

Any **Best Available Model (BAM) for tyre waste management in developed & developing nations?**



Entrepreneurial Perspective and Role in Tyres Waste Circular Economy

**Masters` Thesis of Environmental Management & Sustainability Science
Aalborg University**

Supervisor: David Christensen

Examiner:

Department of development & planning
Skibbrogade 5, 9000 Aalborg, Denmark

Author: Kelvin Mulenga



AALBORG UNIVERSITET
STUDENTERRAPPORT

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Department of Development and Planning
Skibbrogade 5
9000 Aalborg

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Kelvin Mulenga

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David Christensen



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Abstract:

The thesis report is the continuation of the internship research study which was conducted in Zambia with the collaboration of Zambia environmental institute of environmental management (ZIEM). The internship research study was about investigating the *best available practice (BAP)* and *best available technology (BAT)* for managing waste tyres in a developing nation. Consequently, the thesis, further tries to explore the aspect of *the best available model (BAM)* in relation to the development and promotion of tyre waste circular economy.

The thesis research study is based on qualitative case studies approach using both primary data that is semi-structured interviews and secondary data collection. One waste tyre upcycling company from Denmark and one waste tyre downcycling company from Sweden were interviewed. Three waste tyre informal entrepreneurs in Zambia were also interviewed. Additionally, the waste tyre recycling promotion organisation known as Recycling and economic development initiative of South Africa (REDISA) has been presented as a case example for best available model (BAM) using secondary data.

The discussion of the findings have highlighted four types of entrepreneurs categorized as *Survivalist*, *Lifestylist*, *Championist* and *Pioneerist*. Additionally, the thesis has also attempted to illustrate the circular economy (CE) concept based on the case studies and the conceptual framework by using a metaphor of the drupe fruit to simplify the meaning and understanding of the CE concept for both professional and unprofessional people involved in waste tyre management system.

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Table of Contents

CHAPTER 1	1
1. Introduction	1
1.1. Motivation for the research study.....	4
1.2. Research questions:	4
Main questions:.....	4
Sub-questions:.....	4
1.3. The aim of the research study.....	5
CHAPTER 2	5
2. Methodology	5
2.1. Primary data collection.....	6
2.1.1. Informal enterprises Semi-structured interviews	6
2.1.2. Formal enterprises Semi-structured interviews.....	8
2.2. Secondary data collection	11
CHAPTER 3	11
3. End of life tyre	11
3.1. Health and Environmental concerns of waste tyres	13
3.1.1. Environmental concern	13
3.1.2. Health concern	16
CHAPTER 4	18
4. Conceptual framework	18
4.1. Circular Economy.....	18
4.1.1. Waste tyre producer responsibility scheme.....	21
4.1.2. Waste tyre tax system scheme in Denmark	22
4.1.3. Circular economy driving forces.....	24
4.2. Cradle to Cradle (C2C) approach	25
4.2.1. Key tenets of C2C.....	28
4.3. Upcycling Concept.....	29
4.4. Downcycling Concept	30
4.5. Eco-innovation in products and services.....	32
CHAPTER 5	36
5. Presentation of the case studies	36
5.1. Recycling and Economic Development Initiative of South Africa	36
5.1.1. REDISA tyre waste circular economy.....	38
5.1.2. How the REDISA CE model functions:.....	39

▪	Consignment process:	39
▪	The green fee	40
5.1.3.	Collaboration and support initiatives	41
▪	REDISA and waste tyre pyrolysis development:	43
5.2.	Scandinavian Enviro Systems (SES)	44
5.2.1.	Company background:.....	44
5.2.2.	Product processing:	44
5.2.3.	Carbonized by Forced Convection and product processing	48
5.3.	Giving and Living enterprise	50
5.3.1.	Company background:.....	50
5.3.2.	Business analysis:.....	51
5.3.3.	Product processing:	52
5.3.4.	Challenges facing the company:	53
5.3.5.	Environment and health concerns:	54
5.4.	Waste tyre informal entrepreneurs (Lusaka city)	55
5.4.1.	Informal enterprises:	55
5.4.2.	Product processing:	61
5.4.3.	Environmental and Health concerns:	63
5.4.4.	Towards extended producers responsibility in Zambia	64
5.4.5.	How the waste management model for Lusaka city functions	66
5.4.6.	Informal solid waste recycling in Lusaka	67
CHAPTER 6	69
6.	Discussion	69
6.1.	Reflection on informal upcycling business model	69
6.1.1.	Survivalist entrepreneurship	70
▪	Survival oriented:.....	70
▪	Social oriented:.....	70
▪	Profit oriented:	71
▪	Niche oriented:	71
6.2.	Reflection on formal upcycling business model:	72
6.2.1.	Lifestylist entrepreneurship	72
▪	Profit oriented:	72
▪	Customer oriented:	73
▪	Diversity oriented:.....	73
6.3.	Reflection on downcycling business model:	74
6.3.1.	Championist entrepreneurship:	74
▪	Technology oriented:.....	74

▪ Profit oriented:	75
▪ Growth oriented:.....	75
▪ Substitution oriented.....	76
6.4. Reflection on the best available model:	77
6.4.1. Pioneerist entrepreneurship:	77
▪ Compliance oriented	77
▪ Partnership oriented:.....	78
▪ Growth oriented:.....	79
▪ Innovation oriented:.....	79
7. Summation	80
7.1. Metaphor of a circular economy concept:	80
8. Conclusion:.....	82
REFERENCES	85

Appendices: Transcribed interviews

- 1- Tyre and tag shoe innovators Lusaka, Zambia
- 2- Auto rubber innovators, Lusaka, Zambia
- 3- Tyre sandal makers, Lusaka, Zambia
- 4- Giving and Living company, Copenhagen, Denmark
- 5- Scandinavian enviro systems, Goteborg, Sweden

List of figures

Figure 1: General tyre composition illustration.....	12
Figure 2: Conceptual diagram of circular economy.....	19
Figure 3: Waste tyre producer responsibility in EU.....	22
Figure 4: Waste tyre management framework in Denmark.....	23
Figure 5: Waste tyre cradle to grave illustration.....	26
Figure 6: waste tyre cradle to cradle illustration.....	27
Figure 7: waste tyre upcycling concept illustration.....	30
Figure 8: Waste tyre downcycling concept illustration.....	32
Figure 9: REDISA waste tyre hierarchy	37
Figure 10: Scandinavian Enviro Systems products from waste tyres.....	45
Figure 11: Illustration of estimated prices of waste tyre products	46
Figure 12: Illustration of Scandinavian Enviro Systems CFC process.....	49
Figure 13: Illustration of differences between traditional pyrolysis & CFC process.....	49
Figure 14: Illustration of Solid waste management system for Lusaka city.....	65
Figure 15: REDISA waste tyre circular economy model.....	78
Figure 16: Illustration of circular economy concept with a drupe metaphor.....	82

List of Tables

Table 1: Semi-structured interviews for informal entrepreneur.....	8
Table 2: Semi-structured interviews for formal entrepreneur.....	9
Table 3: Key interview themes and questions.....	10
Table 4: Illustration of environmental concerns.....	14
Table 5: Illustration of health concerns.....	16
Table 6: Significance of the concepts.....	35
Table 7: REDISA green fee allocation.....	40
Table 8: REDISA collaboration with upcycling entrepreneurs.....	41
Table 9: REDISA collaboration with downcycling entrepreneurs.....	42
Table 10: Informal waste tyre enterprises, products & tools.....	58

Acronyms:

BAP:	Best available practice
BAT:	Best available technology
BAM:	Best available model
C2C:	Cradle to cradle
C2G:	Cradle to grave
CE:	Circular economy
CBE:	Community based enterprise
CFC:	Carbonized by forced convection
DEA:	Department of environmental affairs
DANIDA:	Danish international development agency
DMF:	Danish tyre trade environmental foundation
EU:	European union
ETRMA:	European tyre and rubber manufacturers association
ELT:	End of Life Tyre
EPA:	Environmental protection agency
EPR:	Extended producer responsibility
EPPCA:	Environmental protection and pollution control act
ECZ:	Environmental council of Zambia
IWTMP:	Integrated Industry Waste Tyre Management Plan
LCC:	Lusaka city council
NGO:	Non-governmental organization
NSWMS:	National solid waste management strategy
REDISA:	Recycling and Economic Development Initiative of South Africa
SES:	Scandinavian Enviro Systems
SWMS:	Solid waste management system
UTH:	University teaching hospital of Zambia
UNEP:	United Nations environmental program
WBCSD:	World Business Council for Sustainable Development
ZEMA:	Zambia environmental management agency
ZIEM:	Environmental institute of environmental management

Definitions of terms

Deductive approach: implies that theory is studied first, and then findings/observations are conducted

Downcycling: is the process of converting waste materials or useless products into new materials or products of lesser quality and reduced functionality

Green fee: a non-commercial fee collected by REDISA from producers, importers and equipment importers of tyres for the effective management of waste tyres

Innovation: innovation is the creation/introduction of the new ideas or the re-arranging of the old ideas in specific ways about existing problems to create new mind-set and value. Or the creation/introduction of something that improves the way we live our lives.

Legacy Waste Tyres: means tyres which were at 'the Date' fitted to motor vehicles and sold or imported or manufactured before 'the Date' and are not legally waste tyres at 'the Date (REDISA)

Plasticizers: any of a number of substances added to materials in order to modify their physical properties. Their uses include softening and improving the flexibility of plastics and preventing dried paint coatings from becoming too brittle.

Re-treading: removing of used or finished tyre treads and applying freshly vulcanized new treads so that the body of the tyre can be reused safely.

The Date: means the date on which the REDISA Waste Tyre Management Plan is gazetted as approved by the Minister of Environmental Affairs

Upcycling: is the process of converting some discarded materials, items or objects into something useful and often beautiful with minor alteration or simply adding value to them

Value proposition: is the analysis that clearly identifies what advantages a customer will receive by purchasing a particular product or service

Vulcanisation: process of treating rubber or rubberlike materials with sulphur at great heat to improve elasticity and strength or to harden them

Waste tyre: means a new, used, re-treaded or un-roadworthy tyre, not suitable to be re-treaded, repaired, or sold as part worn tyre and not fit for its original intended use.

CHAPTER 1

[This chapter presents an introduction about waste tyre management and challenge overview, the motivation for conducting this research, the research questions and the aim of the study as well as the deposition of the thesis paper].

1. Introduction

This thesis takes the point of departure from the internship research study which was conducted in Zambia under the organization called Zambia environmental institute of environmental management (ZIEM). Internship research study was about understanding *the best available practice (BAP) and best available technology (BAT) for managing waste tyres in a developing nation*. BAP entails how end of life tyres (waste tyres) are been utilized for various purposes at the household level, community level, institution level (e.g. schools, church etc.) and business level (entrepreneurship) as well as by the public in general. Whereas, BAT entails how end of life tyres using technological processes are being converted into various materials to create new valuable products and other materials.

Consequently, this thesis takes a furthermore research study by trying to explore the aspect of *the best available models (BAM)* and innovative approaches in relation to the establishment and promotion of tyre waste circular economy especially in developing nations. Herein, BAM involves holistic approaches and integrated initiatives that are pioneered and implemented by various organisations, governments, companies, entrepreneurship and institutions (authorities, universities, etc.) to create sustainable solutions for waste management system such as waste tyre management.

Today, the disposal of waste tyres is a major environmental issue throughout the world, but the biggest challenges have been reported in the developing countries (Nazim et al 2014). United Nation Environmental Program (2013) observes that although there are guiding principles for the treatment of waste tyres “*there are neither enforcement instruments to carry out the rules, nor the appropriate infrastructure and facilities for their recycling and disposal*” in many developing nations.

What is more, the lack of clear and proper legislation guiding the disposal and recycling of waste tyres remains a challenge in many African developing nations (Muzenda and Popa, 2014). Moreover, initiatives to stimulate investments and the role of entrepreneurship to transform waste tyre management into an environmentally sound and socially acceptable business is not well recognized and rarely promoted in many Africa nations (REDISA, 2012).

However, some organisation such as Recycling and Economic Development Initiative of South Africa (REDISA) are emerging and believes that one must recognise the importance of entrepreneurship as an economic driver and poverty eradicator (Bayley, 2014a).

Consequently, REDISA is pairing both entrepreneurial spirit and finding solutions to the many challenges and problems of waste tyres that African countries are facing today (Bayley, 2014a).

Currently, in many developed nations such as member countries in European union (EU), waste tyre management system have been put in place in terms of collection, stockpiling and recycling, as well as the European commission directive on waste management has imposed a ban on the illegal disposal and landfilling of tyres (European environmental agency, 2003).

Whereas, in many African developing nations waste tyres are still traditionally stockpiled, landfilled and illegally dumped and burnt (Mahlangu, 2009). As a result, accumulation of large amount of illegally dumped waste tyres have become an environmental and public health concerns because waste tyres eventually provide convenient breeding grounds for mosquitoes, and blocks the water storm drainages system. Moreover, uncontrolled open tyre burning produces thick toxic smoke that pollutes the air and burnt tyre debris also contaminants the soil and underground water (Mahlangu 2009 & Environmental protection Agency -USA 2010).

Therefore, Reschner, (2008) stresses that in response to the environmental problems and health hazards caused by waste tyres illegal activities and improper management around the world, today some of the industrialised nations have initiated legal guidelines for addressing this challenge. However, regulations differ from country to country, but the main purpose is to provide for environmentally safe disposal of waste tyres in any location as well as to promote and encourage innovative solutions for managing waste tyres (Ibid).

Reschner, (2008) further observes that waste tyre management systems are in place in many developed nations because they have the technologies, resources and business innovation to turn waste tyres into a valuable products and services. Moreover, various types of entrepreneurship are now emerging with innovative solutions and ideas for turning waste tyres into different products/services (www.gaebler.com).

In this thesis, the qualitative case studies using semi-structured interviews to gather primary data and reviewing of company websites and documents for secondary data was undertaken to illustrate some of the innovative solutions and ideas entrepreneurs are using. Two interviewed enterprises involved in waste tyre recycling are from developed nations Denmark and Sweden. The three informal entrepreneurs from the developing nation that is Zambia were also interviewed. Additionally, one organisation known as recycling and economic development initiative of South Africa (REDISA) currently renowned as the best available model for tyre waste circular economy model is also presented as a case study based on secondary data.

Eisenhardt, (1989) urges that qualitative case study is particularly useful where concepts and contexts are not clear, as it enables in-depth understanding and explanation to be derived. The idea of examining different cases is not comparing them as the main goal of the analysis, but to try to understand in-depth the analysis of each case in order to bring forward the details of how they relate to formulated conceptual framework practically and theoretically.

Additionally, a conceptual framework has been developed to try to illustrate and understand the best way of how to create tyre waste circular economy. The conceptual framework consists of concepts about circular economy, cradle to cradle (C2C) approach, upcycling and downcycling concepts and the concepts of eco-innovation.

Miles and Huberman (1994 cited in Maxwell, 2013) asserts that a conceptual framework *“is a visual or written product, one that explains, either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them”*

What is more, discussion of the findings are elaborated and presented into four main sections as informal upcycling business model, formal upcycling business model, downcycling business models and the best available model (BAM) for tyre waste circular economy. The sections are further presented with subsections which give detailed analysis and reflection on the four types of entrepreneurs categorized as *survivalist, lifestylist, championist and pioneerist* in accordance to the findings from the case studies. Additionally, the conclusion is given that attempts to answer the research questions and outlining the limitations of the study.

The rest of the thesis is organized as follows: still in chapter one, the motivation of the study, research questions and the aim of the study are presented. In Chapter two, the methodology of the study is outlined with research approach, the primary data collection with semi-structured interviews, key questions and the secondary data are presented. In Chapter three, the end of life tyre overview together with the health and environmental concerns associated are presented.

Then, in chapter four the conceptual framework is presented, followed by chapters five, which has presented the four qualitative case studies; REDISA, Scandinavian enviro systems, Giving and Living, and informal waste tyre enterprises. Thereafter, in chapter six the discussion part is presented and the thesis wraps up with chapter seven where the conclusion part presented.

1.1. Motivation for the research study

Currently, many developing nations are facing the challenge of managing waste tyres which keep on growing due to increased importation of second-hand cars and second-hand tyres. Genan the Danish waste tyre recycling company and the biggest in the world observes that the practice of exporting second-hand tyres to developing nations results in adverse outcomes (Niederberger et al 2013) such as:

- Poor countries shoulder a disproportionate share of the waste burden, because they import tyres with a very short life time as a result waste tyres are increasingly accumulating there and developing nations are being stuck with all the waste problem (Ibid)
- Very often recycling technology is not available in developing nations, so the waste tyres are illegally dumped or end up in landfills which leads to adverse health impacts such as harbouring mosquitos and other vermin, land pollution, and air pollution due to illegal and uncontrolled burning (Ibid)

Furthermore, there are no legal framework and industrial infrastructure to address the issue of waste tyres collection, legal stockpiling, recycling and even disposing off waste tyres in an environmentally safe and sound manner (Muzenda and Popa, 2014, Mulenga, 2014). Besides, *“there is lack of knowledge in the informal sector with regards to environmental management especially on waste tyre disposal and utilization. This reduces entrepreneurship and job creation opportunities”* (Muzenda and Popa, 2014). On top that, as mentioned earlier, there is also lack of initiatives to stimulate investments and the role of entrepreneurship in creating and promoting waste tyre management into an environmentally sound and socially acceptable business in many African nations (REDISA, 2012). Although, informal entrepreneurship such as tyre sandal making exist indirectly as part of waste tyres business in some African countries, working condition and processing methods present health and environmental risks (Mulenga, 2014).

1.2. Research questions:

Main questions:

How is upcycling & downcycling of waste tyres as a business model defined in theory and understood in practice; and how can it contribute towards the tyre waste circular economy?

Sub-questions:

- I. *What type of entrepreneurs involved in waste tyres business innovation and what kind of challenges and opportunities facing waste type entrepreneurs in developed and developing nation?*
- II. *What measures can be put in place to ensure that waste tyre upcycling and downcycling services and products have less/zero negative impact on the environment and human health?*

1.3. The aim of the research study

This study tries to understand which challenges and opportunities are involved in waste tyres upcycling and downcycling as a business model in developed and developing nations. To show how entrepreneurs in developing and developed nations involved in upcycling and downcycling of waste tyres carrying out their services and produce their products in relation to environmental and health aspects. Furthermore, the study aims to understand what types of entrepreneurs are involved in waste tyres business innovation and the best available models for establishing the tyre waste circular economy especially in developing nations.

The research studies on waste tyres in relation to best available models and the role of entrepreneurship to promoting waste tyre circular economy hasn't had much attention, therefore, my research topic has the academic novelty value. What is more, the author has a background from the African developing nation, Zambia. Therefore, the other aim is to be part of moving the country towards a sustainable waste management and circular economy in today and in the near future through based on this study. The next chapter presents the methodology undertaken for this study.

CHAPTER 2

This chapter focuses on the methodology use to carry out this research study. The research used qualitative method with deductive research approach. The data collection involved primary and secondary data collection.

2. Methodology

Qualitative case research is a theory-building approach (Eisenhardt and Graebner, 2007) and it is a valuable method for the researcher to develop theory, evaluate programs and understand complex concepts (Baxter and Jack, 2008). Furthermore, Eisenhardt, (1989) urges that it can also be used to test certain theories. The research approach applied in this study was deductive approach, implying that conceptual framework in the initial stage were developed. Then from the conceptual framework, suggestions and assumptions were deduced to guide the process of data collections and analyses.

With the deductive approach, preliminary secondary data was collected to establish the conceptual framework as the baseline for collection of primary data. Primary data requires the researcher to obtain information directly from the subject of study and this can be achieved through interviews, observation, original documentations and reports from company websites, archival records, physical artefacts and participation (Yin 1994). While, secondary data, the researcher obtains information through reports, articles, including information from various sources that have been published (Ibid).

The deductive approach was chosen to review the concepts related to the research topic especially to understand circular economy concept (elaborated later) in relation to waste tyre in advance to avoid misconception. The concept of the circular economy, is rapidly gaining traction in terms of practical use cases and believers in today's waste crisis (Kaushik, 2014). However, European parliament (2014) informs that presently, "*the circular economy is little more than a concept*". Nevertheless, Beiske (2007) indicates that deductive research approach explores a known theory or concept and tests if that theory/concept is valid in a given situations. The next section outline the approaches utilised for the primary data collection from informal and formal entrepreneurs that have created waste tyres business innovation in developing and developed nations.

2.1. Primary data collection

Since the main focus area was to understand the waste tyre management system in terms of entrepreneurship and the best available models for tyre waste circular economy in developed and developing nations, one part of the research was done in a developing nation, that is Zambia in the capital city Lusaka, for a period of one month. The other part of research was carried with two enterprises from the developed countries that is Sweden and Denmark. This section is divided into two parts; first the research approach with the informal enterprises in Zambia is presented and then followed by the formal enterprises in Denmark and Sweden.

2.1.1. Informal enterprises Semi-structured interviews

Here, the term *informal enterprise* implies small scale businesses or individuals with small investment and are not registered as legitimate enterprise as well as lacking well organised management system and not governed by the regulations in most of their business activities. The study in Lusaka, Zambia was conducted with three informal enterprises that are involved in waste tyre upcycling businesses. The face to face semi-structured interviews with three entrepreneurs in Lusaka were conducted and each taken as a separate case study.

The author also carried out field studies to observe different ways of how waste tyres are managed and disposal off. Besides, the author as well physically participated in certain waste tyres processing and production activities carried by entrepreneurs in order to test the challenges being faced in their business activities. Recording of the business activities and illustration was allowed.

The brief description of the informal enterprises dealing with waste tyres informal enterprises in Lusaka city, Zambia that were interviewed and observed are presented below:

- *Auto rubber innovators* is an informal business operating as street vending in the city of Lusaka, that produces and sells *rubber strut spacers* made from waste tyres that are placed on vehicle suspenders to elevate the vehicle chassis as a protection from bumpy and bad roads.
- *Tyre sandal makers* is an informal small scale business making the sandals from waste tyres located in the peri-urban area of Lusaka city operating as wholesale and trading enterprise for tyre sandals.
- *Tyre & tag shoe innovators* is an informal shoe business located in peri-urban area of Lusaka city producing innovative shoes made from identity tag strips and shoe soles made from waste tyres

The selection of informal enterprises were based on my previous internship research study conducted in Lusaka city in 2014. For instance, the *tyre sandal makers* participated in the internship research study, so the author was familiar with their business operation and activities. Consequently, that made it easy for the author to contact them again to participate in this thesis research study.

Moreover, the *tyre sandal makers*, actually informed the author about the other two informal enterprises which are *auto rubber innovators* and *tyre & tag shoe innovators* about their involvements in waste tyre upcycling business and the opportunities for possible interviews. The author used that information to arrange an introductory meeting with the two other entrepreneurs for participation in the research study and both agreed.

The author prepared semi-structured interview questions which were used as the guideline during the case studies and face to face interviews were conducted for all the participants. The semi-structured interview questions were prepared focusing on five themes which were entrepreneurship, innovation, environmental and health concerns, upcycling and downcycling, green products and services as elaborated later in **table 3**.

The interviews with informal entrepreneurs in Lusaka, were conducted using English and two other local languages called Bemba and Nyanja because the interviewees thought it was easy for them to express themselves better in certain situations using the local language. Fortunately, the author speaks the two languages, therefore, there were no miscommunication or interview challenges faced. In fact, that arrangement made the interviewees to further give more information, felt comfortable and being open to most of their business activities and operation.

On the other hand, presenting information about the research study when speaking to informal entrepreneurs in general presented some challenges due to less understanding of academic concepts and some words cannot be translated directly in the local language. What is more, informal entrepreneurs seemed to be more opportunistic and cautious especially those operating as street vendors.

For instance, they were sometimes focusing on issues and solution that could benefit them in their business instantly. Therefore, they presented some challenge in terms of making clarification that the studies will don't give them instant solutions.

Table 1 below presents details of face to face semi-structured interviews conducted with the three informal enterprises.

Table 1: Semi-structured interviews for informal entrepreneur

ORGANISATION	INTERVIEWEE	STATUS	FORMAT	LENGTH	RECODRING	REMARKS
Auto rubber innovators:	Owners	Face to face	Semi-structured observation	50 mins	Note taking & video recording	Video recording and photo taking of business activities was allowed after the interviews
Tyre sandal makers:	Owner	Face to face	Semi-structured Participation observation	40 mins	Note taking & video recording	Video recording and photo taking of business activities was allowed after the interviews the next day
Tyre & tag Shoe innovators:	Owner	Face to face	Semi-structured observation	48 mins	Note taking & video recording	Video recording and photo taking of business activities was allowed during and after the interviews

2.1.2. Formal enterprises Semi-structured interviews

Here, the term formal enterprise refers to any business investment and operation that are registered as legitimate enterprise having a certain management system and are governed by the regulations and policies set by the regulating and governing institutions. The author first made a thorough research on formal upcycling and downcycling enterprises, and other organisation involved in promoting waste tyre recycling and entrepreneurship around Europe and Africa. Emails were sent and telephone calls were made as follow ups to the targeted and preferred enterprises. Despite the efforts made, only two companies agreed to participate in the research.

The author conducted two interviews with two formal enterprises, one based in Denmark and the other in Sweden. The company based in Copenhagen, Denmark is known as Giving and Living company is first presented.

Giving and Living is a Danish design and wholesale company commonly known for upcycling of rubber waste tyre into crafted baskets, travel bags and flower pots. The face to face interviews was conducted with Giving and living owner which took place in the company warehouse and the form of language used was English. Along with the interviews, the author was given an opportunity take photos and to have a look at various products in the warehouse the company is producing, packaging and selling to their customers.

The second company is based in Goteborg, Sweden, known as Scandinavian Enviro Systems (SES). SES has a patented technology for downcycling waste tyres to recover carbon black, oil, steel and gas. With SES, the telephone interview was conducted with the company chief executive officer (CEO). Furthermore, addition information was obtained from the SES websites, articles and other websites that had liable information about SES.

For both interviews, the author used the semi-structured interview questions that were used as a guideline to conduct the interviews. The same five themes as in the informal enterprises interviews were used with some minor changes and additions to some of the questions. **Table 2** below presents some details about the face to face and the telephone semi-structured interviews conducted with the two formal enterprises and then **Table 3** illustrates the types of questions used under the five themes.

Table 2: Semi-structured interviews for formal entrepreneur

ORGANISATION	INTERVIEWEE	STATUS	FORMAT	LENGTH	RECODRING	REMARKS
Giving & Living	Company Owner	Face to face	Semi-structured	50 mins	Recorded interviews & Video recording	Video recording and photo taking of business activities was allowed after the interviews. The interviews were transcribed
Scandinavian Enviro Systems	CEO	Telephone interview	Semi-structured	40 mins	Recorded interviews	The interviews were transcribed

Table 3: Key interview themes and questions

Themes:	Key Questions:	Remarks:
Entrepreneurship:	<p><i>-How long have you been in this kind of business?</i></p> <p><i>-What has been your motivation in starting up a waste tyre upcycling business?</i></p> <p><i>-Why did you choose waste tyres as resource for your business?</i></p> <p><i>-Where and how do you get your waste tyres for your business?</i></p>	<p>The questions under this theme were meant to understand the entrepreneur personal interest and motivation for setting up their business activities and operation.</p>
Innovation:	<p><i>-Did you get help for your innovation from someone or somewhere outside?</i></p> <p><i>-Do you perceive the development of your products as innovation?</i></p> <p><i>-How many/much waste tyres are you using per week, month or year to produce you products?</i></p>	<p>The questions under this theme were meant to understand what really innovation mean to them and how it is perceived.</p>
Upcycling/Downcycling:	<p><i>-What do you think are the main barriers and benefits for entrepreneurs involved in waste tyres upcycling in developing countries?</i></p> <p><i>-What kind of equipment, machinery and tools are you using for creating products and adding value?</i></p> <p><i>-Does a market and demand exists for your products?</i></p> <p><i>-How do you see the current and future potential of waste tyre upcycling/downcycling as a model for circular economy?</i></p>	<p>The questions under this theme were meant to understand the determining factors of creating a waste tyre circular economy.</p>
Environmental and health concerns:	<p><i>-How can you describe your business model in relation to environmental and health risks?</i></p> <p><i>-Are waste tyres risk to the environment and human health?</i></p> <p><i>-How do you control or limit the risk of environmental and health risks from products?</i></p>	<p>The questions under this theme were meant to try to understand the commitment towards the environmental and health issues in relation to entrepreneurs business activities and operation.</p>
Green products/services:	<p><i>-What does green products mean to you? so do you think your products are green?</i></p> <p><i>-Who do you see as your competitors in terms of your green products/services? And why?</i></p>	<p>The questions under this theme were meant to understand how green products are defined in practice by different entrepreneurs especially those operating as informal enterprises.</p>

2.2. Secondary data collection

In relation to the research topic, the *best available model* (BAM) for tyre waste circular economy, the author contacted one organisation in South Africa known as Recycling and Economic Development Initiative of South Africa (REDISA) currently renowned as the best model for tyre waste circular economy. Despite showing interest in the research study, the author was not given the opportunity to carry out interviews but was advised get information from internet and their website. Therefore, the author decided to carry out secondary data collection.

The data for the REDISA case study was sourced as secondary data from REDISA website, reports, and other published articles. Actually, REDISA makes an interesting case study for this research due to that the European commission submits that REDISA scheme, “*could provide some useful lessons to countries, regions and municipalities that are seeking to establish more integrated approaches to recycling in the move towards a circular economy*” (ec.europa.eu, 2015).

The conceptual framework was also formulated using secondary data with focus on the following concepts: circular economy, cradle to cradle (C2C) approach, upcycling and downcycling concepts and eco-innovation. The data was sourced from various websites, academic journals, published reports, books and other published materials related to research topic.

The next chapter presents illustrate the concept of End of life tyre (ELT) and some of the observed health and environmental concerns.

CHAPTER 3

In this chapter, an overview of end of life tyre (waste tyre) is presented as well as some of the health and environmental concerns associated with waste tyres illegal disposal and products processing from waste tyres.

3. End of life tyre

The World Business Council for Sustainable Development (WBCSD, 2010) reports that an estimated one billion tyres worldwide (about 17 million tonnes) reaches the end of their useful lives every year. When a tyre can no longer be used on vehicles for example, due to reaching a certain state that’s not fit for its original purpose, then it becomes an End of Life Tyre (ELT). ELT also referred to as waste tyre, or scrap tyre is defined “*as a tyre that can no longer be used for its original purpose (also after re-treading or regrooving); all tires including passenger car, truck, airplane, agricultural, 2-wheel & off-road tires result in ELTs; however, most ELTs result from car and truck tires*” (WBCSD, 2008, ETRMA, 2009).

While Recycling and Economic Development Initiative of South Africa (REDISA) defines a waste tyre as “a new, used, re-treaded or un-roadworthy tyre, not suitable to be re-treaded, repaired, or sold as part worn tyre and not fit for its original intended use” (REDISA¹, 2009).

Generally, tyres are bulky objects which are designed and built to last, therefore, they take a long time to naturally degrade and are difficult to disposal off (Saravanamurthi, 2010). The composition of an average vehicle tyre as illustrated in **figure 1**. The illustration somehow explains why the end of life tyre takes a long time to degrade and why they have negative impact on the environment and on human health when not properly disposed of.

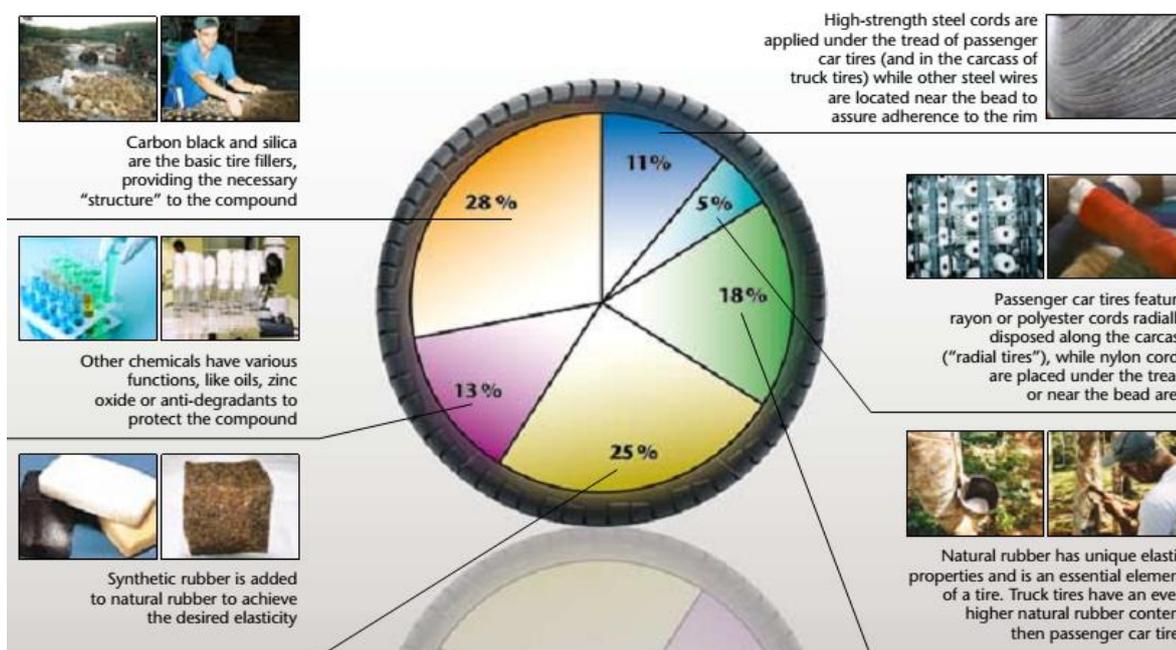


Figure 1: General tyre composition illustration

[Source WBCSD, 2008. Managing end of life tyres]

Tyre contain ant-ageing and protective agents as well as steel wires and hard rubber which makes the tyre typically hard to degrade and bulky to disposal off. What is more, the rubber composition and chemicals used for vulcanisation² (sulphur, zinc oxide etc.) and plasticizers³ (oil and resin) contents make the tyres toxic and inflammables. Consequently, creating negative environmental and health impact if illegally disposal off by burning or dumping in water systems.

¹ **REDISA**-Recycling and Economic Development Initiative of South Africa is a non-profit organization who aim it is to develop a sustainable South African tyre recycling industry through an Integrated Industry through an Integrated Industry Waste Tyre Management Plan.

² **Vulcanisation**: Process of treating rubber or rubber like materials with sulphur at great heat to improve elasticity and strength.

³ **Plasticizers**:

Any of a number of substances added to materials in order to modify their physical properties. Their uses include softening and improving the flexibility of plastics and preventing dried paint coatings from becoming too brittle

The next section illustrates some of the reported and the authors` observation of environmental and health concerns related to waste tyres in terms of poor management and product processing.

3.1. Health and Environmental concerns of waste tyres

This section presents some of the claimed health concern that are caused as a result of exposure to waste tyre products/services and potential environmental issues as result of illegal activities.

3.1.1. Environmental concern

Currently in many developing nations, the disposal of waste tyres have been uncontrolled landfilling, illegally dumping and illegal burning due to poor or lack of regulation and policies (Mahlangu, 2009). While, in many developed nations disposal of waste tyres are regulated and controlled. For instance, in the European union, most member countries have banned waste tyre illegal disposal and landfilling of waste tyres because such practices are viewed as unsustainable and risk to the environment and human health (European parliament and Council, 2008). **Table 4** illustrates some of the negative environmental impacts associated with waste tyres when poorly management.

Table 4: Illustration of environmental concerns

Environmental impact	illustration
<p>Land pollution</p> <p>Illegally disposal of waste tyres in residential areas, and illegal dump sites can create vision impacts and can encourage development of illegal dump sites with mixed tyres of wastes.</p>	<div style="display: flex; justify-content: space-around;">  <p data-bbox="1659 392 1933 647">[Illegally dump waste tyres in the residential area in Lusaka and illegally created dumpsite in lusaka. Foto taken by the author in 2014 and 2015]</p> </div> <p data-bbox="826 815 1944 887">Tyres are bulky and takes a long time to degrade as a result they will remain on the illegal dumpsite for long time causing various impacts on the land and the society.</p>
<p>Air pollution</p> <p>Illegal and uncontrolled burning of waste tyres produces thick toxic smoke that is bad for the ozone layer due to greenhouse gaseous (carbon monoxide) and the living creatures such as humans, insects, animals, vegetation etc.</p>	<div style="display: flex; justify-content: space-around;">  <p data-bbox="1355 922 1939 1305">Waste tyre are highly flammable and the fire is hard to control due to that tyres contain rubber, oil, resin and other chemical as illustrated in figure 1. This is also the reason why tyres produces highly toxic smoke. For instance, this photo obtained from http://www.hararenews.co.zw/2013/09/burning-tyres-for-wire/. Shows how the City of Harare in Zimbabwe is battling with the illegal burning of tyres which is “so bad at times that black smoke</p> </div> <p data-bbox="826 1313 1776 1385"><i>has engulfed nearby residential areas – with detrimental impact on the health of residents”</i>[Harare news, 2014].</p>

Water drainage pollution

Waste tyres are illegally dumped in the drainage system which can result into blockage causing floods and water contamination.



Due to the bulky, and durability nature of the tyres because of rubber, steel wires and fibre cotton, tyres create more risks when dumped in drainage systems in term of causing floods during the rain seasons. Due to that tyres don't decompose easily and they can contribute to trapping other waste material causing drainage system to be blocked and creating water stagnation.

[Foto taken by the author in Lusaka, Zambia 2014 showing illegal dumping of tyres in storm water drainage system at the market place]

Soil pollution

Illegally and uncontrolled burning of tyres can easily contaminate the soil causing loss of vegetation, ecosystem and resulting into soil erosion due to lack of vegetation in the area.



Due to some chemicals, oil and carbon black exuded from the burnt tyres results into loss of vegetation and soil contamination. Both photos indicate loss of vegetation and soil contamination from carbon black.

[Photo A obtained from Mahlangu (2009) showing burnt tyres in South Africa. Foto B taken by the author 2015, showing illegally burnt tyres remain in lusaka city, Zambia].

3.1.2 Health concern

Claims on the health effects from exposures and contact with waste tyres by the people making products and using products made from waste tyres has been reported (Brown, 2007). However, Brown argues that the actual levels of risks to human health due to waste tyre rubber exposures are not well known and are unfounded (Ibid). Nevertheless, there have been some claims such as allergic reaction and respiratory irritations. Besides, illegal burning of waste tyres have been linked to human health issues. While illegally dumped waste tyres due to holding stagnant water has been linked to the potential breeding space for mosquitoes that causes malaria. **Table 5** below illustrates some of the claimed health concerns.

Table 5: Illustration of health concerns

Health impact	Remarks
<p>Allergic reaction</p> <p>Some entrepreneurs upcycling waste tyres in Lusaka, Zambia have reported having skin and eye itching.</p> <p>[Photo taken by author showing an informal entrepreneur making tyre sandals in Lusaka, (2015)]</p>	 <p>They claimed to have experienced skin and eye itching. The plausible causes could be linked to lack of proper personal protective equipment such as overalls, hand gloves and protective goggles. As a results, some people when are in contact with rubber particles they can develop eyes irritations and skin itching.</p>
<p>Respiratory irritations</p> <p>Coughing, headaches and running nose as a result of rubber dust particles and toxic smoke produced when burning rubber during upcycling of waste tyres.</p>	 <p>It was noted that some of people that were upcycling waste tyres used risk methods such as burning rubber without proper breathing mask. This is likely a plausible cause of respiratory irritations.</p> <p>Photo taken by author in Lusaka, (2015) showing an informal entrepreneur making creating holes on the vehicle rubber spacers by burning rubber which was creating thick toxics.</p>

<p>Mosquito carrying diseases</p> <p>Research has shown that mosquitos can breed in discarded or stockpiled tyres that contains stagnant water</p>		<p>Tyres have a hollow space that can hold stagnant water for a long time making it suitable place for mosquito breeding.</p> <p>[Photo obtained from google images showing mosquito breeding space]</p>
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The above health and environmental implications associated with poor management of waste tyres requires sustainable solutions particularly in the developing countries. Consequently, the question of what should happen to a tyre after it has reached its end of life is increasingly being asked by various concern stakeholders such as environmentalist, the governments, researchers and by non-governmental organization (NGO) both in developing and developed nations (WBCSD, 2010).

However, entrepreneurs, recycling companies, NGO and various stakeholders have started to rethink the way waste tyres can create environmental, economic and social benefits by turning waste tyres into various products and services, and by adopting sustainable regulations and policies. What is more, today, there are existing best available models (BAM), best available technologies (BAT) and best available practice (BAP) for managing and turning waste tyres into variable products to create worth and employment both in developed and developing nations.

The next chapter presents the conceptual framework that discusses some of the concepts and approaches being implemented and adopted in relation to BAM, BAT and BAP.

CHAPTER 4

In this chapter the conceptual framework is presented: A conceptual framework “*is a visual or written product, one that explains, either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them*” Miles and Huberman (1994 cited in Maxwell, 2013)

4. Conceptual framework

In the first place, the concept of circular economy (CE) will be presented. The focus on CE is to try to understand the BAM. Then, next the concept of cradle to cradle will be presented and the focus also is to understand the BAM. Then the concepts of downcycling and upcycling will be presented to understand the BAT and BAP. Lastly, the concepts of innovation is presented.

4.1. Circular Economy

The concept of circular economy (CE) is rapidly capturing attention as a way of decoupling growth from resource constraints. Today’s “*take-make-dispose*” economy also referred to as “*linear economy*” has for a period of time relied on mainly on raw materials to create conditions for growth and stability (Ellen MacArthur Foundation and McKinsey & Company 2004). Consequently, many business organisations, government institutions and NGOs are urging the shift from linear economy to circular economy as a solution to save diminishing raw materials as well as a solution to promote the idea of reducing, reusing and recycling of materials and products that have reached their end of life time (Ibid).

Biwei, Almas, and Yong (2012) state that the concept of circular economy was first introduced by two British environmental economists, Pearce and Turner in 1990. They suggested a closed loop of material flows within an economy by analysing the relationship between economic and natural systems (Ibid). The analysis implied that a circular economy will be valuable to the society and to the economy as a whole by minimizing use of the environment as “*waste bin*” and by minimizing the use of raw materials for economic activity (Andersen 2006). Shu-hua ma et al (2014) inform that a circular economy is “*a mode of economic development that aims to protect the environment and prevent pollution, thereby facilitating sustainable economic development*”

According to Ellen MacArthur Foundation and McKinsey Company (2004) “*a circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models*”.

European commission (2014a) on YouTube video defines Circular economy as a system in which the production, consumption and trade are designed to minimize the extraction of key resources such as fossil fuels, raw materials, water, land, the environment and the pollutants along with challenging environmental and health impacts.

European commission (2014b) illustrates a simplified conceptual diagram **figure 2** with the main phases of a circular economy model, with each phase representing opportunities in terms of minimizing costs and dependence on natural resources, boosting growth and creating jobs, as well as limiting waste and harmful emissions to the environment. The aim is to minimise the resources escaping from the circle so that the system functions in an optimal way. Therefore, *“the phases are interlinked, as materials can be used in a cascading way, for instance, industry exchanges by-products, products are refurbished or remanufactured, or consumers choose product-service systems”* (European commission, 2014b).

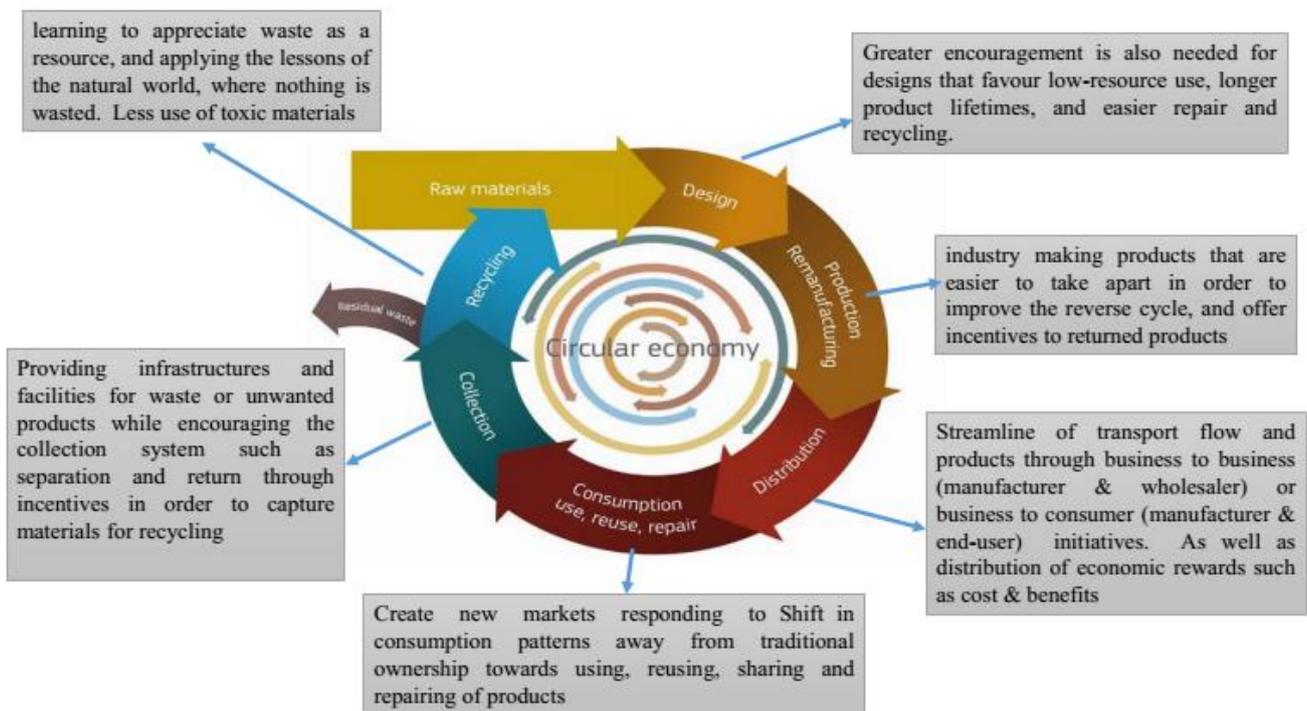


Figure 2: Adjusted conceptual diagram of circular economy: [Source: European commission 2014b]

European commission (2014b) submits that circular economy represents a development strategy that necessitates economic growth without increasing consumption of resources, deeply transform production chains and consumption habits and redesign industrial systems. Some of the principles attributed to achieving the circular economy baseline are as follows:

- *Design out waste:* This is related to the design, and production phases presented in **figure 2**. First, at its core, a circular economy aims to phase out waste so that waste does not exist. Thus, products are designed and optimized for a cycle of disassembly and reuse. The products should be designed with the intention to fit within a biological or technical materials cycle to facilitate disassembly and refurbishment of the product whereby waste will be considered as a resource or material (Ellen MacArthur Foundation and McKinsey & Company (2004).
- *Shared goods as services:* Circular economy favours ‘shared’ goods as a services whereby the use of common transportation for instance is encouraged transporting goods and other logistics to minimize the challenge of environmental pollution (Stahel, 2013).
- *Reverse logistics:* this is represents the collection, distribution, consumption and recycling phases in **figure 2**. In the circular economy, the aspect of reusing products and material is vital. With reverse logistics it implies that certain logistic equipment and products are collected from their final destination after their final purpose and returned for the purpose of capturing value, refurbishing (EU, 2014), through reusing, upcycling or downcycling approaches.
- *Collaboration:* is one of the key drivers of circular economy because it is through business partnership and through working together with different stakeholders that the value chain of circular economy (CE) is achieved and a win-win situation is created. CE encourages Partnerships such as business to business (B2B)⁴ and business to consumers (B2C)⁵ to meet common service, transportation, infrastructure, and other business opportunities (Yong Geng et al 2012).

Moreover, in order to move more towards circular economy, the European union (EU) member countries has also adopted the producers responsibility, tax system and free market system. The next section illustrates the producer responsibility. This is due to that one case study is from Sweden where the producer responsibility scheme is undertaken. While, the tax system is undertaken in Denmark and one case study is from Denmark.

B2B⁴ is when for instance two business companies focus on selling products or services to each other companies or out sourcing for certain agreed business arrangement.

B2C⁵ Business or transactions conducted directly between a company and consumers who are the end-users of its products or services.

4.1.1. Waste tyre producer responsibility scheme

Circular economy encourages the policy of producers responsibilities designed to encourages integration of environmental issues in business activities by shifting of responsibility upstream toward the producer and away from municipalities or consumers and the provision of incentives to producers to take into account environmental considerations when designing their products (Expra, 2015).

According to the European tyre and rubber manufacturers association (ETRMA) the producer responsibility legal framework assigns the responsibility to the producers (tyre manufacturers and importers) to organize the management chain for waste tyres (ETRMA, 2011). Consequently, the not-for-profit company financed by tyre producers are set-up with the responsibility to manage the collection and the recovery of waste tyres in the most economical way.

Therefore, the so called association of producers is obliged to report its obligation towards the national authorities to provide a clear and reliable traceability (Ibid). **Figure 3** below, illustrates the producers responsibility scheme which has been adopted by some EU member countries. The *users* (consumers) pays an eco-fee when they buy new tyres from the *distribution* (tyre dealers, tyre fitters, car dealers etc), that eco-fee is passed on to the association of producers which is paid to the operators (recyclers, cement kilns etc) for the treatment of the waste tyres. The system guarantees transparency of costs through a visible contribution, which clearly indicated on the invoices (ETRMA, 2011).

The association of producers engage operators through contracts to sort the collected waste tyres, to transform them into various products and to be used for energy recovery. This a general overview presented by ETRMA for EU and currently the following EU countries are have adopted the responsibility regime: Belgium, Bulgaria, Czech Republic, Estonia, Finland, France, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden and Turkey (ETRMA,2011).

The EU Member States have to be in compliance with the EU legislation in transposing the Directives into the countries local legislation. Therefore, they are free to set national initiatives to reach the EU targets. However, it is in the interest of the tyre industry to take responsibility collectively for waste tyres (Ibid).

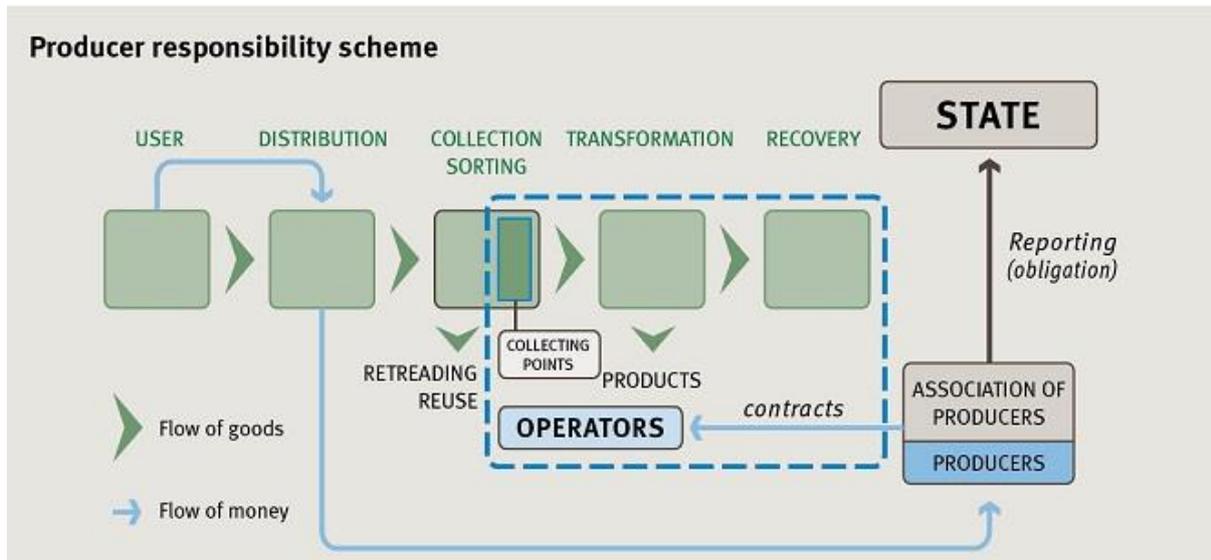


Figure 3: Waste tyre producer responsibility in EU

[Source: <http://www.etrma.org/tyres/ELTs/ELT-management/producer-responsibility>]

4.1.2. Waste tyre tax system scheme in Denmark

[In this section, a brief explanation of waste tyre management scheme in Denmark which is based on tax system scheme is illustrated. The idea of illustrating the waste tyre tax system scheme is because one the case study; Giving and living is a Danish company].

ETRMA (2011) submits that under the waste tyre tax system the government is responsible for the recovery and recycling of the waste tyres. The system is financed by a tax levied on tyre production, distributors and users. It is an intermediate system whereby the producers/importers/users have to pay a tax to the State which is responsible for the organisation and reimbursing the operators in the recovery chain (Ibid). This system has been adopted and implemented in Denmark as illustrated in **figure 4** below:

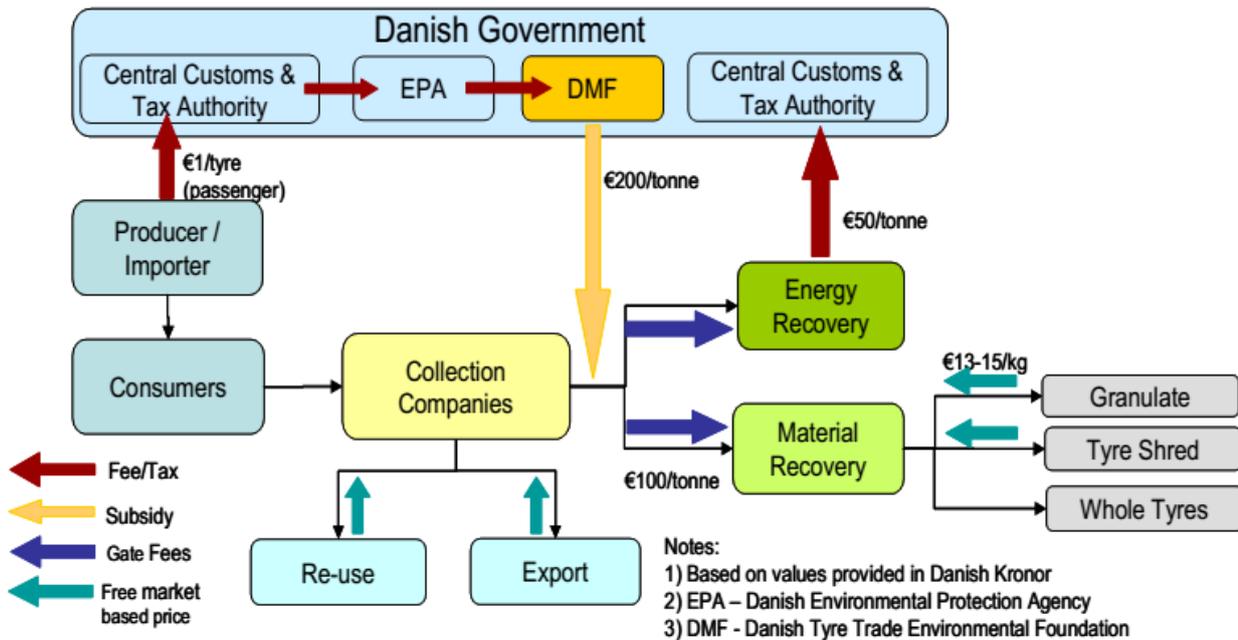


Figure 4: Waste tyre management framework in Denmark: [Source: Boyarkina, et al 2008 (WRAP Project TYR039)]

The Danish environmental protection law drives the regulatory framework and it demands that producers and importers of tyres are required to pay a tax that covers the full or partial costs associated with waste tyre management and disposal. The Danish Ministry of the Environment and the municipal authorities have a signed agreement with the Danish Association of Motor Vehicle Trade and the Danish recycling industries for a take-back scheme on waste tyres (Boyarkina, et al 2008). Therefore, any company dealing with tyres are required to take back an equal number of used tyres at no additional cost from the users. This approach has been agreed upon and implemented as a means to avoid landfilling and to ensure that waste tyres are collected, recycled or combusted (Ibid).

Producers and importers are obliged to pay a fee on tyres they place on the Danish market, to the Danish Environmental Protection Agency (EPA) through the Central Customs and Tax Authority. The fee paid by the producers/importers is determined according to the type and size of a tyre, and the tax varies from 0 to 24 Euros per unit. Producers/importers are also required to submit quarterly reports on tyre sales to the Central Customs and Tax Authority. The Danish EPA are responsible for certification of waste tyre collection and treatment facilities, and they are also responsible for settlement of any disputes between the scheme administrator and collection and treatment facilities.

The scheme administration is administered by the Danish Tyre Trade Environmental Foundation (DMF)⁶ that has been approved by the Ministry of the Environment and the Danish EPA (Boyarkina, et al 2008).

Recycling of waste tyres material is the most preferred and priority over the use of waste tyres for energy recovery. The special “*Statutory Order on a Fee on Tyres and Recovery Subsidy*” has been established as a framework for implementing the tax on tyres and a subsidy for the recovery of waste tyres. As part of the scheme, certified collection companies collect the tyres from retailers, vehicle dismantlers, repairing services and municipal collection schemes (Ibid). The Public Authorities Municipalities and the Ministry of the Environment are responsible for used tyre collection (Boyarkina, et al 2008).

Depending on the condition of the waste tyres collected, some are taken for re-treading/reuse or reprocessing and are delivered to appropriate facilities for re-use or recovery. The collection companies are entitled to receive a subsidy for each tyre delivered to a recovery facility. Nevertheless it will in turn, pay part of the gate fee to the receiving facility and gate fees are determined by market forces (Ibid).

When it comes to the combustion of waste tyre, only a very small fraction of tyres are combusted and that is because by law energy recovery is only an option for non-passenger vehicle tyres. What is more, there is a tax of €50 for each tonne of waste tyres that is combusted or landfilled which make this option economically unattractive for tyre approach (Ibid).

4.1.3. Driving force for circular economy

Circular economy focuses also on creating and promoting new business opportunities that entails entrepreneurship and eco-innovation with the aim of waste being fed back into the production process as raw material for new products (European commission, 2014a). In order to achieve this, there are many driving forces needed and some of these driving forces are presented here and they need government support for better implementation. According to Li Xinan and Li Yanfu, (2011) the development and implementation of a circular economy may be enhanced by support of the following driving forces:

- *The need of institution:* The development of circular economy is a systematic project, therefore, it needs backing from different stakeholders, capital investment and government support through law or policy making or encouragement (Ibid).

⁶ **Danish Tyre Trade Environmental Foundation (DMF: Dækbranchens Miljøfond)** is the Environmental Protection Agency designated the administrator of the grant payment under [the order no. 148](#) (Statutory Order on a Fee on Tyres and Recovery Subsidy) of 16 February 2009 on fees and subsidies for recovery of tyres. <http://www.dbfr.dk/>

- *Entrepreneurs` participations:* Entrepreneurs need to get involved and given a better understanding about the urgency and importance of circular economy and the relationship, and to understand the conflict between the current economic development and environment in order to make a change from linear to circular economy (Ibid).
- *High level of public participation:* The importance of environmental education and the public awareness about waste generation, health and environmental impacts in today's business activities and community practices needs to be clarified and rectified. This can be achieved by working closely together with formal and informal sectors, and the general public at large (Ibid).
- *Establish public education system.* Since , the concept of circular economy is somewhat a new mode for sustainable thinking and development, there is need to install and publicize the basic ideas to the general public, the government, and education institution in order to create a perfect cornerstone for building up the circular economy. That entails perfect coordination between the government institution, education institution, entrepreneurs and the general public somehow to create communication, information sharing and collaboration through different education and awareness mechanisms (Ibid).

The concept of circular economy has been related to the fundamentals of the cradle-to-cradle concept developed by McDonough and Braungart presented in the next section. According to Braungart, “*the engine of the circular economy is Cradle to Cradle thinking*” which focuses on value proposition⁷ and innovation platform for improving the quality of processes, products and systems (Braungart cited in Sawahata, 2014).

4.2. Cradle to Cradle (C2C) approach

McDonough and Braungart contend that the traditional model of “cradle to grave” has led to overconsumption and depletion of nature resources. They argue that cradle to grave of product and service development is incapable of providing a solution to the current environmental, economic, health, and social challenges (McDonough & Braungart, 2002). The model of cradle to grave is also been looked upon as unsustainable due to that environmental, economic, health and social issues are growing. As a result manufacturers, distributors and end-users are being urged to rethinking their way of doing business.

⁷ **value proposition** is the analysis that clearly identifies what advantages a customer will receive by purchasing a particular product or service

Mulhall, and Braungart (2010) point out that the conventional approach of many industries, organisations and governments have been to minimize waste and “*other environmental impacts by being less bad as products go from Cradle to Grave*”. The cradle to grave is the linear economy whereby industries extract raw materials, apply energy and labour to manufacture a certain product.

The author illustrates the cradle-to-grave (C2G) approach as a linear economy using a tyre product as presented in **figure 5** below. The cradle-to-grave concept as linear economy starts with raw material *extraction*, then moves to *execution* that is the manufacturing of products to be used for intended purpose, the end-user puts the tyres into use (*exert*). When the tyres reach the *end of life*, they end up in the grave (*extinction*) that may involve activities such as illegally disposal through burning or landfilling as illustrated in **figure 5** with **4-EX** below:

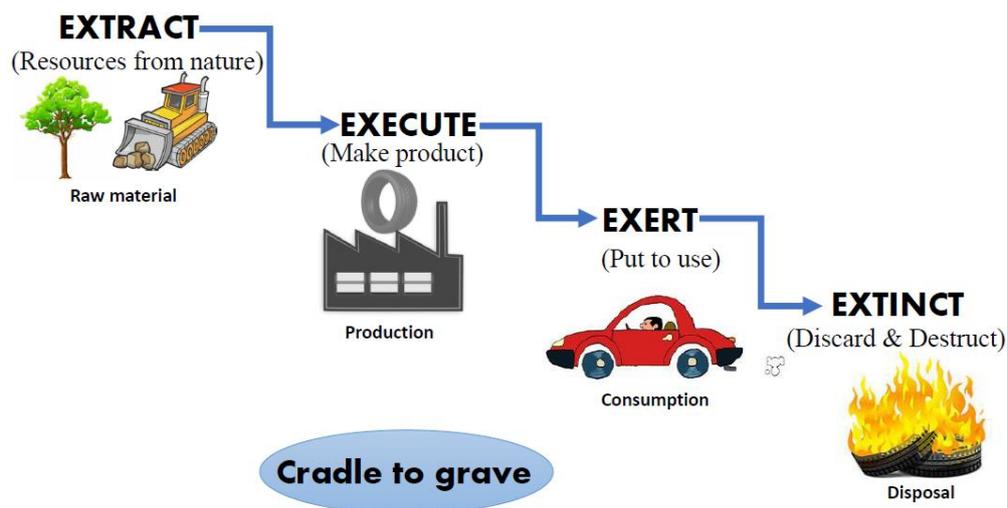


Figure 5: waste tyre cradle to grave illustration by the author

Several scholars and researchers have criticized the cradle to grave framework and recommend the “*Cradle to Cradle approach*”(C2C) as a framework that is more appropriate to provide the solution to the current challenges especially for the mounting waste generation in product and service development (McDonough and Braungart,2002, Stephen, Judith , & Andrew, 2011). They argue that C2C approach urges industries, individuals, and governments to address environmental impacts , over-consumption and waste generation by attempting to turn waste materials into nutrients enabling their continuous flow within either biological or technical metabolisms, (McDonough and Braungart 2003, Stephen, Judith , & Andrew, 2011). The biological or technical metabolism is elaborated further in the section about C2C tenets.

McDonough and Braungart (2003) inform that “just as in the natural world, in which one organism’s waste cycles through an ecosystem to provide nourishment for other living things, cradle-to-cradle materials circulate in closed-loop cycles, providing nutrients for nature or industry”. The author illustrates C2C approach using tyre and elaborated as follows: Tyre production begins with extraction of raw materials, then moves to manufacturing of products (execution) for intended purpose. When the product has been used and it reaches its end of life, it should not be disposed of, but should be utilized for other necessary needs or functions (i.e. by exploiting other usage) or recovering the components of product and reprocessing them into various necessary materials. In that way, waste is eliminated and valuable components (nutrients) are then taken up to be used as secondary material to create other products.

That approach then brings about a closed-loop economy which minimizes depends on raw materials and disposal of waste. **Figures 6** illustrates the cradle to cradle cycle for a tyre production and services using the **5-EX** and images.

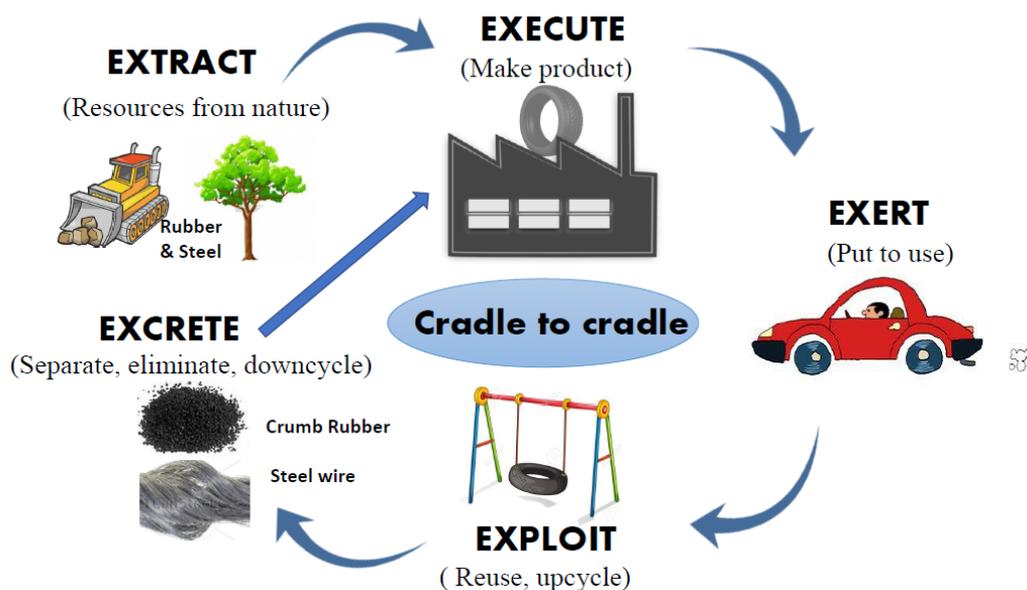


Figure 6: Waste tyre cradle to cradle illustration by the author

Stephen, Judith & Andrew, (2011) stress that the basic concept of Cradle to Cradle is to use the same approach that nature does whereby everything becomes nutrients and recycled as valuable materials within the closed-loop. According to McDonough & Braungart, (2002), materials are categorized as either “biological nutrients” or “technical nutrients”. *Biological nutrients are biodegradable and will easily re-enter water and soil whereas technical nutrients will continually circulate as valuable nutrients.* McDonough et al (2003) inform that C2C has three key tenets as follows: (1) *waste equals food*, (2) *use current solar income*, and (3) *celebrate diversity*.

4.2.1. Key tenets of C2C

Waste equals food: In nature, all materials are considered as ‘nutrients’ for something else; due to that waste virtually does not occur in nature because each organism’s processes contribute to the health of the whole ecosystem (McDonough et al 2003). For instance, fruits from the tree fall to the ground and decompose to become nutrients for other living organism or animals that eat the fruit, excrete the waste containing various components which are separated and taken up by other living things such as trees or animals. Therefore, a closed –loop of materials and waste management exist naturally in nature. The waste equals food criteria can be related to waste equals money or simply waste to worth in terms of products processing. Just as the idiom One man's trash is another man's treasure: implying that something that one person considers worthless may be considered valuable by someone else.

Use current solar income. McDonough and Braungart cite living organisms’ dependence on nature energy from the sun, stating that plants produce food using solar energy. Solar energy is renewable energy that is considered to be abundant energy source and does not cause pollution (Stouthuysen and Roy, 2010). In addition to the solar income, there other nature abundant energy sources which are renewable energy such as wind energy, biomass energy, hydro power, etc. (McDonough et al 2003), that can be taken advantage of for the production and provision of products and services. Besides, Human energy systems can be nearly as effective, and that it can be applied in upcycling of waste tyres into various product. However, C2C should co-exist with other source of renewable energy such wind power, hydro power etc.

Celebrate diversity: Stouthuysen and Roy (2010) assert that the design pattern of nature leads to exuberant diversity, in which biological systems are continuously evolving. Thus, McDonough et al , (2003) insist that the nature’s diversity offers many models for humans to replicate, for instance, diversity in nature builds resilience. Diversity should serve as a model for human design which would lead to more resilient organisations and entrepreneurship (Stouthuysen and Roy 2010). Pieterneel et al (2011) assert that as an integral part of the Cradle to Cradle concept, “celebrate diversity” takes all forms of diversity including biodiversity, cultural diversity, and diversity of ideas and innovation that should suit local conditions.

Therefore, instead of relying solely on one type of product/service from waste tyres, entrepreneurs and organisations are encouraged to think outside the box, and to adapt to the local context to come up with various products and services from one type of waste. For instance, *waste to worth*, organisation or entrepreneurs can set up waste tyre initiative programs based on incentive and government support such collection, distribution, upcycling and downcycling into products. Also *waste to energy* can be taken advantage by entrepreneurs whereby they get engaged in collection and distribution for use in production industry kiln as source of energy.

Pieterneel et al (2011) affirm that C2C approach takes creativity beyond the boundaries of design, and it foresees innovation, collaboration and added value as part of diversity. What is more, collaborating with various stakeholders and adapting the business idea to the local context and being resilient is also part of celebrating diversity.

In relation to waste tyre circular economy, the concept of C2C embraces upcycling and downcycling initiatives to demonstrate the technical nutrients in terms of valuable nutrients (material) to circulate in the loop as well as the acknowledgement of the three key tenets. However, Braungart, (2010) stresses that *“the difference between the other traditional environmental concepts is that C2C is not primarily about the environment, it’s about innovation”*. Institute in science in society, (2011) claims that upcycling and downcycling are key concepts in the cradle to cradle approach. The next section presents the upcycling concept and then followed by the downcycling concept.

4.3. Upcycling Concept

Upcycling is not a new concept, and the modern-day upcycling has been practiced by my individuals, families and communities for many centuries especially those who traditionally did not have the resources to go out and buy products whenever they wanted. It has been a way of living and life in many developing countries (Hipcyle.com). *“Upcycling denotes the process of re-purposing waste in a manner that maintains or increases its value”* (Musewe, 2013). In simple terms upcycling is a practice of creating or repurposing disposable, discarded, or unwanted items into useful, valuable or aesthetic objects to save a certain purpose or need. Upcycling is easily undertaken by both unskilled or skilled individuals and even professional (Ibid).

The process of upcycling an items includes many aspects such as someone’s own creativity, learning from others, experimentation and usually simple domestic or improvised tools are utilized. Upcycling has been associated with less demands in terms of investment, cheap resources, processing and business activities operation. Upcycling been practiced in Africa, Asia and elsewhere around the globe for centuries. For instance, Musewe, (2013) observes that upcycling has been used in African developing nations especially among poor people as means to acquire household good and other home appliances. Even today, upcycling is being practiced however, many initiatives and innovative ideas have evolved from individuals and organisations.

Currently, upcycling is being practiced as a business model, arty, edutainment (education and entertainment). What is more, it has also become a new passion for saving the environment and creating further resources for the society. Consequently, in concepts such as circular economy and C2C, upcycling is been seen as vital component. Therefore, different products that reaches their end of life are being given a second chance by converting them into various new products to serve other purposes.

The upcycling process is based on simple approaches such as use of waste materials e.g. waste tyres, and converting them into new products by using simple manual tools as illustrated in **figure 7** below:

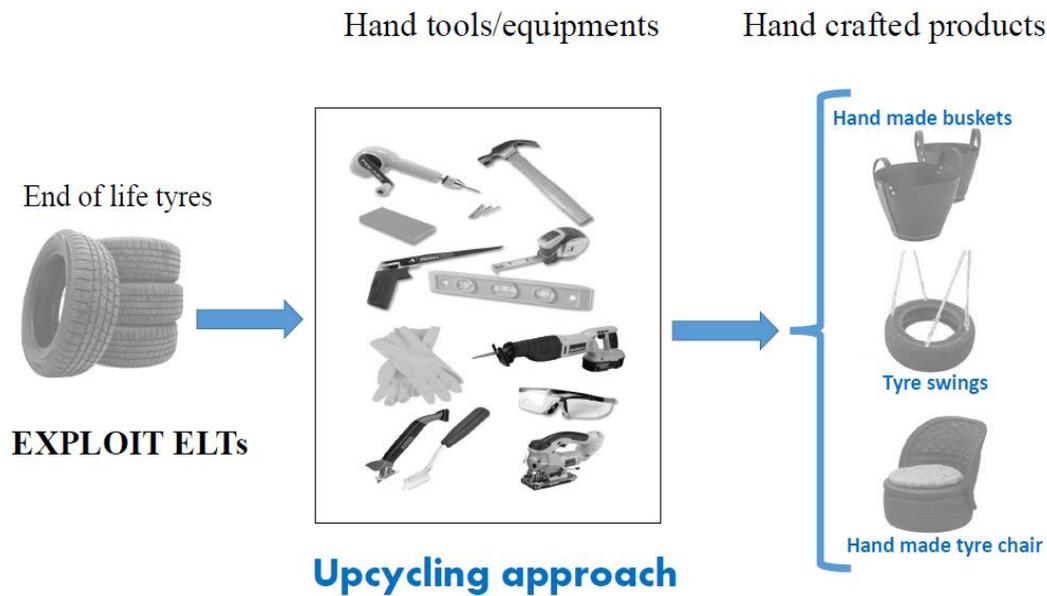


Figure 7: Waste tyre upcycling concept illustration by the author

It's essential to indicate that upcycling of waste tyres depending on the intended products (e.g. basket, and sandals) are only produced using certain part from the tyres. For instance, making baskets from tyres only the inner cotton fibre is needed. Therefore, some of part of tyre are not used as a result the remaining parts are discarded. In such situation, upcycling is criticized for not creating a closed loop as in C2C. Moreover, it is also criticized as postponing the inevitable for instance, the tyre basket or tyre swings may be later on illegally dumped when the reach their second end of life.

4.4. Downcycling Concept

Downcycling *“is a process of converting waste materials or useless products into new materials or products of lesser quality and reduced functionality”* (Greenwiki nd). When compared to upcycling, downcycling takes a more complex and industrial approach due to that it requires engineered process to carry out the separation and recovering of waste tyre components, that are then processed into different products. Downcycling helps to prevent wasting potentially useful materials, reduce consumption of fresh raw materials, tries to minimize energy usage, reduce air pollution, water pollution and lower greenhouse gas emission (Greenwiki nd).

However, downcycling requires engineered process and often skilled or professional people are behind the engineering process. Depending on the set up and the extraction methods and the end products, downcycling processing at the industrial level may utilize more energy, and might require advanced industrial equipment and logistics. Therefore, downcycling may demand high investments, complex operation and processing. Nevertheless, downcycling of waste tyres currently is being practiced as business model especially in developed nations due to easier accessibility of the finances and technologies. Currently, downcycling of waste tyres into rubber granules is one of the most useful options, provided that there is a local and regional market for recycled rubber (Reschner, 2008). Waste tyres can be downcycled through various processes and the most commonly used processes are explained below:

Cryogenic process: this process involves processing tyres chips by cooling down to a temperature of below minus 80 degrees (freezing) in a cryo-chamber with liquid nitrogen. Below this temperature, rubber is frozen to become nearly as brittle or glass and then size reduction is accomplished by crushing and breaking (Reschner, 2008). The hammer mills crush the frozen tyre chips to the required size, the steel is removed magnetically and the fibre are removed through screening. The end products are rubber dust, fibre and steel.

Pyrolysis process: is based on the principle that a waste tyre is heated without oxygen in a reactor at the temperature between 400C to 1000C degrees. The process leads to the separation and creation of Char (carbon black), Steel, hydrocarbon gas and pyrolysis oil (www.pyrolysisplant.com).

Crumbing process: this process reduces waste tyres or any other form of rubber into uniform granules with the removal and separation of components like steel using magnets and removal of fibre using screening. The whole tyre is processing steps take place at or near ambient temperature and no cooling is applied. The end products are crumb rubber, steel and fibre (Reschner, 2008).

Figure 8 below illustrates the downcycling of waste tyre based on “*crumbing grinding process*” which is accomplished by granulation or cracker mills. The industrial process uses a setup of usually four main machines, to reduce the tyre into small pieces, then to separate and recover material i.e. rubber, metal, and fabric components of the tyres. The recovered materials can then be used to create various end products (www.scraptirenews.com).

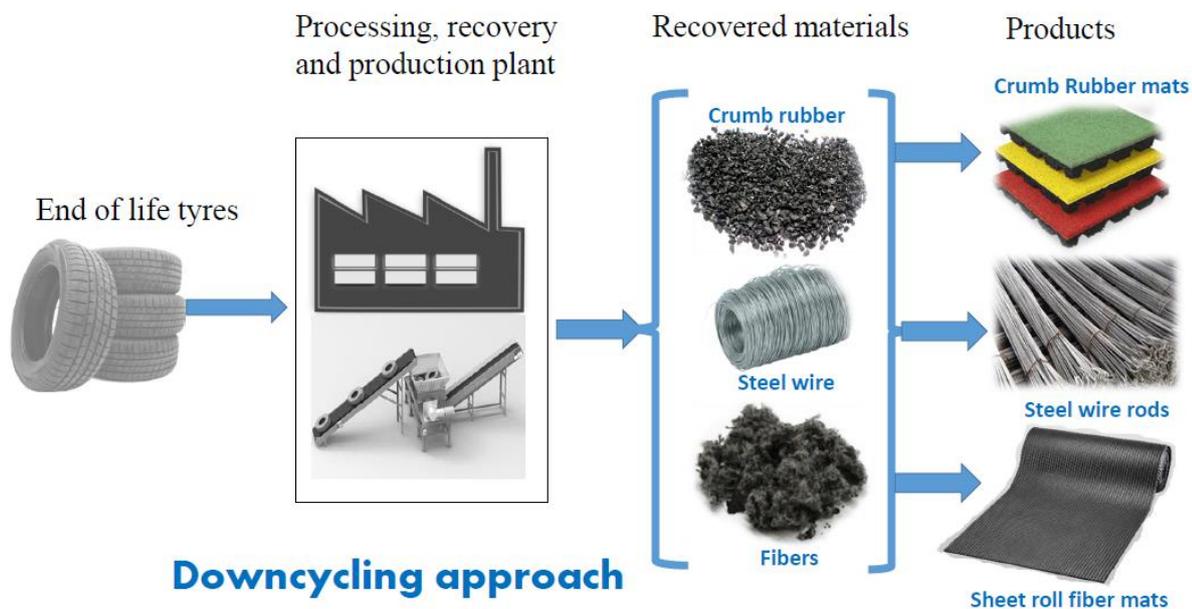


Figure 8: Waste tyre downcycling concept illustration by the author

Some of the critics of downcycling are that it consumes energy due to industrial processing. Furthermore, due to that downcycling is related to producing of products and materials that are lower quality than the first life ones, it is therefore criticised for easily resulting into contamination and pollution of contents and contacts. For example, a downcycled plastic bottle can contaminate water that is put in the bottle because the bottle. Moreover, just like upcycling, downcycling is also criticized as postponing the inevitable (intercongreen.com) Nevertheless, both upcycling and downcycling are “ushering in an entirely new wave of entrepreneurial innovation” (wang 2011). The next section enters the concept of innovation in product and services in relation to waste tyres.

4.5. Eco-innovation in products and services

Joseph Schumpeter is one of the 20th century's pioneers of innovation and entrepreneurship concepts. Schumpeter believed that economic change and growth revolves around innovation and entrepreneurial activities (Śledzik K., 2013).

However, he referred to innovation as economic change causing gales of “creative destruction” which implied that innovation is a “process of industrial mutation, that incessantly revolutionizes the

economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Schumpeter, 1942).

Schumpeter (1934 cited in Śledzik K., 2013 & www.catalign.in/) identified five types of innovations that define the entrepreneurial act as follows:

1. Launch of a new product or a new species of already known product
2. Application of new methods of production or sales of a product (not yet proven in the industry)
3. Opening of a new market (the market for which a branch of the industry was not yet represented)
4. Acquiring of new sources of supply of raw material or semi-finished goods
5. New industry structure such as the creation or destruction of a monopoly position

Albino et al (2013) definition of innovation reflects some Schumpeter ideas by stating that innovation generally refers to the implementation of a wide range of new products, processes, or organizational methods without focusing on the related environmental impacts. However, today, the issue of environmental impact seem to have entered the concept of innovation. According to Machiba et al (2012) argue that innovation should allow for new ways of addressing current and future environmental challenges, and minimizing resource consumption, while promoting sustainable economic and social activities.

Therefore, if countries, business firms and entrepreneurs want to move towards a more ecologically sound and prosperous society, it is important to promote specific areas of innovation known as eco-innovation (Machiba et al (2012). Eco-innovation is a combination of two words ecological (eco) and innovation. *eco-innovation is defined as "the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle "* (Eco-Innovation Observatory⁸, 2013).

Rennings (2000) urges that eco-innovation can be developed by individuals, firms or non-profit organizations, and it can be traded on markets or not, the nature of it can be technological, organizational, social or institutional. Today, eco-innovation has *"become the driver of economic and social progress on a national level (macro) as well as a driver of business success and competitive advantage at the firm level/entrepreneur (micro) level"* (Machiba et al, 2012).

⁸ **The Eco-Innovation Observatory** is a 3-year initiative financed by the European Commission's Directorate-General for the Environment from the Competitiveness and Innovation framework Programme (CIP). The Observatory is developing an integrated information source and a series of analyses on eco-innovation trends and markets, targeting business, innovation service providers, policy makers as well as researchers and analysts

Eco-Innovation Observatory (2013) asserts that one focus of eco-innovation is new technologies, however creating new products, services and introducing organisational changes are just as important. It is about establishing business models that are both competitive and respect the environment by reducing resource intensity of products and services (Ibid). Nevertheless, Machiba et al (2012) observes that most “*eco-innovations have a very slow journey to the market or even remain in prototypes, experimental and pilot projects*”. However, Horboch, Rammer and Rennings (2012) review of different literature inform that the increasing interest in eco-innovation as a business concept to produce green products and to address the environmental problems is mostly driven by four main determinants as presented below:

- *Regulatory push/pull* is when eco-innovation is as a result of regulation and policy pressure
- *Technology push* is when eco-innovation is as a result of technological capabilities and technical knowledge availability
- *Market pull factors* is when eco-innovation is as a result of customer benefits and demand
- *Firm/entrepreneur specific factors* is when eco-innovation is as a result of other factors such as network, area of expertise, diversification , firms resource based views (green ideas)

Machiba et al (2012) stress that eco-innovation aims to create both economic and environmental value and business models act as a value driver and enabler of green technologies and solutions. Moreover, eco-innovation observatory (2013) informs that eco-innovation can be an idea for a new start-up or product as well as for making improvements to existing operations. Peltomaki, (2015 cited from ec.europa.eu) stresses that “*eco-innovation is a crucial factor for delivering the transition to a more circular economy*”, therefore it is important “*to look beyond waste to incentives, drivers and business opportunities*”.

The following chapter presents conducted qualitative case studies that tries to correlate and reflect on the concepts. Before that, Table 6 below outlines how the concepts relate to each other and how they manifest in the selection and understanding of the case studies. This is done in order to give the reader a sense of the context and relevance of concepts in the research topic, case studies and the outcomes.

Table 6: Significance of concepts

Concepts	Significance	Remarks
Circular economy (CE)	A circular economy is the direct opposite of linear economy which is a take-make-consume-throw away pattern. CE promotes materials and products reuse, and turning waste into a valuable resource.	In developing nations linear economy is still the practical solution to waste management. European parliament (2014) informs that presently, the circular economy is little more than a concept, although a potentially powerful concept. Therefore, in this research study understanding the key factors and opportunities associated with CE through the case studies is vital in relation to moving developing nations towards the circular economy.
Cradle to cradle (C2C)	C2C provides the conceptual and methodology framework that makes circular economy work (EPEA ⁹ & Kienbaum)	In this study, it is essential to try to understand from theory to practical point of view how existing formal and informal business model depicts the concept of C2C.
Downcycling and Upcycling	Both downcycling and upcycling concepts form part of loops that are fundamentals for cradle to cradle concepts in terms of technological loops and the key tenants.	In this study, it is essential to understand what type of entrepreneurship in practice are have embracing downcycling and upcycling. Also to understand the activities involved in these two concepts from the developed and developing nations point of view.
Eco-innovation	Upcycling and downcycling are have become the new surge of eco-innovation which is a “key factor for delivering the transition to a more circular economy” (European commission).	In this study, identifying the eco-innovation in developing nations especially in the informal sector through the case studies and what kind of entrepreneurship are associated is crucial.

⁹ Environmental Protection Encouragement Agency (EPEA) Internationale Umweltforschung GmbH Founded by Professor Dr. Michael Braungart in 1987, works with clients worldwide to apply the Cradle to Cradle® methodology to the design of new processes, products and services

CHAPTER 5

[In this chapter, the four case studies are presented that illustrates the circular economy approach, informal upcycling, formal upcycling and downcycling approaches. The qualitative case studies are based on the primary data and secondary data. The case studies are presented as follows: first the REDISA case is presented which depicts the tyre circular economy, then followed by the Scandinavian Enviro Systems case study which depicts downcycling model of waste tyre. Thereafter, Giving & living case study is presented that depicts the formal upcycling model. Then, lastly, three case studies that are presented depicting informal upcycling]

5. Presentation of the case studies

Tellis (1997) submits that qualitative case study can be single or multiple-case designs. In this thesis, multiple case designs is used. The multiple case study has been chosen to try to confirm, illustrate and challenge the theory.

Case study 1

5.1. Recycling and Economic Development Initiative of South Africa

[A case study has been conducted on an organisation that has gained attention as a model for tyre waste circular economy, with the intention of having a better understanding and illustration of circular economy model approach and success. The data used for REDISA case study is based on secondary data obtained from REDISA website, published articles and reports, YouTube video and other credible websites such as the European commission]

Recycling and Economic Development Initiative of South Africa abbreviated as REDISA, is a non-profit company formed in 2010 and became a registered independent body in 2012 to oversee and facilitate the recycling of waste tyres in South Africa (www.redisa.org.za, www.engineeringnews.co.za, 2015). The organisation has been set up to deal with South Africa's waste tyre problem through an Integrated Industry Waste Tyre Management Plan (IIWTMP) that REDISA submitted to Department of Environmental Affairs (DEA) and the Plan was approved to manage the waste tyre challenges in South Africa through the creation of a new tyre recycling industry (Ibid).

REDISA claims that prior to its formation, there was no scheme to manage waste tyres in South Africa resulting in an estimated 60 million waste tyres lying in stockpiles countrywide, many of which were illegally disposed in open fields (www.redisa.org.za). Before the formation of REDISA, the recovery rate for old tyres in South Africa was 3%, after 18 months of REDISA strategy, the recovery rate went up to 70% (CEO-REDISA, 2015 cited from <http://ec.europa.eu>).

REDISA has developed the waste tyre hierarchy which has been the cornerstone for implementing and building an effective and sustainable recycling model for waste tyres (REDISA, 2012).

Today, various stakeholders in South Africa follow the waste tyre hierarchy and it has been approved by the department of environmental affairs (DEA). **Figure 9**, illustrates REDISA waste tyre hierarchy which is based on 4Rs of recycling (Reduce, Reuse, Recycle & Recover).

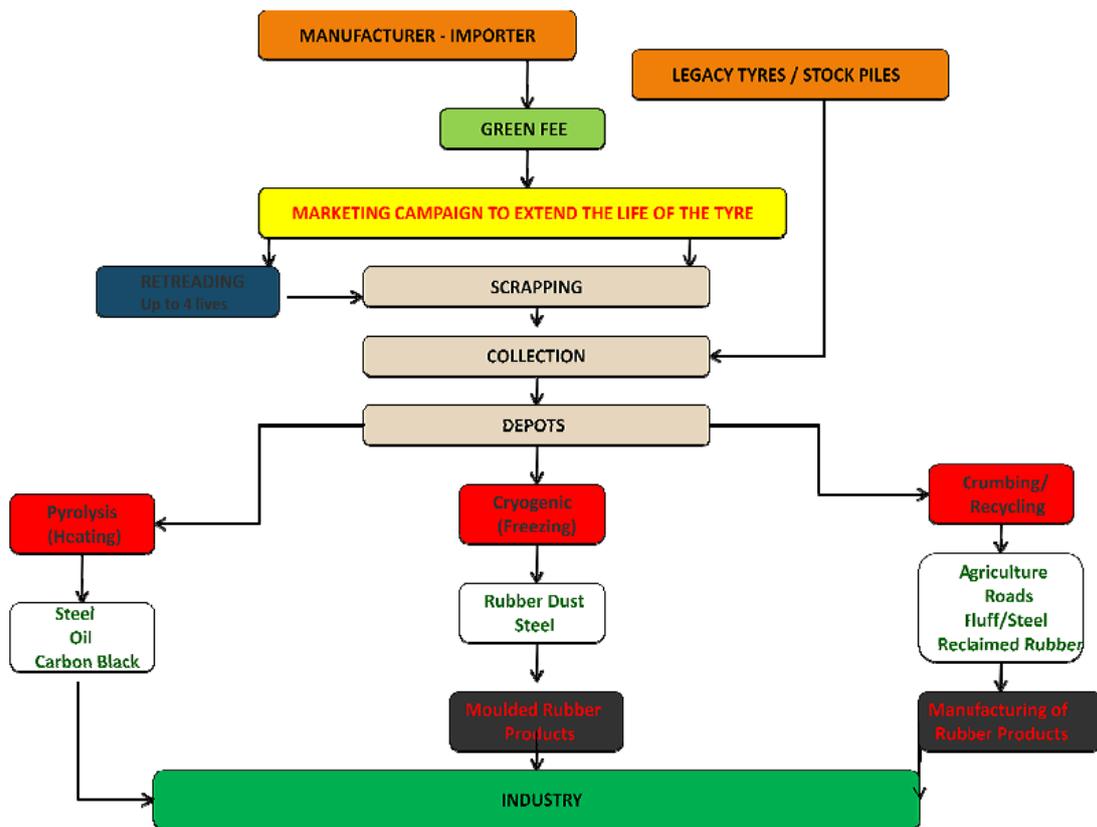


Figure 9: Waste tyre hierarchy illustration by REDISA, 2012

- **Reduce:** implies the reduction of material inputs and creation of waste at the source by the tyre producers. Therefore, producers are encouraged to produce durable tyres to extend the life span of tyres. Besides, REDISA believes that the introduction of green fee as part of extended producers responsibility and marketing campaign such as such as consumer education to teach end-users on how to manage and reduce tyre wear and damages through better maintenance and usage (REDISA, 2012).
- **Reuse:** Reusing the tyre is the second preferred option which includes Re-treading of the used tyres. Re-treating is the process of “removing used tyre treads and applying freshly vulcanized new treads so that the body of the tyre can be reused safely” (www.bridgestone.com). Reuse also implies the collection and stockpiling of waste tyre for upcycling purpose and other entrepreneurship activities (REDISA,2012).

- **Recycle:** involves collection and stockpiling of waste tyre for downcycling through pyrolysis, crumbing and cryogenic processes to produce new products and services as illustrated in hierarchy figure 9 (REDISA, 2012).
- **Recover:** the least preferred option is recovery which implies energy recovery whereby waste tyres are used as fuel in cement kiln, power plants, industrial boilers etc. (REDISA, 2012, www.oneteamoneplanet.com).

5.1.1. REDISA tyre waste circular economy

REDISA believes it has established a viable tyre waste circular economy by setting up a unique model that emphasize the viability of recycling as a business and a social benefit (CEO-REDISA, 2015 cited from <http://ec.europa.eu>). The Department of environmental affairs (DEA) in 2012 approved the REDISA waste tyre management plan to manage and to support the creation of a sustainable recycling industry to deal with a major and problematic waste tyres, as well as to create jobs and to foster small and medium sized businesses in communities throughout the South Africa (Africa review, 2012, REDISA,2012).

The REDISA model is built on extended producer responsibility, incentive based recycling, entrepreneurship, mandatory subscription and registration and various stakeholder inclusion (www.redisa.com). REDISA has created the Integrated Industry Waste Tyre Management Plan (IIWTMP) which includes waste management fee known as “green fee” which is basically the extended producers responsibility. Therefore, tyre producers and importers are obligatory charged R 2,30 (South Africa rand) that is equivalent to EUR 0,20 on every kilogram of new tyre rubber produced or introduced on the market. The tyre producers¹⁰ and importers of tyres are obliged to register to REDISA, including all importers of vehicles and they risk both penalties and prison time when they do not comply (www.govsgocircular.com). Moreover, under the Integrated Industry Waste Tyre Management Plan, the dealers¹¹, the collectors¹² and the transporters¹³ are encouraged to join the scheme but they should be self-registered to REDISA and it is a free of charge subscription. They are encouraged to be registered

¹⁰ **Tyre Producers** means a person or institution engaged in the commercial manufacture or import of tyres and retreadable casings, and the import of vehicles fitted with tyres for distribution in South Africa

¹¹ **Dealer** implies an individual or entity registered to REDISA that distributes or deals commercially in tyres

¹² **Collectors** implies individuals or organisation registered to REDISA collecting waste tyres and stockpile them and they can deliver to REDISA recycling depots where they receive payment for their services

¹³ **Transporters** means individuals or organization registered to REDISA to pick up waste tyres consignments from the dealers and delivery them to depot and are paid for their services.

due to that REDISA has to inform them about the waste tyre consignments, the locations and payments because REDISA has created a database and mapped waste tyre collection points, stockpiles and depots around South Africa.

If an unregistered individual or organization delivers waste tyres to the depot there will not be accepted and paid because they are not recognized as legitimate contractors or suppliers to REDISA (www.redisa.org.za). However, REDISA knows that there are many unregistered informal waste tyre collectors and transporters who are not visible to the REDISA formal systems but they contribute to the system through some registered stakeholders. The informal waste tyre collectors and transporters usually are collecting and transporting the waste using some trolleys and wheelbarrows (REDISA, 2009).

5.1.2. How the REDISA CE model functions:

This section illustrates how the REDISA tyre waste circular economy function concerning consignment process, the green fee allocation, and the collaboration with various stakeholders.

▪ **Consignment process:**

The registered dealers, are placed on the map of registered collectors, transporters and recycling depots. When a dealer has the waste tyre consignment, REDISA sends mobile phone text message to the appropriate transporters or collectors about the details of the consignment to be collected. The targeted transporter should either accept or decline the offer. If the transporter declines the offer for any reason, REDISA has to pass on the consignment to the next appropriate transporter based on the location and the load type.

Once the transporter accepts the offer, both the dealer and the appropriate depot are notified and all the necessary details are verified from the dealer and the transporter, then the consignment is moved to the depot. When consignment reaches the appropriate depot, verifications are once again done and then the transporter or the collector receives the payment electronically. At the depot, waste tyres are stockpiled ready to be transported to the recycling industry or entrepreneurs for processing. (REDISA, 2013). According to CEO-REDISA (2015 cited from <http://ec.europa.eu>) claims that “*the fleet is not owned by REDISA and the organization has not bought any single vehicle or contract a major logistics company*”.

- **The green fee**

As mentioned before, its mandatory in South Africa that tyre producers and importers of equipment or items that use tyres (e.g vehicles, tractors, etc.) subscribe to REDISA and a waste tyre management fee of R2.30 (Rands) (€0.20) is paid on every kilograms of new tyres coming on the market. The waste tyre management fee is referred to as “*the green fee*” defined by REDISA as a “*non-commercial fee collected by REDISA from producers, importers and equipment importers of tyres for the effective management of waste tyres*” (REDISA, 2009).

REDISA uses part of the green fee to pay individuals and small and medium sized businesses who are registered as collectors and transporters of waste tyres. Besides, the green fee is also allocated for establishment and support for storage depots, recyclers, and secondary industries that are involved in upcycling and downcycling of waste tyres in various marketable products and services (www.redisa.org.za). The **table 7** below illustrates how the green fee of R2.30 (€0.20) is allocated to different stakeholders under the REDISA’s Industry Waste Tyre Management Plan (IIWTMP).

Table 7: REDISA green fee allocation. Source: [REDISA,2009 & Nkosi et al 2013]

Focus area	Allocation	Description
Administration	20%	Helps to run the organization task and other functions
Transporters	38%	Service payment for transporters registered to REDISA to pick up waste tyres consignments from the dealers and delivery to depot.
Depot	19.5%	The fund is used to develop recycling depot in different part of south Africa to stockpile waste tyres ready for processing and other valuable use.
Recyclers	13.5%	Used to support entrepreneurs, both large and small on development of waste tyres saleable products. Providing equipment, building the business where the entrepreneur can do a management buy-out.
Marketing	2%	It used for market research for the products for exploiting new markets and also the acceptability of the waste tyre products. methods used such as field trial, focus groups, survey, interviews, presentations, advertising etc.
Research and development	2.5%	Investing and financing research and development of rubber recycled products to help stimulate the market for waste tyres and their components. For instance, REDISA has established a testing centre at Nelson Mandela Metropolitan University.
Training	1%	Providing education and support for transporters so that their responsibilities in terms of collecting from dealers is clear and hosting seminars and conference concerning waste tyre management and innovation.
Social uplifting	3.5%	Used for providing social responsibility to the various communities such as recycling competition, community waste cleanup initiatives etc.

5.1.3. Collaboration and support initiatives

REDISA collaborates and supports companies, both large and small, who recycle waste tyres into saleable products. The support for recyclers ranges from business plan development, assisting with environmental impact assessments (EIA) and free delivery of waste tyre feedstock to the recyclers. According to the CEO-REDISA (2015 cited from <http://ec.europa.eu>) REDISA provides support by buying equipment, and build the business to the stage where an interest entrepreneur can do a management buy-out.

However, the interested organization have to submit the proposal of how they would recycle the tyres via REDISA website. REDISA also collaborates with both international and local industries that have role in waste tyre management by providing them with a free opportunity to display their technology and innovation around waste tyres on REDISA website (classified).

The intention with the Platform is to provide for a recycling forum where users may engage with one another and with other secondary industry members (www.redisa.org.za). Some of formal upcycling and downcycling enterprises currently collaborating with REDISA are presented in **table 8** and **table 9** below.

Table 8: REDISA collaboration with upcycling enterprises

Upcycling Entrepreneurs	Product type
<p>Ozzy's Eco Décor</p> <p>Ozzys Eco Décor is a South Africa small upcycling enterprise that manufactures unique, functional & decorative furniture from waste tyres</p> <p>http://ozzydecor.co.za/index.html</p>	
<p>Roche.Recycle.Relove</p> <p>Is a South African artist and design company that upcycle waste tyre into products such as lighting decoration, jewelry, rubber trees and furniture for Architecture and green building designs.</p> <p>http://roche-recycle-relove.withtank.com/</p>	

<p>Free Flow Design</p> <p>Is a South African design enterprise that utilizes waste tyre tubes to create upcycled products such as laptop bags, tablet covers, backpacks, handbags, wallets, pencil cases, and sports bags.</p>	
<p>Scarab Cable Protection (PTY) Ltd</p> <p>Is a South African enterprise that uses waste tyres as means to deter cable thieves by protecting and sandwiching copper electric cables on waste tyre strips which acts as an anti-digging device for high risk tunnels, bridges and underground cables. This kind of protection makes it hard for cable thieves to dig up and cut the cable or pull the cable because it is protected by two tyre strips that are bolted and welded together. http://scarabsystems.org/</p>	

Table 9: REDISA collaboration with downcycling enterprises

Downcycling Entrepreneurs	Product type
<p>Dawhi rubber recycling</p> <p>Is a rubber crumbling industry based in South Africa specialized in downcycling waste tyres into different grades of crumble granules which are reused in various products such as road asphalt, pavement, tiles, playgrounds etc. (http://www.rubberrecycling.co.za/)</p>	
<p>Newco recycling pty</p> <p>Is a recycling enterprise based in South Africa with fully operational waste tyre processing facility which downcycle waste tyres into products such as pavers, tiles, and artificial grass (turf) for sport complex etc. (http://www.newcorecycling.co.za/)</p>	
<p>Mathe Group Company</p> <p>Is a recycling enterprise based in South Africa with a fully operational waste tyre processing facility which downcycle waste tyres into rubber crumble and recovery of steel wires. Rubber crumble is used for road asphalt and pavements, roofing tiles, insulation products etc. Extracted steel wires are sold to other industries for making construction reinforcement bars and other steel products. http://www.mathegroup.co.za/index.php</p>	

- **REDISA and waste tyre pyrolysis development:**

Engineeringnews.co.za (2015) informs that pyrolysis for waste tyre downcycling is gaining traction in South Africa and REDISA is behind the adoption and development of waste tyre pyrolysis. Currently REDISA is working hand in hand with Milvinetix company which has been receiving an infrastructure development grant and free delivery of waste tyres from REDISA scheme for the last two years. Milvinetix company is has developed a waste tyre pyrolysis plant which is now processing an average of 180 tons of waste tyres a month (Ibid).

Bayley, (2014b) cites the Managing Director of Milvinetix company that *“the infrastructure development grant paid by REDISA is a solid and reliable source of income. It has allowed us to focus on developing our core business and improving some of our existing infrastructure, acquiring new equipment, and enabling the business expansion”*.

Milvinetix’s pyrolysis plant, processes waste tyres into various products mostly carbon black, oil, and steel. However, currently, the company does have the full capacity and technologies to produce the end products with high quality. Therefore, Milvinetix has engaged in a business to business (B2B) arrangement. So their end products are further supplied to some enterprises that purifies the oil and refine the carbon black into much better quality and marketable products (Bayley, 2014b).

Engineeringnews.co.za (2015) cites the director-REDISA that *“Milvinetix company is certainly proving that pyrolysis is an industry with growth potential in South Africa. Setting up a pyrolysis plant is an incredibly technical and expensive exercise, however, Milvinetix are working hand in hand with REDISA in establishing a new tyre recycling industry*. What is more, REDISA assures that interestingly Milvinetix’s pyrolysis system is not designed only to process waste tyres but also other waste material such as municipal solid waste, electronic waste, rubber, medical waste, plastics etc. (Engineeringnews.co.za (2015).

The next section presents a case study of Scandinavian enviro systems a recycling company based in Sweden that is downcycling waste tyres using a new technology of pyrolysis.

Case study 2

5.2. Scandinavian Enviro Systems (SES)

[The SES case study has been conducted with the intention of having a better understanding of waste tyre downcycling in relation to C2C approach, tyre waste circular economy, and downcycling challenges. The data used to build up the SES case study is based on telephone interviews conducted with SES-CEO and other reliable information gathered from SES website and publication]

5.2.1. Company background:

Scandinavian Enviro Systems (SES) was founded in 2001 and SES began investing in a large scale demonstration plant in Gothenburg, Sweden in 2007 to optimize and verify the modern way of downcycling waste tyres. SES' technology is based on patented pyrolysis technology that was invented by Bengt-Sture Ershag in 1994 known as Carbonized by Forced Convection (CFC). According to SES, the developing of CFC technology was to find a way to recycle tyres in a profitable and environmentally friendly way (www.envirosystems.se).

Since the adoption of CFC, SES has worked with universities and a number of research institutes for verification and development of the technology in order to refine its economies of scale, assure the quality of the end products, and to improve the pyrolysis process. In 2013, a full-scale plant was built in Åsensbruk, Sweden and entered into trial operation in 2014 with a planned technical production capacity of approximately 10,000 metric tons of waste tyres per year (www.envirosystems.se).

The interviewed SES-CEO who had joined the SES in 2013 revealed that the motivation in taking up the position of CEO has been ... *"the interest of being part of building up new technology in a new company and to be part of the environmental friendly company...trying to contribute towards the better world..."* (SES-CEO, 2015). Currently, they are 23 employees working for SES with 16 people running the plant, and 7 people are managers and processing engineers (SES-CEO, 2015). The plant functions as a production and demonstration facility, as well as marketing facility for the CFC technology.

5.2.2. Product processing:

SES submits that the recycling of waste tyres with CFC technology yields oil, carbon black, steel and gas with the following approximate percentages by weight as illustrated in **figure 10**

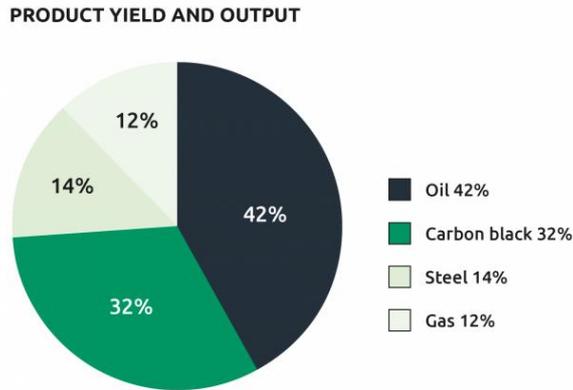


Figure 10: Scandinavian enviro systems products from waste tyre pyrolysis

According to the SES-CEO, their end products do not have the environmental friendly demand or eco labels at the moment. The CEO argued that *“we are not working in the commodity market besides, the so called green in the industrial environmental is not giving any commercial benefits but it’s good and everybody loves it. However, the laws and regulation for processing of waste tyres are ... “quite tough laws for the environment so we are measuring everything and we have to report to the authority how much we are realizing to the nature, ... what we discharging back into the water and how much we polluting out in the air particles sizes and everything”* (SES-CEO, 2015).

SES takes care of the environment and the society by measuring continuously, also the external consultant are measuring two to four times per year and the reports are submitted to the authorities (SES-CEO, 2015). Therefore, the CEO claimed that end products and services are green because *“a green product or service is one that’s not giving the negative impact to the environment and society... and should be one that is not producing too much waste and ... should come from the circular economy”* (SES-CEO, 2015).

Currently, SES have no other processing plants somewhere else because the technology was almost ready last year and they have just started to promote it out. However, the CEO mentioned that the company has so far attracted a lot of interest all over the world because of CFC technology in relation to waste tyre business opportunity (SES-CEO, 2015). The CEO stressed that *“our basis of our company is the technology... and also the market demand for our products”* and these have been the SES determining factor for product and service innovation (Ibid).

When it comes to the raw material for processing that is waste tyre, the CEO mentioned that in Sweden, there is more less a monopoly in collecting waste tyres from the collection depots (e.g. garages) (SES-CEO, 2015). According to SES, the price of a metric ton of waste tyres in Sweden is around SEK 350, yet this volume generates saleable end products with a value significantly in excess of this price.

SES estimates that the selling price of raw materials recovered by the process can run to over 3500 SEK per metric ton of tyres fed into the process (www.envirosystems.se). SES claims that *“the operating cost is relatively low compared to the value of the end products, the process harbors significant profit potential”* (Ibid). **Figure 11** below illustrates the selling prices of end products and the profitability.



Figure 11: Illustration of prices from waste tyres to products by SES. Source: SES website

SES reports that the market price of the waste tyre products are steadily rising every year creating a very positive economic situation. As a result the company is ready to cooperative with other partner to build recycling plants all over the world; because the end products have high profitability and the pay-back time of the plant can be achieved within a short term (www.envirosystems.se).

However, the CEO stressed that setting up a waste tyre downcycling factory in developing nations especially in Africa nations is challenging. This due to that someone needs to understand how the waste tyres system and infrastructure looks like and to understand the investment needed (SES-CEO, 2015) ... *“it’s a big investment to build the factory, so a lot of people who are calling me up to say we would like to build up the partnership, some of them are what we call lacking researching people”* because they not understand the collection system and the challenge concerning the processes needed to acquire the permission as well as setting up the a new technology especially in developing nations (SES-CEO, 2015).

The SES-CEO pointed out that the difference between developing nations and developed nations is that *“it’s very easy to find tyres in Europe as compared to African or other developing nations... there is a challenge in the way of getting the waste tyres in many developing nations.*

While in Europe that is not really a problem because it has been decided that waste tyres should not be disposal off tyres...in all European countries”. Therefore, ... they have built up collecting points where you can get tyres ...but when it comes to Africa this is a problem of course...”(SES-CEO, 2015).

The SES-CEO sees that the current and the future potential of processing waste tyres as business model is brilliant and very promising at the moment and in the near future especially with Carbonized by Forced Convection technology. SES-CEO claimed that *... as far as waste tyre pyrolysis is concern, is Scandinavian Enviro Systems plant that they have seen in operation and performing very well...SES is one company that is advanced in this technology process... and our customers are absolutely satisfied with SES products and services”* (SES-CEO,2015).

Furthermore, SES is also receiving the positive reaction from the general public because of working in the processing industry where people are saying that this is really good for the environment and its good for the world as well (Ibid). The CEO claimed that SES downcycling process and business activities share an example of the *“circular economy”*... by emphasizing that the company takes back waste in the into the production and processing stream to create new materials as result minimizing the consumption of raw materials by using secondary material that is waste tyres, *...it’s an interesting process”* (SES-CEO, 2015).

Nevertheless, the CEO emphasized that it is very important to educate people collecting tyres, that for SES, a waste tyre is are not considered as waste ... *“but as a raw material because in the circular economy there is no waste ... Actually, SES is not in the waste industry we are in the process industry”* (SES-CEO,2015).

According to the CEO, some the challenges that SES has encountered as a waste tyre processing industry are issues regarding the regulations around the new technology that is the CFC. CEO highlighted that the authorities are extremely slow when it comes to understanding the new technology and processing the permits (SES-CEO,2015). The CEO believes that *“the authorities and government are living with the old technology”*... therefore they are very slow in adapting and understanding what’s going on... *as a result the regulation around this kind of situation is not really the fastest to implement especially when you the first doing it”* (Ibid). *“It’s very hard for the authorities to adapt to the new technological systems”* (Ibid).

Moreover, the CEO informed that this situation is also being encountered not only in Sweden by also in many other countries. *“...it takes two to three years to get the permission and to build the factory for downcycling of waste tyres with a new technology and that’s not viable”* (SES-CEO,2015).

5.2.3. Carbonized by Forced Convection and product processing

Scandinavian Enviro Systems claims that Carbonized by Forced Convection (CFC process) is the fast, efficient and environmentally friendly technology for recycling of waste tyres. SES defines Pyrolysis as the thermochemical decomposition of organic materials at elevated temperatures in the absence of oxygen (www.envirosystems.se). The processing of waste tyres at SES with the CFC technology is done as follows:

Shredding process: The pyrolysis CFC process starts by loading waste tyres into shredding machine and the shredded waste tyres are conveyed and load into a reactor. There are two reactors which are interchanged to allow heating, cooling, emptying and filling for continues processing. To decrease and remove the oxygen, the reactor must be purged with nitrogen prior to heating using a valve and a blower creating a circulating gas heated at 600 degree Celsius through a heating unit, and the gas is entered into the middle of the reactor through a perforated pipe (www.envirosystems.se, Raja, 2012).

Cooling process: Two coolers are used for process of pyrolytic gas and oil, the first heat exchanger (cooler) is used to condense the gasified oil into pyrolytic gas from the shredded rubber in the reactor using thermal oil. Further, gasified oil is passed to the second heat exchanger and its cooled using water into oil. Some gases does not condense and those gas are pass through a cyclone and then returned to the blower to be used in the heating unit (Ibid).

Magnetic Separation: From the reactor, a mixture of carbon and steel wires are then passed through the magnetic separator where steel is extracted from carbon and steel stored as a product (Ibid).

Milling process: After the magnetic separation, the carbon is passed further into a milling machine and then the carbon is micronized into carbon black powder (Ibid).

Pelletizing process: The carbon black powder produced from the milling process is passed through the granulating machine to convert carbon black powder into pellets using water or oil (Ibid).

Drying process: When water is used for pelletizing, then the pelletized carbon black is passed through the dryer otherwise the drying process is not utilized (Ibid). **Figure 12** created by the author illustrates the CFC processing and end product.

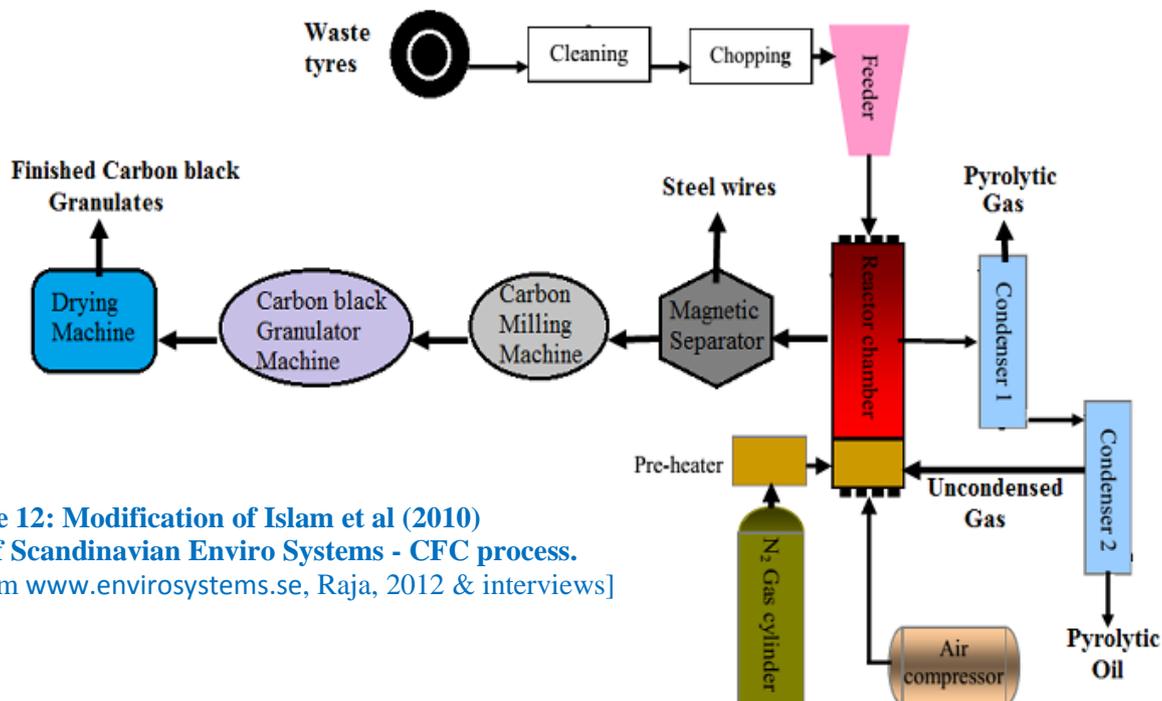


Figure 12: Modification of Islam et al (2010)
Illustration of Scandinavian Enviro Systems - CFC process.
 [Source: Info from www.envirosystems.se, Raja, 2012 & interviews]

SES emphasizes that the CFC technology is different from the traditional pyrolytic process in that pyrolysis gas is used as a heating medium and is in direct contact with the reacting organic material (www.envirosystems.se). SES stresses that with CFC “the entire mass is heated at the same time and maintains an even temperature, which makes the process controllable. This is a key factor in the process, and constitutes the difference between CFC process and traditional pyrolysis” (Ibid).

What is more, in the traditional pyrolysis, the reactor is heated from the outside with the organic material, leading to uneven distribution of the heat, and making the process difficult to control. This may result in lower-quality end products (SES-CEO, 2015, www.envirosystems.se). **Figure 13** below illustrates the difference between the traditional pyrolysis process and the CFC pyrolysis process.

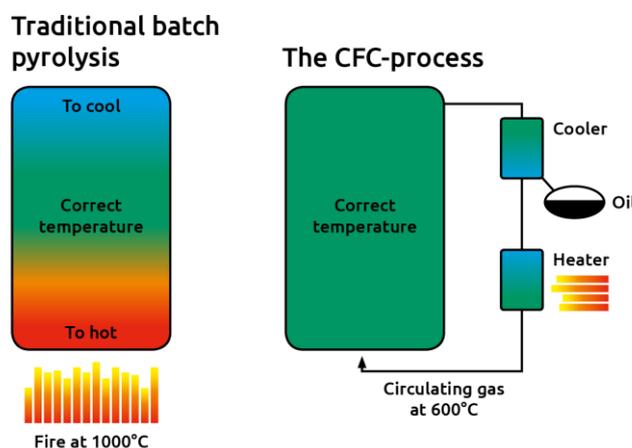


Figure 13: Illustration of differences between traditional pyrolysis & CFC process.
 [Source: Info from www.envirosystems.se]

Case study 3

5.3. Giving and Living enterprise

[Giving and living company case study has been conducted with the intention of illustrating formal entrepreneurship of upcycling of waste tyre in relation to C2C approach, and tyre waste circular economy. The case study also tries to illustrate the challenges and opportunities of waste tyre upcycling in terms of innovation and entrepreneurship. The data used to build up the case study is based on face to face semi-structured interviews conducted with the owner of Giving and living and part of the information obtained from the company website and brochure]

5.3.1. Company background:

Giving and living (G&L) is a Danish design and wholesale company based in Copenhagen and founded in 2001. The company is managed by two owners and they have one employee working in the wholesale as a stock manager. Besides, the company also outsource a freelance designer and an accountant. Giving and living is mostly known for its “Dacarr collection” that is the range of rubber waste tyre crafted baskets, travel bags and flower pots. The Dacarrs collection are sold to their customers who are mostly “European furniture and design stores, handicraft and gift shops, nurseries and designer florists” (G&L-Owner,2015) in Denmark, Sweden, Norway, Finland and Germany and the company has established agents in this countries. In addition, the products are also sold to individuals that orders from the website and the products are also marketed by going to professional trade fair shows (Ibid) as indicated below:

- *Formland trade fair:* the Trade Fair for Skandinavian Design, Table Top, Giftware, Handicraft & applied, held in Herning Denmark.
- *Formex trade fair:* the Trade Fair for Design-led Gifts and Interior Accessories from Scandinavian Textiles, Tableware, Folk Arts and Crafts, Toys, General Gifts, Paper which held in Stockholm, Sweden.

The price of the dacarrs range from DKK¹⁴ 28 (single item) to DKK 550 (set of 3or 4 items) as illustrated in the photo below:

[Images obtained from Giving & living brochure 2014-2015]



[“Our customer don’t like it when it too perfect it has to have that handmade feeling because that goes well with upcycling... and our company is alone on the market in Denmark (G&L-Owner, 2015)]

¹⁴ DKK- Danish currency known as kroner

According to the G&L-owner, the motivation to get into waste tyre upcycling was due to that *“we found the products made from waste tyres to be very cool and it was new and we liked it that it was recycling. we also could see a lot of possibilities of developing new products both for indoors and outdoors from waste tyres”* (G&L-Owner, 2015). Today, people appreciate Giving and living innovation very well and the company is looked as the promoters in the way of living and doing business using recycled material in Denmark (Ibid). Also, the owner insisted that they are as well perceived as one of the leading company in upcycling in Scandinavian (Ibid).

5.3.2. Business analysis:

Currently, Giving and living has a big wholesale (as shown in see photos below) in Copenhagen were they stock their products coming from the contracted supplier in Vietnam, and it is also used as packaging place for product deliveries to their various customers and agents.



[Photos taken by author showing G&L wholesale with collection of Dacarrs in Copenhagen, Denmark (2015)]

The owner revealed that Dacarrs collection are the products mostly on demand and selling well on the market for the company today because they can be used for different things such as fire wood and other stuffs. However, the owner believes that currently, the company lacks the innovation in terms of upcycling of waste tyres in various marketable products. Therefore, the Owner stated that it would a great idea to come up with completely new concepts but the challenge is that *“I don’t have the time to make the big thinking because I am almost doing everything myself... so I sometimes need people from outside to tell me what should I do to survive the next coming years”* (Ibid).

However, the Owner emphasized that the determining factor for the product innovation in their company has been the market demand. *“In the beginning the Dacarrs were seen as innovation but I think where we are now I would benefit to rethink a new concept and that’s a challenge right now because currently some of the products are ten years old, but they still sell very well because they have become classic products now especially the Dacarr collection”* (G&L-Owner,2015).

Nevertheless, the Owner pointed out that they listen very much to what their customers ask for and also sees the new trends in the market to try to come up with some new ideas using the same waste tyre materials. Actually, *We want to be perceived as a design and living company, with good style and design, and we see diversity as an important factor in upcycling business, like to try new products created from waste”* (Ibid). However, the company believes that *“being simple in the upcycled products is the best solution because people will not pay for a lot of extras”* (G&L-Owner,2015).

5.3.3. Product processing:

The company cooperates with a wide range of arts and craftsmen from minority communities in Asia who are contracted to upcycle waste tyres into various products which are exported to Denmark for sale. The company has been working closely with supplier from Syria for 5 years, however, the cooperation stopped when the civil war broke out. Currently, the company is cooperating with a new contracted supplier, a small family business in Vietnam residing in the country side (G&L-Owner, 2015). The Owner stated that they are always visiting the production area of the contracted small business family even though it’s very far out to make sure that there is no child labour and that everything is under control (G&L-Owner, 2015).

The investment required to set up a waste tyre upcycling company is low because the material is cheap and easy to find particularly in developing nations like Syria and Vietnam (Ibid). As a result *“we have quite a good margin on the products because the material is so cheap...basically it’s the manpower and shipping we pay for only, but the manpower in Asia is also cheaper”* (G&L-Owner, 2015). The company buys waste tyres from various individuals, tyre dealers and also from auction sales in Vietnam as they did in Syria and stockpile them for production as illustrated in the photos below. The typical production tools used by upcycling contractors both in Vietnam and used in Syria as well for production are cutter knives, hook awl stitch, and pair of pliers, and other simple hand tools as illustrated in the photos below:



Photo obtained from Giving & living illustrating the collected waste tyres in Syria for processing by contracted upcycler



Photo obtained from Giving & living illustrating improvised tool for cutting waste tyres in Syria for processing by contracted upcycler



Photo obtained from Giving & living illustrating the improvised tool for removing rubber layer from tyres for processing by contracted upcycler in Syria



Photo obtained from Giving & living illustrating the contracted upcycler stitching the Daacar in Syria

The owner revealed that though the manpower is cheap, the workers actually do a hard work to product the products. Therefore, we have tried once to change the production process but it didn't work. For instance, *“we bought a machine that could press out the materials from the waste tyre easily for the contractors in Syria, but the never used it because they want to cut out by hand even though the machine was fast and efficient, they seem to just like the way of manufacturing by hand and feeling the materials. So sometimes it's better to listen to the locals on how the doing the things”* (G&L-Owner, 2015).

5.3.4. Challenges facing the company:

Since the company have contractors and suppliers from the developing nations such as Vietnam and Syria, the Owner mentioned that building trust with contractors is a challenge. The owner pointed out that it is very important for their business to find contractors/suppliers that they can work with for a long time and rely on. The most important thing is to develop a constant production and supply and building an effective communication in order to get products on time and with good quality (Ibid).

Actually, an effective communication and trust is very vital for Giving and living ... *“because we need to start pressing orders by email not just to go there to Vietnam or Africa every time we need the order so we have to make sure the communication is working and we have to tell them to give us good prices ... that we can rely on for the next two years for example”* (G&L-Owner, 2015).

The Owner complained that the other challenge is replication of their products by the local entrepreneurs in Vietnam. *“we have seen our products completely copied because they can go to our website see all the measurements so when we go to Vietnam on the trade fairs we can see our products completely copied and ...they supply the same products like ours to other companies and customers in Europe...”* (G&L-Owner, 2015).

The other challenge is concerning the unstable currency in the countries where production is been done like in Vietnam. The Owner insisted that the currency rate in Vietnam are not raising slow like in Europe because it's not regulated and that makes it difficult to do business with the suppliers/contractors sometimes. The company owner also mentioned that the other challenge they are facing is concerning company expansion in terms of investment whether it should be done by getting more customers by... *“introducing more products or to expand by going into new markets with the current products”... or simply by investing into human capital so that the company can focus on being more creative and innovative* (G&L-Owner, 2015).

5.3.5. Environment and health concerns:

The Owner sees Giving and Living business services in terms of waste tyre upcycling as a positive business activity when it comes to environmental and health issues. The Owner stated that it's very good that the tyres are used to make products instead of just being thrown in the streets because waste tyres can be bleeding place for mosquitos that cause malaria outbreak especially in developing nations. Furthermore, stated that using waste tyres to make products also reduces the reckless practice of burning tyres and illegal dumping on land and water especially in developing nations.

The Owner revealed that some of their customers are concern about the health risks with waste tyre products because *“some of our customers ask whether its health to have tyres products in the house... and being in contact with people and pets... whether it's safe or gives allegoric reaction”*(G&L-Owner, 2015). However, the owner argued that *“since our products are made from recycled material we can actually make a test of one product but am not sure that the test will be similar to the next product because it comes from other tyre from another supplier and sometimes we don't even know which tyre manufacturers the tyres comes from”* (Ibid).

So it's very hard to make a specific test which can actually produce some results to depend on for rest of the products. Therefore, the only control to limit the health risk that the company considers is by making sure that the production materials (waste tyres) are properly washed and if they there is any allergic reaction encountered by their customers, they are obliged to return the products and get the refund (G&L-Owner, 2015).

Currently, the owner informed that their products are not certified or have any environmental friendly demand or ecolabels and this is due to that ...”*still we don't know where the tyres are coming from. So I would like if the authorities could be more helpful for companies like us doing the recycling because I think there is no much help in guiding us on how to get certification concerning environmental and health approval*” (G&L-Owner, 2015). However, the company owner insisted that Giving and Living company image can be seen as “*green business idea... because green products should be related to products made from recycled materials and it could be good if we could get some kind of certification to indicate that we are actually a green company in Europe ... because today a lot of companies are calling them green without really being green*”(Ibid).

Case study 4

5.4. Waste tyre informal entrepreneurs (Lusaka city)

[This case study presents analysis of the semi-structured interview and participatory observation conducted with three different informal waste tyre upcycling entrepreneurs in Lusaka, Zambia. The intention of carrying out this case study was to understand and to illustrate the role of informal sector in relation to building up a circular economy. What is more, to try to understand and to illustrate the challenges and opportunities faced by informal entrepreneur dealing with waste tyre upcycling. The data used to build up the case study is based on face to face interviews and participatory observation. In addition some data from the previously conducted internship research study in the Lusaka while looking at the best available practice and the best available technology for managing waste tyres has been used to illustrate the solid waste management model in Lusaka city, Zambia]

5.4.1. Informal enterprises:

Three informal waste tyre upcycling entrepreneurs based in Lusaka, Zambia were interviewed and observed for a period of one month which were *Auto rubber innovators, tyre sandal makers and tyre & tag shoe innovators*.

Auto rubber innovators was established in 2010 and it has five members. The main activity the author focused on was the production of *rubber strut spacers* which are used for the suspension system on the vehicle to provide a lift to the vehicle chassis in order to be secured when going over road humps, road pot holes and bumpy roads. According to Auto rubber innovators, before they were making strut spacers from aluminum but *“the customers complained that aluminum was wearing out vehicle chassis specifically at an area between where the strut aluminum spacer and the car chassis made contact due to the friction”* (Auto rubber innovators, 2015).

Consequently, one of the their member suggested an idea of rubber strut spacers made from waste tyres and rubber conveyor belts that he had head of being created by one entrepreneur. *“One guy was making strut rubber spacer but the vehicle owners didn’t know about it because the guy didn’t promote and was not so serious, so we tapped into this idea and we noticed that the vehicle owners were interested and buying them”* (Auto rubber innovators, 2015). However, they had to carry out several experiments to find out how easy they can make the perfect and good quality products (Ibid).

Tyre Sandal makers is a small scale informal enterprise established in 2008 and it has four members at the moment. The main business activity is the production of sandals using waste tyre rubbers and the enterprise operates as the wholesaler as while as the trader (tyre Sandal maker, 2015). The production workshop is located in the Kanyama shanty town of Lusaka city.

The founder of the tyre sandal makers revealed that the establishment of waste tyre business activity was due to personal family issues concerning livelihood and *“I learnt on how to make these kind of sandal by just trying and looking at how others have done it... and my family pushed me to take up the challenge”* (tyre sandal maker, 2015). The interviewee claimed that they don’t think that they have competition with other shoe makers because people who buy waste tyre sandals are just a certain type of people who appreciate green products (Ibid).

Tyre and tag shoe innovator is an informal shoe maker located in Kabanana compound of Lusaka city. The shoe and tag innovator established the business in 2010 and it have two members that have come with an innovation to make shoes using waste tyre for the shoe sole and the top part of the shoes are covered with identity card tag holders and old jean clothe materials.

The shoe innovator owner stated that the innovation of the shoe came about due to his artist background as a painter and drawing artist. *“ the type of shoes I have been imaging and drawing inspired me to create and put my drawn up shoe into reality and turned the idea into business.*

But to be more innovative I chose the idea of turning trash to cash... I call my business activities as; war on the waste for survival”(tyre & tag shoe innovator, 2015).

The interviewee stressed that they have specific customers and mainly there are football fans. Therefore, ...*“we use a lot of different football clubs identity tags holders to the shoes and we are selling the products through networking and Facebook to our customers”* (Ibid). The interviewee currently don't see anyone as a competitor because their product is unique and innovative. the interviewee claimed that they have received many positive reactions and compliments *“that it's an innovative way of creating shoes from waste materials and promoting recycling especially in Zambia where recycling is not yet appreciated* (Ibid). **Table 10** below illustrates the business activities, products and tools being used by the three entrepreneurs.

Table 10: Informal waste tyre enterprises, products & tools

Informal enterprise	products	Processing Tools
<p>Tyre sandal makers:</p> <p>Initial investment in 2008 for 20 EUR</p> <p>The wholesale price for one pair of sandal is 5 EUR and the retail price is 6 EUR for one pair.</p>	 <p>Per day they produce about 20 pairs of sandals and the highest demand they have once reached was 100 pairs of sandals. The production rate depends on the order pressed by the traders selling the sandals in the streets.</p> <p>[Foto taken by the author in Lusaka, Zambia 2015 showing informal sandal maker using waste tyres]</p>	 <p>The tools being used are hooks for removing fibre strings from the tyre, a pair of piers, cutter knives, sand paper, & hook awl stitch. Most of the tools are just improvised depending on the type of material extraction.</p> <p>[Foto taken by the author in Lusaka, Zambia 2015 showing some of the tools for extracing material from tyres and for stitching the products]</p>

Auto rubber innovators:

Initial investment in 2010, for the strut-rubber spacer business was 50 EUR.

Four pieces of strut of rubber spacers make one set and a set cost 18 EUR .



[Foto taken by the author in Lusaka, Zambia 2015 showing strut spacers made of aluminum and the newly introduced rubber strut spacers made from waste tyres and conveyor rubber belts]

The production rate depends on the order pressed by the customer however, the interviewee stated that they can produce about six sets a day that is about 24 pieces.

Rubber strut spacers are placed on the suspension Spring shown in the photo.

[Foto taken by the author in Lusaka, Zambia (2015) showing the vehicle suspension where the strut spacers are placed to elevate the vehicle chassis]



To make holes on the rubber strut spacers, they have come up with an improvised tool made from steel bars and sharpened that is heated on the charcoal brazier to become hot in order to easily go through the rubber strut spacers to create holes as illustrated in the photos.

[Foto taken by the author in Lusaka, Zambia (2015)]

Tyre & tag Shoe innovators:

Initial investment not known

A pair of shoe is sold for 26 EUR, and makes a profit of 10 EUR



Currently, the production is just done at home and due to lack of proper tools and equipment, usually two pair of shoes are produced per day. However, if the customers have pressed many orders then sometimes they can achieve to many four pairs per day but it takes a long time processing.

[Foto taken by the author in Lusaka, Zambia (2015) showing some of the shoe models made by the shoe innovator using ID tags and shoe sole made from waste tyres]



The tools that they use are manual sowing machine, a pair of scissors, cutter knives, a pair of pliers, shoe modeler, hammer, shoe maker rasp, hook awl stitch, sand paper, screw driver etc. as illustrated on the photo

[Foto taken by the author in Lusaka, Zambia (2015) showing the tools the shoe innovator uses to manufacture the shoes]

5.4.2. Product processing:

Tyre sandal makers: Production of sandal from waste tyres has been in existence for a long time in Lusaka city and around Zambia, so it's not a new innovation (tyre sandal maker, 2015). It has practiced especially in rural areas and villages where people made tyre sandal shoes to protect their feet when walking in the bush. Due to lack of proper tools for extracting the material from the tyres, the tyre sandal makers have resorted to using different methods and tools.

To illustrate, the layer of fiber cotton is cut off using the cutter knife (photo A) then part of the tyre strip is pressed under the car tyre to hold the waste tyre firmly due to the weight of the car (photo B) and then the layer of fiber cotton is extracted by pulling off from the waste tyre (photo C) as illustrated below. The fiber cotton layer is used for making the top of the sandal belts and the cotton is also used for stitching. According to the owner stated that *“we use about three truck tyres per week... and the waste tyres can be found easily and the investment in the material and tools is very small”*(Ibid).



Photo-A sandal maker member cutting off a layer of cotton using cutter knife.

Photo-B: Tyre strip is pressed under the car tyre to clamp the tyre strip firmly when the layer of cotton fiber is being extracted.

Photo-C: Members of tyre sandal maker enterprise extracting the cotton fiber layer by physically pulling it off.

[All the photos taken by the author, in Lusaka, Zambia (2015)]

Tyre & tag shoe innovator: According to the owner, to produce a shoe 20 pieces of identity tags string are used which are cut into different pieces for the front part and back part of the shoe. Then they are sown together using the manual sowing machine, and then attached to the shoe sole made from the waste tyre as illustrated in the photos below. The interviewee stated that it's very easy to make shoe sole from waste tyres.



Photo-D: Shoe innovator stitching together ID- tags to make top shoe layer using a manual sowing machine. cutting off a layer of cotton



Photo-E: A piece of waste tyre that is used to create the Shoe sole.



Photo-F: The finished product created by shoe innovator.

[All the photos taken by the author, in Lusaka, Zambia (2015)]

Auto rubber innovators: The interviewee stated that the materials used to produce the strut rubber spacers are locally available and very cheap to acquire . Furthermore, claimed that the investment is small so the business of selling strut rubbers spacer is very profitable because of cheaper material and cheaper production methods (Auto rubber innovator, 2015). The production process involves assigning about 3 to 4 members to carry out the production which involves cutting the rubber from the tyres to the required strut spacers size. As well as preparing the charcoal brazier for heating up the improvised sharpened steel bar tools for pricking the holes on the spacers. Once the holes have been made, two pieces of strut rubber spacers are glued together in order to achieve a certain required thickness. Photos G, H & I below illustrates the process.



Photo-G: A member of Auto rubber innovator cutting a piece of waste tyre to create a strut rubber spacer using a cutter knife.



Photo-H: Another member making holes on the strut rubber spacers using an improvised steel bar heated on the charcoal brazier.



Photo-I: The third member applying glue to attach two pieces of strut spacer to increase the thickness as required.

[All the photos taken by the author, in Lusaka, Zambia (2015)]

Auto rubber innovators enterprise has no established workshop to manufacture their products, therefore, the processing activities are done within the city behind the buildings in isolated areas. For trading, they have their business activities “...positioned to close to the hardware shops selling auto spares parts and other accessories, because we can get the customers that way and that’s the way the strut rubber spacers business have come to be known to different car owners” (Auto accessory, 2015).



An isolated area behind the shops in Lusaka city, it is an ideal place for strut rubber spacers production of being close to trading place just in front of buildings.



The strut rubber spacers being sold in the street and the trader has located their business just next to the formal hardware stores.

[All the photos taken by the author, in Lusaka, Zambia (2015)]

5.4.3. Environmental and Health concerns:

All the three interviewed informal enterprises acknowledged that the waste tyres management in Lusaka is a big challenge because there is no one from the formal sector who is engaged in carrying out the collection and recycling of waste tyres. People just dispose of the used tyres illegally in places such as waste drainage system, open areas, and even setting the tyre on fire (Tyre sandal maker, 2015, & tyre/tag shoe innovator, 2015). According to one interviewee, the most health issues concerning manufacturing of strut rubber spacers is inhaling of thick smoke produced when making the holes on the product because “we are burning the rubber when we make the holes with hot steel bars and that produces thick smoke and its very toxic” (Auto rubber innovator, 2015). The only precaution to avoid inhaling the smoke is by “carefully checking the direction of the wind, but wind direction is unpredictable... so you keep on turning and changing position and in the process you can burn yourself with the very hot steel bar ” (Ibid).

What is more, all the interviewed informal enterprises have revealed that accidents such as cutting themselves with a cutter knives have happened before and a member of Auto rubber innovators remembered that *“one of team member ended up in university teaching hospital (UTH) in Lusaka because he injured himself so badly with a cutter knife and the injury required many stitches*). Furthermore, other interviewee from the tyre sandal maker also stressed that due to lack of proper tools, *“pulling the textile cord layer from the tyres gives backs-pains”* .

All the interviewees indicated that they need some proper tools as well as personal protective equipment but they usually see that as an additional costs and they don't trust the quality of the equipment/tools that are now on the market especially those coming from China, though they are the cheapest and affordable. *“The personal protective equipment and tools from China are very cheap but they are not durable, so you can keep on buying and losing your money”* (tyre sandal maker, 2015).

When the informal enterprises were asked whether they consider their products and services as green, they stated that when a product is made from recycled material then that product should be regarded as green product and the activity as green service. A member of the auto rubber innovator insisted that *“our products are green products... it's just the production methods which are not good for our health because we lack equipment, tools and capital to invest in proper production”* (Auto rubber innovators, 2015). The informal enterprises also highlighted that their services somehow prevents waste tyres to be illegally disposed of, and *... that is good for the environment and the society in terms of waste tyres management and creation of small businesses* (tyre sandal maker, 2015).

5.4.4. Towards extended producers responsibility in Zambia

Zambia has established regulations, policy and national strategy for solid waste management that was enacted by Zambia environmental management agency (ZEMA), ministry of the local government and housing, and the ministry of tourism, environment and natural resources. In 2011, through ZEMA, Zambia legislated the principles of extended producer responsibility (EPR) in its regulatory framework (www.unep.org, UNEP & Environmental council of Zambia, 2011). However, the full implementation has not yet been achieved (Ibid). Basically, the recycling activities of certain solid waste such as paper and reuse of beverage bottles for beers and drinks exist in Lusaka. Yet, waste tyres illegal disposal, waste tyre illegal burning and waste tyres reaching the landfill is a concern activity in many parts of Zambia.

Therefore, the cradle-to-grave management of solid waste continues and it remains a challenge for policy makers, companies as well as the households (www.unep.org).

Figure 14, illustrates the Lusaka city solid waste management model (SWMS) that tries to encourage entrepreneurship, continuous solid waste management and stakeholder participation. The model was established by the author using interviews data, websites and analysing of different literature about solid waste in Zambia.

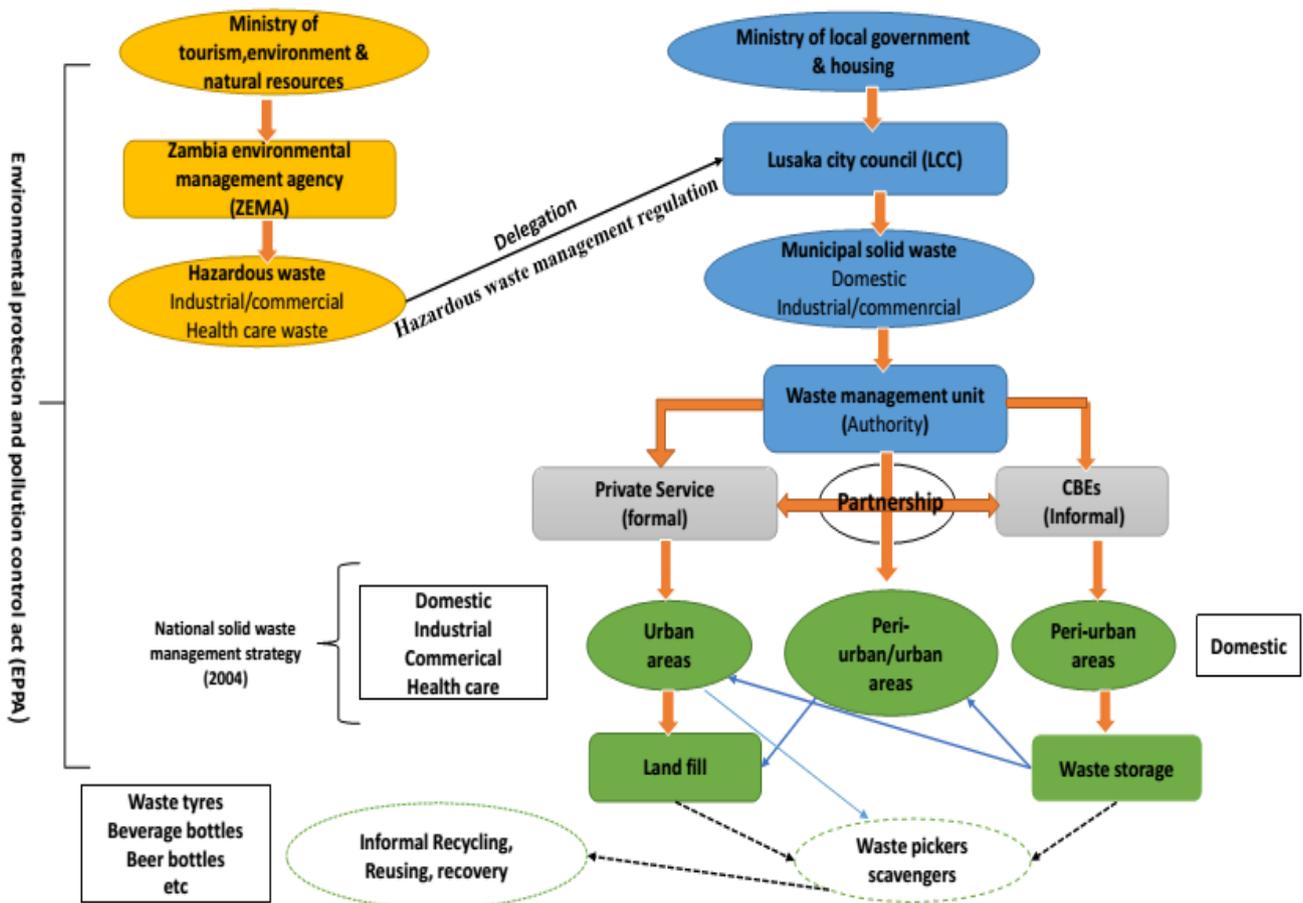


Figure 14: Illustration of Solid waste management system in Lusaka City
[Composited by the Author, 2014]

Zambia environmental management agency (ZEMA) is a regulating institution which falls under the ministry of tourism, environment and natural resources. ZEMA directly regulates hazardous wastes and it has the possibility of delegation of such functions to the Local Authority (Mulenga, 2014, Sibanda, 2010).

ZEMA is responsible of licensing of waste collectors and transporters, compliance, monitoring and attending to public complaints and emergencies (www.zema.org.zm). While, the municipal solid waste management is the responsibility of the local authority that is Lusaka city council under the ministry of local government and housing Sibanda, 2010).

The Lusaka city council has an established waste management unit (WMU) as a board responsible for managing municipal solid waste in urban areas and peri-urban in Lusaka city through stakeholder collaboration, contracting and providing support for collection and disposal of waste to the landfill (Mulenga, 2014, www.lcc.gov.zm). WMU is “*mandated to plan, organize, execute (directly or indirectly) and supervise waste management services in other selected areas in the City and the management of disposal site*” (www.lcc.gov.zm).

The environmental protection and pollution control act (EPPCA) of 1993 and hazardous waste management regulation of 2001 provides specific procedures and practices for waste generation, storage, transportation and final disposal (Sibanda, 2010, www.zema.org.zm). Moreover, ZEMA, in 2004 developed a national solid waste management strategy (NSWMS) with the support by Norwegian Government which categories different type of wastes into domestic, industrial, commercial and health care (Environmental council of Zambia, 2004).

5.4.5. How the waste management model for Lusaka city functions:

The waste management unit (WMU) collaborates with formal and informal enterprises through legal contracts and agreement on collection and disposal of solid waste from urban and peri-urban areas. Formal enterprises are registered solid waste service organisations while informal enterprises are Community based enterprises (CBE). Herein, the Author defines peri-urban areas as unplanned settlements surrounding the city or town established by low income people and poor people as a result of urbanisation; with the living conditions perceived as unhealthy and risk due to poor housing, poor sanitation, and poor environment conditions.

In the peri-area the CBEs` collaborates with the WMU and they are the primary collection of waste from individual households. CBEs collects and transport waste to the communal dump site at an agreed monthly fee collected from the household, and part of the money is paid to the WMU by CBE as per agreement (Phiri, 2014, LCC & ECZ 2008, Munthali, 2006). WMU have established the communal dump site as intermediate storage for primary collected waste, which is then collected as secondary waste by WMU to be disposal of to the designated landfill.

While in the urban which are planned, the collection of waste is done through franchise contract system with formal enterprises and residents in urban areas pay a fee for the services every month. Depending on the condition, some contracted formal enterprises disposal off at some intermediate dumpsite and some pick waste from intermediate dumpsite to disposal of at the designated landfill for a certain applicable fee (Phiri, 2014, LCC & ECZ 2008, Munthali, 2006). Lusaka city, has only one engineered designated landfill known the Chunga dump site for disposing off all kinds of waste (DANIDA, 2010, LCC & ECZ, 2008).

Besides, *waste picking from dumps* usually referred to scavengers who sort through wastes prior to being covered, at the landfill or dump sites actively involved and indirectly part of the model. Pickers of discarded waste have a role to play even though they are not recognised in the waste management system as legitimate stakeholders.

Actually, the author observed that waste pickers are the ones mostly collecting waste tyres, plastic and beer glass bottles selling them back to individuals and enterprises dealing producing bottled drinking water and supplying beers. What is more, the waste pickers are also collecting used tyres from landfills, industries and residential areas that are in some good conditions to be sold to the vehicle owners and also to informal businesses dealing with waste tyre upcycling.

5.4.6. Informal solid waste recycling:

Many Africa developing nations like Zambia, if the local authorities are incapable to effectively address the solid waste issues, the formal and informal enterprises have been seen coming to take up some of the activities. However, due to lack of equipment, technology and poor infrastructures for collecting, storing, recycling and disposal of wastes, there very few established formal enterprises engaged in solid waste management as observed in Lusaka, Zambia.

On the other hand, informal enterprises and individuals were mainly observed to be engaged in many different solid waste collection and recycling. The observed informal enterprises and individuals were collection solid waste from different illegal dumpsites, designated dumpsites, and even from landfill.

The observed informal sectors activities reflected Klundert & Lardinois (1995) and Wilson et al (2006) research studies concerning informal sector waste collection and recycling activities. They research studies reveals that they four categorizes of informal waste collectors as explained below:

1. *Itinerant waste collectors*: They collect recyclable materials from households and from mixed waste in communal bins and sometimes just buy or barter for the unwanted materials. Once they acquire waste or unwanted materials, they deliver to the appropriate buyers, users or recyclers at a certain fee.
2. *Street waste pickers*: They pick up or recover discarded waste materials from a mixed of waste thrown on the streets, roads side or from communal bins and trash pits. The recovered waste can be reused or upcycled for personal use or if the picked up item is in good condition or can be by other individuals it can then be traded for cash.
3. *Municipal waste collection crew*: They recover waste materials from vehicles transporting municipal waste and also from the dumpsites and landfills. The individuals involved in these activities usually have specific material they collect and they have established buyers. For instance, in Lusaka, Zambia, municipal waste collectors recover certain beverage plastic bottles (water bottles), plastic containers and glass beer bottles which are washed and reused again.
4. *Waste pickers from dumpsites*: Also referred to as scavengers usually sort through wastes prior to being covered, at the landfill or dump sites. Scavenging is often associated with people living in peri-urban areas close to the dumpsites or landfills. They pick up various waste items whether for people use, trading, and as a treasure due to a matter of interest.

CHAPTER 6

[This chapter presents the discussion part of the thesis which is divided into four sections as follows; reflection on informal upcycling, reflection on the formal upcycling, reflection on downcycling business model and then a reflection on the best available model (BAM). Each of the section details the discussion of four types of entrepreneurship in accordance to the findings from the case studies]

6. Discussion

[The four sections mentioned above are further divided into for subsections that tries to analyse and interpret the meaning of the case studies in relation to the types of entrepreneurship activities and their main focus in term of promotion and contribution to the move towards a tyre waste circular economy].

6.1. Reflection on informal upcycling business model

Papola, (1980) observed that the informal enterprises in many African developing nations bare the following characteristics:

- an ease of entry for the new enterprises
- unregulated and competitive markets
- reliance on local resources,
- family ownership with small scale operations
- labour intensive production
- lack of access to government favour
- skills and knowledge are mostly acquired outside the formal learning system

Indeed, the waste tyres informal enterprises investigated in Lusaka, Zambia reflects the same characteristics. What is more, the auto rubber innovators, tyre sandal makers and tyre/tag shoe innovator all of them can be referred to what Fischer, (2011) and Garoma (2012) called “*Survivalists entrepreneurs*”. In this part of the discussion, the three informal upcycling enterprises will be referred to as survivalist. Survivalists operate their business activities as economic survival mainly to generate day to day income to feed themselves and their families (Ibid). The findings from the informal upcycling case study in Lusaka have highlighted that the driving forces for survivalist entrepreneurs were as a result of four main drivers for their business activities which were social oriented, profit oriented, niche oriented, and survival oriented.

6.1.1. Survivalist entrepreneurship

- **Survival oriented:**

The informal waste tyre upcyclers, in Lusaka, Zambia, their business were family/friend ownership, unregulated and they don't have any access to government support, clearly reflecting Papola, (1980) study. However, currently in Zambia, street vending is temporarily allowed, and the informal sector in general regard it as being part of government support especially that they have an opportunity to display and sell their products in front of some legitimate shops that sell similar products.

In spite of that, running unregulated and unregistered business presents some challenges among themselves in terms of competition, and making the trading area to be recognized as belonging to a specific entrepreneur. As a result, the informal business activities can be regarded as survival oriented because of being unpredictable and short-term achievement.

What is more, their business activities in terms of product processing indicates being survival oriented due to that they rely on trial and error innovation as well as "*endogenous technology*". Endogenous technology implies a technology that grows from within an organization or from processing activities (Garoma, 2012). For instance, the use of improvised tools and processing activities such as using the vehicle to act as a clamp tool to support the cotton fiber extraction from the waste tyre is survival means of carrying out the product production.

- **Social oriented:**

The survivalist entrepreneurs were social oriented in the sense that the business operation and activities are carried out in an open and interactive environment such as in the city streets and corridors . One of the main reason is that their products were street vended as a result being social is a key strategy to marketing and selling their products. Moreover, social focus provided them with street knowledge in terms of acquiring more business strategy, likelihood and business diversification. Additionally, the social oriented aspect is key for them to *acquiring skills and knowledge outside the formal learning system* (Papola, 1980).

However, street vending has created more social network for survivalist entrepreneurs they have more access to information exchange on how to sustain their business activities. What is more, the study has indicated that survivalist also depends on social focus in terms of scanning their business environment, an ease entry to new business opportunities and innovation, as revealed in the case study of Auto rubber innovator with their shift from *aluminium strut spacers to rubber strut spacers*.

- **Profit oriented:**

The study has revealed that survivalist entrepreneurs are profit oriented due to the way their business operation and activities were conducted. For instance, the idea of using cheaper methods for product processing can be seen as maximizing their profit. Furthermore, survivalist overlooked the precaution

“The personal protective equipment and tools from China are very cheap but they are not durable, so you can keep on buying and losing your money”

of health and safety risks in their business activities just because they want to make high profit. They would rather inhale toxic rubber smoke, rely on intense physically labour, use improvised tools and time consuming processing to cut expenses and

generate more profit. Therefore, investing in personal protective equipment and better production methods and tools is regarded as extra expenses. What is more, the idea of using waste materials somehow can be seen as being profit oriented because the survivalist can generate high profit by using easily acquired and cheap waste materials to produce marketable products. This approach is referred to as “*buy low-sell high*” in upcycling entrepreneurship (www.triplepundit.com).

- **Niche oriented:**

Survivalist as well as lifestylist entrepreneurs (discussed in the next section) are niche oriented in the sense that waste tyres presents a situation that particularly suits their interest and ability to survive and be specialized in using waste to generate income. Moreover, for survivalist to use waste tyres to create products gives them the opportunity to create a niche market because in many situation the products and services are appreciated and used by some specific customers. Survivalist entrepreneur like the Auto rubber innovators with their strut rubber spacers have created a niche market to address the need for a product or service that is focused on a portion of customers because usually the end-users of strut rubber spacers are people owning specific type of vehicles like Toyota corolla and those are very concern about the terrain (bumpy and pothole roads) were the drive their vehicles .

“we are burning the rubber when we make the holes with hot steel bars and that produces thick smoke and its very toxic”

To sum up, the informal upcyclers as well as the itinerant waste buyers, street waste pickers, municipal waste collection crew and the waste scavenger highlighted by Klundert & Lardinois (1995) and Wilson et al (2006) they all fall under Survivalist

entrepreneurs. They all have a vital role to play when it comes to promoting and establishing a tyre waste circular economy especially in developing nations like Zambia. However, survivalist activities magnifies high risk of health and environmental impact due to that their poor working conditions, environment and poor product processing methods. However, Nkosi and Muzenda (2013) argue that even though the survivalists often operates outside the formal channels, unlicensed, untaxed and unregulated they contribute significantly to the national economy and sustainable development.

6.2. Reflection on formal upcycling business model:

Upcycling is being regarded as a means to pursue the promotion of the conservation and preservation of the natural resources by reusing secondary materials. This seemingly basic idea has generated a

“we have quite a good margin on the products because the material is so cheap...basically it's the manpower and shipping we pay for only, but the manpower in Asia is also cheaper”

business model which is based on lifestyle as a sustainable way of living and doing business. The case study of Giving and living is a perfect example of such kind of business model and it is the kind of entrepreneurship that Kaplan (2003 cited in Marchant, 2009) refers to as “*lifestyle entrepreneurs*”. Kaplan (2003) defines lifestyle

entrepreneurship “*as where individuals design the entrepreneurial activity around their preferred lifestyle and personal circumstances*”(Ibid). Fisher (2011) informs that lifestyle entrepreneurs create their business model based on generating profit out of passion and they can engage in high value activities and use more resources (Ibid) as compared to survivalists entrepreneurs. What is more, having the flexibility and freedom in pursuing their business activities is vital for lifestyle entrepreneurs (Ibid).

In this part of discussion, Giving and living formal upcycling business model has been referred to as *lifestylist entrepreneurship*. The findings from the case study has highlighted the following drives for lifestylist entrepreneurship as being: *niche oriented, profit oriented, customers oriented and diversity oriented* which are discussion further on the next section below.

6.2.1. Lifestylist entrepreneur

The element of *niche oriented* for lifestylist entrepreneurship is don't discussed here because it bear a resemblance to the points raised about survivalists, therefore that part will not be elaborated here again. Morrison (2001 cited in Marchant, 2009) observes that Lifestylist entrepreneurship has “*a multiple set of goals associated with their business, and profitability in their business operations will be only one of these goals*”.

Profit oriented:

The findings have revealed that lifestylist entrepreneurship is profit oriented because their operation also embraces the principle of “*buy low-sell high*” (www.triplepundit.com). This implies the use of waste material and cheaper production methods. For instance, Giving and living business model is built on the principle of using waste tyres and the production involves the collaborating with survivalist in developing nations due to cheap labour and cheap materials.

However, lifestylist entrepreneurship usually have better resources such as money, innovation and better market to run their business successfully. As a result, they are able to collaborate with survivalist entrepreneurship by making them producers and suppliers. Lifestylist entrepreneurship like Giving and living company does not require big organisation structure, the company can be managed by one to three members. This is due to that lifestylist wants to run their business with flexibility and less risk as a result the set their own goals and control their returns successfully and that somehow results into acquiring high profit margin.

“I am almost doing everything myself”

▪ **Customer oriented:**

lifestylist entrepreneurship can have less/no competitors, however, they need to establish good markets with royal customers to buy their products. According to Peterson, (2015) “*successful lifestyle entrepreneurs know that it’s better to find a corner of the market and dig deep, developing expertise and establishing themselves in that niche, rather than picking a wide market and trying to serve everyone*”. Just like Giving and living, they understand that their products are not for everyone, therefore, they focus on serving their small, narrow niche market very well. For instance, the author noticed that company has a policy the can be referred to as *refund/replace no dispute* as means to maintain and satisfy their royal customers. Therefore, lifestylist understands that creating royal customers focusing on flexibility and satisfaction is very vital for sustaining the niche market. What is more, lifestylist entrepreneurship also understands that it’s better to be great at one thing than at everything.

“Some of the products are ten years old, but they still sell very well because they have become classic products now especially the Dacarr collection”

▪ **Diversity oriented:**

Lifestylist entrepreneurs strategically diversify their product collection by transforming some of the existing products as well as bring in new innovated products. However, the being great at one thing is important, therefore, product diversification still evolves just around their main classic products. The idea of doing this is to maintain or increase their profit by trying new markets or keeping their royal customers. Giving and living has now added new products and making some modification to their existing products. Since, upcycling is based on using waste materials, lifestylist entrepreneurs are not afraid of taking risk to try new products or invest in any innovative product in additional to existing products .

“We want to be perceived as a design and living company, with good style and design, and we see diversity as an important factor in upcycling business, like to try new products created from waste”

Actually, focusing on diversity in terms of introducing new products or modifying the existing products many add more value to the company image and attract new customers.

To sum up lifestylist entrepreneurship like Giving and living company wants to be seen as a living company that understands that *waste equals food* in relation to concept of waste to worth as well as *celebrating diversity* in terms of creating valuable and functional products from waste material.

6.3. Reflection on downcycling business model:

Albarico, (2013) reviews the strategies of champion entrepreneurs and points out that their business activities are based on the following characteristics:

- *Crisis turned to cash:* is the motto for champion entrepreneurs that every crisis can be turn into cash. Today, waste has become a global crisis.
- *Being innovative:* implying that it's through innovation new something can be introduced
- *Dare to be different:* implying that the business concept must be able to stand out from the rest
- *Benchmark and hit the mark:* focusing on evaluating and studying a business concept or model in relation to the business status quo
- *Maximize the technology:* learning to let go of some ancient and prehistoric technologies and try to make new advancement
- *No business is an island:* collaborating and teaming up with others to grow the business model and to produce greater results is vital

The Scandinavian Enviro Systems (SES) reflects some of the above characteristics therefore in this discussion part, SES has been referred to as *Championist entrepreneurship*.

6.3.1. Championist entrepreneurs:

The findings from the SES case study however revealed that championist entrepreneurship is driven by being; technology oriented, substitution oriented, profit oriented and growth oriented as discussed below:

- **Technology oriented:**

As indicated above Scandinavian Enviro Systems (SES) has *maximized the technology and dare to be different* (Albarico, 2013) by adopting carbonized by forced convection (CFC) pyrolysis as the new technology for downcycling processing of waste tyres.

The CFC is recommended for producing high quality products with high functionality and profitability.

“Our basis of our company is the technology... and also the market demand for our products”

Therefore, in comparison to traditional pyrolysis, the approach by SES to adopt CFC is a trend of focusing on new technology rather than on

“ancient and prehistoric technologies” (Ibid) when it comes to finding better solution for waste tyre management.

According to Reschner (2008), the discussion on which is the best downcycling process for waste tyres, i.e. ambient, cryogenic and pyrolysis are often discussed in the industry, however, the answer depends on a multitude of factors. Ambient processing also known as crumbling can only be compared to cryogenic due to that the end products from the two processes are basically the same, the only difference relies in temperature, number of machinery set up and type and the cost of the plant as noted by Reschner (2008). Nevertheless, Reschner argues that generally speaking cryogenic waste tyre processing is more economical with clean and fine mesh rubber powder. However, as far as pyrolysis process, Reschner argues that pyrolysis of waste tyres has been proven to be technically viable. Therefore, generally speaking SES is trying to champion the downcycling of waste tyre industry with its CFC technology in terms of product quality and functionality.

- **Profit oriented:**

According to Albarico, (2013) turning the crisis into cash is the motto of championist entrepreneurship.

“The operating cost is relatively low compared to the value of the end products, the process harbors significant profit”

SES has taken the advantage of turning the current waste tyres crisis into a profitable business model. The use of waste tyre as their raw material for producing new products is

profitable because the price of obtaining the waste tyre is low, yet the end product yields significantly excess profit as revealed by findings. Therefore, SES also understands the idea of *buy low-sell high*. What is more, SES is investing in research and development to refine the production processes and business activities in order to acquire better revenues.

- **Growth oriented:**

Albarico, (2013) stresses that champion entrepreneurship understand that *no business is an island*. kanssona and Snehotab (2006) argue that “viewing a business as part of the main and not as a self-contained entity could open new perspectives and opportunities on the concepts of business strategy and growth”.

As for SES, offering turnkey waste tyre recycling plants with associated license and the core-technology to interested organisations wanting to invest in waste tyre recycling industries is part of promoting

“... a lot of people who are calling me up to say we would like to build up the partnership, some of them are what we call lacking researching people”

growth. However, since, the SES-CFC pyrolysis technology is patented, implying that the SES has the exclusive rights to the

technology and design for a certain period of time. Hence, when it comes to partnership, evaluating and selection of potential investors and partners is very vital.

▪ Substitution oriented

Substitution of existing products can be achieved through innovation of new products. Albarico, (2013) insists that champion entrepreneurship believes in innovation and technology. Therefore, investing in innovation through research and development such working in collaboration with universities to create marketable products that are comparable to other existing similar products on the market is important. SES stresses that “*carbon black produced by the CFC process is high-grade with properties essentially comparable with the virgin carbon black N550*”. In that case, SES business approach can be considered as creative destruction because the CFC pyrolysis can substitute the traditional pyrolysis as well as introducing new high quality products from waste tyres. For instance, SES claims that *new products*

Creative destruction is a 'process of industrial mutation, that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one' (Schumpeter, 1942).

produced from waste materials are now on the market in Africa, Latin America, Asia and Europe. In fact, SES claims that their customers are absolutely satisfied with their products and services.

To sum up championist entrepreneurship like SES can be considered somehow as stirring *creative destruction* of waste tyre processing methods because the traditional pyrolysis of waste tyres is being transformed by the new CFC pyrolysis processing method. Even though the CFC has not yet be implemented in other countries apart of Sweden, SES believes its will soon be recognized as the new best available technology for waste tyre downcycling. SES claims that the company has so far attracted

“The authorities and government are living with the old technology”... they are very slow in adapting and understanding what’s going on... the regulation are not really the fastest to implement especially when you the first ones doing it”

a lot of interest all over the world because of the CFC pyrolysis technology and the new opportunities it presents in the

recycling and processing industry. However, one of the challenge of facing championist when it comes to creative destruction is the slow acceptance of new technology by the authorities and the government as revealed by SES.

6.4. Reflection on the best available model:

Bothma, (2015) warns that “*we have crisis on our hands, our landfills are reaching their limit*” and urges that “*we need to reduce our rubbish, revamp our resources, redistribute the trash*”. Further demands that “*what we need is a circular economy and we need it now*” (cited from: www.enca.com).

Duangburong et al (2014) and UNEP¹⁵, (2009) observe that in order to establish an effective and successful waste tyre management model, the following five key factors must be integrated: (1) *policies and regulations*, (2) *supporting institutions*, (3) *Proper financial mechanisms* (4) *Stakeholder participation* (5) *Supporting technologies and innovations*.

The case study of REDISA model has revealed some of the practical approach on how to integrate the five key factors above. Currently, REDISA organisation has established a waste tyre management model that is pioneering tyre waste circular economy in South Africa. According to REDISA-CEO, “*by implementing a waste into worth/circular economy concept into the industry, and pioneering the REDISA model the tyre industry has now been able to contribute to the environmental remediation of the products they produce-drive and assist in economic growth in a sustainable way, and finally to become more resource efficient*” (cited from waste management world, 2015). In that case, REDISA has been dubbed as pioneerist entrepreneurship in this part of discussion.

6.4.1. Pioneerist entrepreneurship:

Pioneers are known for discovering new opportunities, leading the change and forging new trails and trends. In this study REDISA has been referred to as *pioneerist entrepreneurship* based on the following four characteristics analysed from the REDISA case study: compliance oriented, partnership oriented, growth oriented and innovation oriented as discussed below

- **Compliance oriented**

According to www.pioneer.com, a pioneer will promote and protect innovation, and protection fuels innovation to bring the next generation of technology through compliance. For REDISA as the pioneerist of waste tyre recycling industry in South Africa, the findings has revealed that without legislation and support from the Department of environmental affairs, implementation the REDISA plan would never have been possible and the success would never have happened (www.redisa.com). Compliance here is related to issue of policies and regulations and creating of financial mechanism.

¹⁵ **UNEP:** United Nations Environmental program is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system (<http://www.unep.org/>)

REDIS has pioneered an Integrated Industry Waste Tyre Management Plan (IIWTMP) and the waste tyre hierarchy which is an holistic approach to waste tyre management and compliance. With the IIWTMP, compliance also entails self-registration of dealers, transporters, collectors and mandatory subscription of green fee. Besides, communication, assignment and delivering of consignments by registered members is as well governed by complying to REDISA plans and standards. **Figure 15** below illustrates REDISA plan and compliance system for waste tyre management.

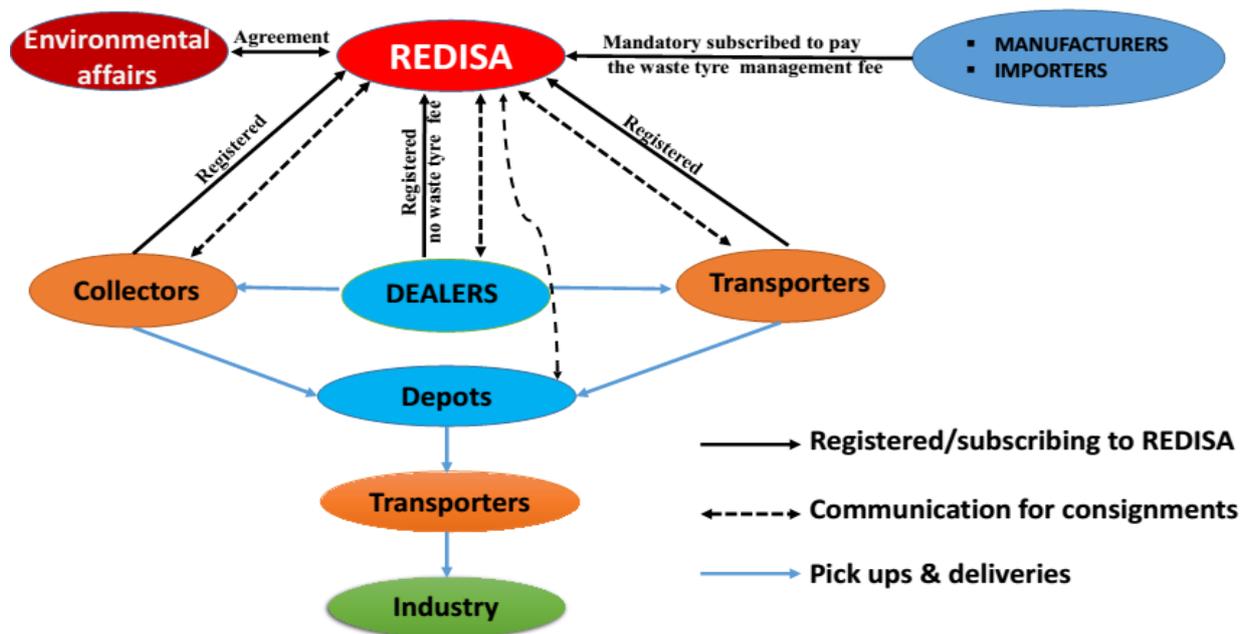


Figure 15: Illustration of REDISA tyre waste circular model by the author.
 [Based on REDISA data, from YouTube video, website and articles]

▪ **Partnership oriented:**

Pioneering collaboration among various stakeholders, such as the government, private sectors, individuals and various industries has been the cornerstone for REDISA model to create a network that works towards establishing *supporting institutions and stakeholder participation* (UNEP, 2009) in order to attain a win-win situation. REDISA is working closely with formal upcycling entrepreneurs (lifestylist), and the formal downcycling entrepreneurs (championist) and universities as earlier illustrated in table 8 and 9. The informal upcycling entrepreneurs (survivalist) in the REDISA model are indirectly involved because they are not registered. However, through an association known as South African waste pickers association (SWAPA) the REDISA understands the importance of recognizing survivalist entrepreneurship in REDISA model.. Furthermore, some formal waste upcyclers (lifestylist) also partners with informal upcycler (survivalists) to provide services for them in terms of product production that also implies an holistic approach for the REDISA model.

- **Growth oriented:**

Pioneering economic growth, infrastructure development, social uplifting and employment is REDISA agenda. The organization is achieving all these through the pioneered green fee scheme as extended producers responsibility which is further allocated for various development and business schemes as illustrated in table 9 earlier. REDISA is pioneering growth by supporting and empowering large, small and medium enterprises in order to create more employment opportunities especially in the waste recycling industry. Currently, REDISA claims that they have about 1851 registered dealers with 46 depots created and it has created about 2502 jobs (www.redisa.org.za).

- **Innovation oriented:**

REDISA is innovation oriented because it is creating and driving value from waste through various pioneered and adopted innovations such as upcycling and downcycling processing technologies. It an approach that reflects the key factor of supporting technologies and innovation as indicated by UNEP, (2009). What is more, REDISA is also using technologies for data collection and consignment processing as part of innovation. For instance, it has pioneered an innovation of using a comprehensive and geo-located data collection process through mapping system that assists to identify the sources of waste tyres and also allocation of consignment to the dealers and transporters. Through this innovation, REDISA currently has mapped about 1683 waste tyre collection points and 96 stockpiles.

When it comes to downcycling, REDISA is embracing and supporting various types of technologies and innovation of waste tyre downcycling. For instance, its working hand in hand with a pyrolysis process company in South Africa known as Milvinetix , and crumbling process companies as illustrated earlier in table 8.

To wrap up, REDISA is pioneering the holistic approach for tyre waste circular economy. What is more, REDISA as a pioneerist is also pioneering creative destruction (Schumpeter, 1934) in the recycling industry by discovering new ways such as: supply of raw material, launching of new products, application of new production methods, opening new markets and creating a whole new recycling industry.

7. Summation

According to Chartered Institution of Wastes Management (CIWM, 2014), “*the circular economy concept is a hot topic that has been widely discussed and analysed in recent years and has rapidly gained credibility in the waste and resources sector and also amongst various stakeholders and large businesses*”. As the debate and discussion concerning the concept of circular economy (CE) keep growing, it is vital to gain a better understanding of the concept and to illustrate the circular economy concept in a simplistic way for both professional and unprofessional people.

Inspired by the basic principles of Cradle to Cradle in terms of ecosystem, biological nutrients and technical nutrients, the author tries to illustrate the concept of circular economy using the metaphor of the fruit commonly known as the drupe. The metaphor has also been inspired by my previous research about metaphors of sustainable organisation (Mulenga, 2012).

Just like the cradle to cradle concept, the metaphor of a circular economy concept is drawn from accepting and appreciating nature in terms of sustainability and continues growth. Based on this idea, the circular economy is related to a drupe fruit as discussed and illustrated below:

7.1. Metaphor of a circular economy concept:

Drupe: A drupe for example a mango fruit, is a fruit consisting of an outer leathery skin known as *exocarp*, a fleshy edible layer called *mesocarp* and a pouch (inner shell) layer known as *endocarp* that encloses and protects usually a single *seed*. When growing, the drupe fruit is supported and attached to the tree by *stem*.

In this metaphor, the **seed** in the drupe represents core concept of circular economy because when we reap the fruit and consume the fleshy edible layer, the seed should be circulate for another growth and development. In that way, we create the closed loop in terms of *reap-consume-circulate*. Therefore, the seed becomes a vital part the we need to safeguard and maintain in order to attain another development of the drupe fruits.

The **endocarp** is the pouch or inner shell that takes care of the seed. It plays a significant role in making sure that the seed is protected for further growth and development. Here, the endocarp represents the *best available model* (BAM). The concept of circular economy (the seed) cannot be usable if it has been weakened due to lack of proper and health endocarp. The endocarp plays a primary role in seed dispersal (implementation and adoption). In certain situation the endocarp can fail to maintain its duty as a result the seed can be destroyed.

Therefore, making sure that the best available model (endocarp) is healthy and strong is the key towards growing and circulating a successful circular economy concept (the seed). BAM can be like the *tax system* on waste tyres and *industrial symbiosis*¹⁶ like the ones in Denmark. Also it implies models like *extended producers responsibility* and *polluters pay principle*¹⁷ like the ones in some EU member countries.

Mesocarp: that is the edible layer in a drupe and here it illustrates the *best available technologies* (BAT) and the *best available practices* (BAP) because the nutrients (resources) we need is manufactured in the mesocarp. Mesocarp store nutrients which are consumed by humans and animals etc. The same applies to materials and products that we generating through innovation and technology using the BAP and BAT. It also entails the idea of biological nutrients because the mesocarp can naturally decompose. It can also be looked up as technical nutrients when the mesocarp can be preserved and further used in developing other useful products.

Exocarp: That is the outer skin of the drupe fruit and its main function is to protect the internal elements of drupe and to contribute certain requirement for the internal element to continue growing. However, when the drupe fruit is ready for consumption, the exocarp can either be removed and discarded or it can be used depending on the condition and intended purpose.

Here, exocarp has been related to be the best available contributors (BAC) meaning that we need the exocarp if the contribution is necessary once the drupe fruit is reaped. If the contribution is not necessary we can rip it off. BAC consists of survivalist entrepreneurship such as waste pickers or scavengers, informal upcycler. However, Choto, Tengeh and Chux (2014) insist that survivalist are vital players and contributors to economic development, they consists of producers, distributors and service providers.

Stem: The stem holds and supports the all drupe structure during its development and prevents it from dropping off while growing. The other function of the stem is transporting fluids and nutrients needed for the growth of the drupe fruit. Therefore, the maturity of the of the drupe is very much dependent on the support and functionality of the stem. Here, the stem has been dubbed as the *best available support* (BAS). For the CE concept (the seed) to grow successfully, support from various stakeholders such as the governments, authorities, institutions, and the general public is required. However, the government is the bigger vein in the stem that need to provide much support and other necessary requirements to make sure that the drupe as a whole attains the main objectives. Below is the illustration of the metaphor.

¹⁶ **Industrial symbiosis** is the sharing of services, utility, and by-product resources among industries in order to add value, reduce costs and improve the environment (Wikipedia).

¹⁷ **Polluters pay principle** is an environmental policy principle which requires that the costs of pollution be borne by those who cause it (European commission)

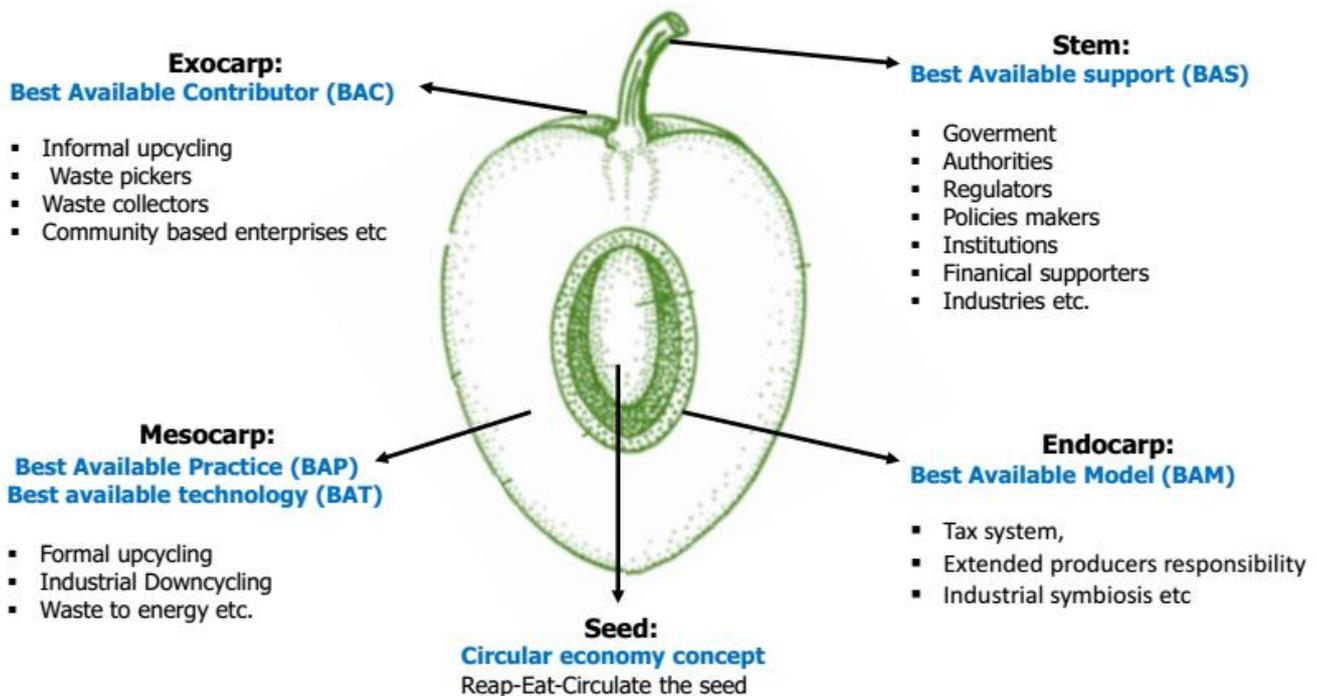


Figure 16: Illustration of Circular economy concept with a drupe metaphor
[Source: Authors inspired Mulenga, 2012]

8. Conclusion:

This thesis has been conducted with the main focus on best available models (BAMs) for tyre waste circular economy in developed and developing nations. This study has attempted to illustrate that the concepts of circular economy with the help of the REDISA model while presenting the main attributes associated such as upcycling and downcycling concepts as well as eco-innovation. Consequently, the main attributes mentioned above have been used to illustrate the entrepreneurs perspective and role in the tyre waste circular economy by analyzing and categorizing the case studies in four types of entrepreneurship; *survivalist*, *lifestylist*, *championist* and *pioneerist*. The use of “*IST*” after the terms was just to be constant with the already coined term survivalist.

This research study intended to answer three research questions. However, in this section, only the main research and one sub-question are explained. The other sub-question is not explained here due to that the answers have been covered in the discussion part.

- **How is upcycling & downcycling of waste tyres as a business model defined in theory and understood in practice; and how can it contribute towards the tyre waste circular economy?**

The definitions of upcycling in theory is different when seen in practice. Currently, in theory, upcycling is not well elaborated and there some missing element when its compared to the practical approach.

However, one definition from wikipedia tries to integrate the aspect of environmental values stating that *“upcycling is the process of transforming by-products, waste materials, useless and/or unwanted products into new materials or products of better quality or for better environmental value”*. In this research study, the author insists that including the aspect of *“waste to worth”* as well as health aspect might provide a better picture of the concept.

The study reveals that upcycling is also profit oriented and the health aspect is vital to focus on too as illustrated by the survivalist and lifestylist entrepreneurs. In that case, the author tries to adjust the definition of upcycling as *the process of converting by-products, waste materials, useless and/or unwanted products into new materials or products for personal use or worth generation while focusing on less/zero environmental and health impacts*.

When it comes to downcycling definition *“it is a process of converting waste materials or useless products into new materials or products of lesser quality and reduced functionality”* (Greenwiki nd). Herewith, the argument against and for the definition may depend on the processing approach applied and the end product obtained. This study somehow illustrates that the end product can also be high quality and better functionality as contested by Scandinavian Enviro Systems CFC technology. However, the author has not given the definition here because quality and functionality entails many aspects such as testing and analyses.

The study has revealed that both upcycling and downcycling are crucial elements and have important role in establishing and promoting tyre waste circular economy in developed and developing nations. However, for downcycling entrepreneurs, there is need for more support and promotion of new technologies by the authorities and government as informed by Scandinavian Enviro Systems.

What is more, recognizing the informal upcycling (survivalist entrepreneurship) as being part and parcel for the development and promotion of circular economy especially in developing nations is necessary. In many situations, survivalist entrepreneurs have been viewed as having little or no significant impact on economic growth as result, they are unaware of their potential.

Choto, Tengeh & Iwu (2014) warn that survivalist are isolated from market and isolated from the eco-innovation, as a result they tend to develop negative individual mind-set such as lacking the driving force and determination to become lifestylist or just to take their skills on another level. This is because, they are not looked up as the *best available contributors* even though they play significant roles such as being the suppliers, collectors and service providers in waste management.

Therefore, informal entrepreneurs such as the survivalists needs to be recognized and supported in the creation and promotion of the circular economy. They can be given incentives, awareness, collaboration and guidance on how to take their business activities on another level through eco-innovation project

and participation. In that way, informal upcyclers can have the positive mind-set towards building a better entrepreneurship.

- **What measures can be put in place to ensure that waste tyre upcycling and downcycling services and products have less/zero negative impact on the environment and human health?**

Survivalist entrepreneurship presents many challenges when it comes to environmental and human health due to their unsafe processing methods, lack of proper equipment, bad working conditions, poverty, and taking health risk in order to generate more profit. The key measures that can be put in place to help them with their services and products is by giving them awareness, education, guidance and support. What is more, working in collaboration with the authorities can also ensure that they understand how to consider health issues in their services and products as well as being environmental friendly.

The issues concerning products or services that are created from waste as *green*, somehow is taken for granted. Not all products or services created from waste can be considered as green therefore, informal and formal upcycler as well as downcycling enterprises can somehow enhance their products and services by obtaining certification and recognition from organisation such as eco-labels, International Organization for Standardization; for instance ISO 14000 environmental management and ISO 45001 occupational health and safety or any other local labels and standards in their countries.

Limitations: To wrap up, this study has several limitations, first, even though the study has used multi qualitative case studies, the data would have been more compelling if the author had the opportunity to investigate the downcycling and upcycling enterprises in developing nations similar to the one investigated in developed nations. Furthermore, only one company downcycling waste tyre based on pyrolysis was investigated, however, it would have been more captivating if this study had an opportunity to involve other companies that are using similar technology as well as those using other downcycling processing methods such as crumbling, cryogenic and traditional pyrolysis.

Additionally, the data used in the REDISA case study is based on secondary data, even though, the data is compelling, primary data such as interviews can contribute more to the outcome of the case study. What is more, REDISA tyre waste circular economy presents a challenge in terms of adoption in developed nations due to that the current nature of waste tyre management system for instance in European are typically monopolized by the state. Therefore, REDISA tyre waste circular economy is much suitable for developing nations like the African nations because that were the most challenges for waste tyre management are visible and were all four types of entrepreneurship identified exist.

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