine(240,55,240,299);   // Draws Vertical Link Line to Consumer //
        g.drawRect(70,300,290,130);   // Draws Consumer //
        g.drawLine(361,365,464,365);  // Draws Link Between Consumer and Customised Business //
        g.drawLine(30,265,30,460);    // Draws Outside Vertical Line for Consumer Self Association //
        g.drawLine(30,265,120,265);   // Draws Upper Horizontal Line for Consumer Self Association //
        g.drawLine(30,460,120,460);   // Draws Lower Horizontal Line for Consumer Self Association //
        g.drawLine(120,299,120,265);  // Draws Upper Inner Vertical Line for Consumer Self Association //
        g.drawLine(120,460,120,430);  // Draws Lower Inner Vertical Line for Consumer Self Association //
        g.drawLine(120,299,127,293);    // Draws Right Arrowhead for Consumer Self Association //
        g.drawLine(119,299,112,293);    // Draws Left Arrowhead for Consumer Self Association //
        // SYSTEM DESIGN (PRE-REQUISITE) RIGHT COLUMN //
        g.drawLine(760,55,1100,55);   // Draws Horizontal Link Line to Producers //
        g.drawLine(1100,55,1100,299); // Draws Vertical Link Line to Producers //
        g.drawRect(945,300,330,130);  // Draws Producers //
        g.drawLine(780,365,945,365);  // Draws Link Between Producers and Customised Business //
        g.drawLine(1320,265,1320,460); // Draws Outside Vertical Line for Producers Self Association //
        g.drawLine(1230,265,1320,265); // Draws Upper Horizontal Line for Producers Self Association //
        g.drawLine(1230,460,1320,460); // Draws Lower Horizontal Line for Producers Self Association //
        g.drawLine(1230,299,1230,265); // Draws Upper Inner Vertical Line for Producers Self Association //
        g.drawLine(1230,460,1230,430); // Draws Lower Inner Vertical Line for Producers Self Association //
        g.drawLine(1231,299,1238,293); // Draws Right Arrowhead for Producers Self Association //
        g.drawLine(1229,299,1222,293); // Draws Left Arrowhead for Producers Self Association //
```

```
        //      SYSTEM                          DESIGN                          LABEL
//
        g.drawString("Relationship",660,30);    // Writes Relationship //
        g.drawString("Responsibility",660,55);  // Writes Responsibility //
        g.drawString("Efficiency",660,80);      // Writes Efficiency //
        g.drawString("Enhancement",660,100);    // Writes Enhancement //
        g.drawString("Consumer", 175,370);      // Writes Consumer //
        g.drawString("Producers", 1100,370);    // Writes Producers //
        g.drawString("Customised Business",555,370);      // Writes Customised Business
//
        g.drawString("Customer Ownership", 30,220);       // Writes Customer Ownership
//
        g.drawString("and Usage", 30,240);      // Writes and Usage //
        g.drawString("Plastic Packaged Goods via", 300,520);  // Writes Plastic Packaged
Goods via //
        g.drawString("ISBN Scanned and Bought", 300,540);     // Writes ISBN Scanned
and Bought //
        g.drawString("Sold Customised Plastic Packaged",430,220);   // Writes Sold
Customised Plastic Packaged //
        g.drawString("Goods and ISBN Tracked",430,240);   // Writes Goods and ISBN
Tracked //
        g.drawString("Customised Plastic Packaged Goods",760,220);      // Writes
Customised Plastic Packaged Goods //
        g.drawString("Bought and ISBN Tagged",760,240);  // Writes Bought and ISBN
Tagged //
        g.drawString("Tailored Manufactured Plastic",1120,220);   // Writes Tailored
Manufactured Plastic //
        g.drawString("Products ISBN Given",1120,240); // Writes Products ISBN Given //
        g.drawString("Sales Of Tailored Manufactured",900,520);   // Writes Sales Of
Tailored Manufactured //
        g.drawString("Plastic Products to Customised Business",900,540); // Writes Plastic
Products to Customised Business //
        g.drawString("Consumption", 175,600);     // Writes Consumption //
        g.drawString("Production", 1100,600);     // Writes Production //
        g.drawString("Journey From",580,600);     // Writes Journey From //
    }
}
```

DESIGN DETAILS OF SECOND HALF – 'C to P' SHOWING REGISTERED RECOVERY JOURNEY TO RECYCLABLE RELEASE FIGURE CODE

```
import java.awt.Graphics;
import java.awt.Color;
import java.awt.Font;
import java.awt.Cursor;
import java.awt.Desktop;
import java.awt.EventQueue;
import java.awt.event.MouseAdapter;
import java.awt.event.MouseEvent;
import java.io.IOException;
```

```
import java.net.URI;
import java.net.URISyntaxException;
import javax.swing.JFrame;
import javax.swing.JPanel;
import java.awt.event.*;
import java.applet.*;
import java.awt.*;
import java.net.*;
import java.applet.*;
import java.net.HttpURLConnection;
import java.io.BufferedReader;
import java.io.BufferedWriter;
import java.io.FileWriter;
import java.io.InputStreamReader;
import java.net.URL;
import java.util.Set;

 public class outlay extends java.applet.Applet       // "java.applet.Applet gotten from and referenced to:  (Otu, 2014)//

 {

  public void  paint(Graphics g)

  {


          g.drawRect(630,10, 130, 95);   // Draws Relationship //
          g.drawLine(630,60,760,60);     // Draws Lower Line in Relationship //
          g.drawLine(630,35,760,35);     // Draws Upper Line in Relationship //
          g.drawLine(690,105,690,300);   // Draws Joining Line //
          g.drawLine(25,620,1340,620);   // Draws Base Horizontal Directional Line //
          g.drawLine(1335,626,1340,621); // Draws Lower Arrowhead of Base Horizontal Directional Line //
          g.drawLine(1340,619,1335,613); // Draws Upper Arrowhead of Base Horizontal Directional Line //


          g.drawLine(762,56,766,61);         // Draws Lower Arrowhead of UD Between Producers (Child Class) and Research (Super Class) //
          g.drawLine(761,54,766,49);         // Draws Upper Arrowhead of UD Between Producers (Child Class) and Research (Super Class) //
          g.drawLine(689,106,682,111);       // Draws Left Arrowhead of UD Between Customised Business (Child Class) and Research (Super Class) //
          g.drawLine(698,111,691,106);       // Draws Right Arrowhead of UD Between Customised Business (Child Class) and Research (Super Class) //
          g.drawLine(622,61,629,56);         // Draws Lower Arrowhead of UD Between Consumer (Child Class) and Research (Super Class) //
          g.drawLine(629,55,622,49);         // Draws Upper Arrowhead of UD Between Consumer (Child Class) and Research (Super Class) //
          // SYSTEM DESIGN (PRE-REQUISITE) MIDDLE COLUMN //
```

```
            g.drawRect(465,300,315,130);   // Draws Customised Business //
            //      SYSTEM          DESIGN          (PRE-REQUISITE)          LEFT
COLUMN                  //
            g.drawLine(240,55,630,55);     // Draws Horizontal Link Line to Consumer //
            g.drawLine(240,55,240,299);    // Draws Vertical Link Line to Consumer //
            g.drawRect(70,300,290,130);    // Draws Consumer //
            g.drawLine(361,365,464,365);   // Draws Link Between Consumer and Customised
Business //
            g.drawLine(30,265,30,460);     // Draws Outside Vertical Line for Consumer Self
Association //
            g.drawLine(30,265,120,265);    // Draws Upper Horizontal Line for Consumer Self
Association //
            g.drawLine(30,460,120,460);    // Draws Lower Horizontal Line for Consumer Self
Association //
            g.drawLine(120,299,120,265);   // Draws Upper Inner Vertical Line for Consumer
Self Association //
            g.drawLine(120,460,120,430);   // Draws Lower Inner Vertical Line for Consumer
Self Association //
            g.drawLine(120,299,127,293);    // Draws Right Arrowhead for Consumer Self
Association //
            g.drawLine(119,299,112,293);    // Draws Left Arrowhead for Consumer Self
Association //
            //      SYSTEM          DESIGN          (PRE-REQUISITE)          RIGHT
COLUMN                  //
            g.drawLine(760,55,1100,55);    // Draws Horizontal Link Line to Producers //
            g.drawLine(1100,55,1100,299);  // Draws Vertical Link Line to Producers //
            g.drawRect(945,300,330,130);   // Draws Producers //
            g.drawLine(780,365,945,365);   // Draws Link Between Producers and Customised
Business //
            g.drawLine(1320,265,1320,460); // Draws Outside Vertical Line for Producers Self
Association //
            g.drawLine(1230,265,1320,265); // Draws Upper Horizontal Line for Producers
Self Association //
            g.drawLine(1230,460,1320,460); // Draws Lower Horizontal Line for Producers
Self Association //
            g.drawLine(1230,299,1230,265); // Draws Upper Inner Vertical Line for Producers
Self Association //
            g.drawLine(1230,460,1230,430); // Draws Lower Inner Vertical Line for Producers
Self Association //
            g.drawLine(1231,299,1238,293); // Draws Right Arrowhead for Producers Self
Association //
            g.drawLine(1229,299,1222,293); // Draws Left Arrowhead for Producers Self
Association //

            //      SYSTEM                  DESIGN                  LABEL
//
            g.drawString("Relationship",660,30);     // Writes Relationship //
            g.drawString("Responsibility",660,55);   // Writes Responsibility //
            g.drawString("Efficiency",660,80);       // Writes Efficiency //
            g.drawString("Enhancement",660,100);     // Writes Enhancement //
            g.drawString("Consumer", 175,370);       // Writes Consumer //
```

```
            g.drawString("Producers", 1100,370);     // Writes Producers //
            g.drawString("Customised Business",555,370);      // Writes Customised Business
//
            g.drawString("Customer Proof with Discounted Cashback", 30,220); // Writes
Customer Proof with Discounted Cashback //
            g.drawString("Refund or Coupon Points Benefits", 30,240);      // Writes Refund or
Coupon Points Benefits //
            g.drawString("ISBN Scanned Plastic Packaging", 300,520);   // Writes ISBN
Scanned Plastic Packaging //
            g.drawString("Returned via Customised Channels", 300,540); // Writes Returned
via Customised Channels //
            g.drawString("Checked Customised Plastic Packaging",430,220);     // Writes
Checked Customised Plastic Packaging //
            g.drawString("Received and ISBN Tallied",430,240);     // Writes Received and
ISBN Tallied //
            g.drawString("Gathered Customised Plastic Packaging",760,220);     // Writes
Gathered Customised Plastic Packaging //
            g.drawString("Redirected and ISBN Recorded",760,240);  // Writes Redirected and
ISBN Recorded //
            g.drawString("Plastic Packaging Recycled with",1120,220);   // Writes Plastic
Packaging Recycled with //
            g.drawString("ISBN Reissued and Revolved",1120,240); // Writes ISBN Reissued
and Revolved //
            g.drawString("Plastic Packaging ISBN",900,520);   // Writes Plastic Packaging
ISBN //
            g.drawString("Matched and Accepted",900,540); // Writes Matched and Accepted
//
            g.drawString("Registered Recovery", 175,600);       // Writes Registered Recovery
//
            g.drawString("Recyclable Release", 1100,600);       // Writes Recyclable Release //
            g.drawString("Journey To",580,600);       // Writes Journey To//
        }
}
```