MSc Program
Engineering Management

Adapting sustainable policies at the end-of-life stage in the product life cycle in SME's in the UAE – Enablers and Barriers

A Master's Thesis submitted for the degree of
“Master of Science”

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Vienna, 08.04.2020

Affidavit

I, **GEORGEY ABRAHAM, B-TECH**, hereby declare

1. that I am the sole author of the present Master's Thesis, "ADAPTING SUSTAINABLE POLICIES AT THE END-OF-LIFE STAGE IN THE PRODUCT LIFE CYCLE IN SME'S IN THE UAE – ENABLERS AND BARRIERS", 59 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted the topic of this Master's Thesis or parts of it in any form for assessment as an examination paper, either in Austria or abroad.

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II. Abstract

United Arab Emirates (UAE), a member of the Gulf cooperation council (GCC), has one of the fastest growing economies in the world. This has led to intense pressure on SMEs, that cover a major portion of the manufacturing sector, to produce products that not just meet international standards in terms of quality but also are sustainable. Thus, UAE's concern over reducing waste generated throughout the life cycle of the manufactured products, especially on what ends up in the land scarce country's landfills, has led it towards circular economic thinking. This research investigates into finding the influencing factors that enable SMEs in UAE to adopt End of Life design thinking policies into its product manufacturing process. Through conducting a case study into an SME from the manufacturing sector in UAE, this paper presents an in-depth research into the various triggering factors that act as enablers and barriers towards EOL management design thinking adoption. The finding suggests that in this market the trade partners act as the biggest influencing factor and within this, clients though having the strongest affecting power behave both as an enabler and a barrier. Also, other factors like influence of international agencies and infrastructure contribute towards enabling this innovation adoption. While suppliers and competitors act as barriers. Government and improving internal knowledge of employees are future potential enablers especially in the UAE-SME context.

The primary contribution of this study is to deepen our understanding of innovation adoption process and offer insight into the process of such an innovation adoption in this particular context. This research serves as an initial study towards further work, which will in turn, create a basis for both industrialist and academic personal to foster the quick adoption of EOL design thinking policies into organizations, thus making their product truly circular and sustainable.

Keywords: Circular Economy, End of life management, United Arab Emirates, Gulf cooperation council, Neo-Institutionalism.

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Chapter 1. Introduction

1.1 Introduction

Over the past 20 years, the Gulf Cooperation Council (GCC) countries have experienced rapid economic development and population growth. The predominant linear economic model of "take, make, use, waste" experiences enormous stress due to this. The region is falling out of resources at an alarming rate while creating large quantities of waste and emissions, that impacts the regions environment, economy and social life.

UAE has initiated steps towards sustainable solutions, such as alternative sources of energy, minimising resource utilization, and increasing recycling efforts. However, changing the current development pattern will need a holistic method. The region should hence embrace the concept of the circular economy.

The Circular Economy is the innovative idea to replace the end-of-life concept with reducing, reusing, recycling and recovering materials and to slow down, close and narrow material and power loops. Small and medium-sized enterprises (SMEs) are becoming conscious of the growing advantage of closing loops and improving resource efficiency. End of life stage in the product life cycle is a key position that helps make the circular economic business model complete. However, various obstacles pose challenges to SME businesses in their shift to a circular economy, especially with regards to end-of-life management.

This thesis project aims to increase knowledge and understanding of the influences experienced by SMEs in the UAE when implementing Sustainable policies at the end-of-life stage in the product life cycle. To achieve this objective, I propose to conduct a case study of an SME particularly in the manufacturing sector in the UAE and to discover the enablers and barriers that affect this process through interviewing key personals in the company involved in designing their products.

1.2 Problem statement

United Arab Emirates (UAE) is one of the members of the Gulf Cooperation Council (GCC) comprising of 7 emirates with Abu Dhabi as its capital. The economy of the UAE is the 2nd largest in the Middle East (after Saudi Arabia), with a gross domestic product (GDP) of USD 405 billion in 2019. (*Economy of the United Arab Emirates - Wikipedia*, 2020)

The UAE has been successfully diversifying its economy, (Abdul Kader, 2011) particularly in Dubai. They however remain heavily dependent on incomes from petroleum and natural gas. This even today play a vital role in its economy. According to the UAE Ministry of Economy, the SMEs sector is more than 98 % of the total number of companies functioning in the UAE and supports towards 52 % of the non-oil GDP. (Alafeefi, 2019)

These SMEs contribute not only to its economy but also to its landfills where most of the waste currently is diverted. UAE understanding the limitation in its already limited land

area and the impact this has on its environment, along with aims to push sustainable growth, has taken severe actions through UAE Vision 2021 and the Centennial Strategy 2071. The nation is bound to enforce strict rules and regulations that will push companies to manage their waste. Even before that comes to play, it would be of interest to understand what are the present influencing factors that affect SMEs in UAE to adopt or reject the End of Life (EOL) management concept into its process and procedure. The current research aims to study an SME from the manufacturing sector already trying to implement the circular economy model and find out what are the influencing factors that trigger it or demotivates it from adopting EOL design thinking into its product manufacturing process.

1.3 Significance of the study

With the increase in the UAE governments push towards circular economy model thinking and its mandate to help achieve the countries sustainable development goals by 2030 , UAE Vision 2021 and the Centennial Strategy 2071, just like in Europe, it is only a matter of time before this thinking turns into laws and regulations. This research looks particularly into the case of SMEs in the manufacturing sector which is a major contributor to the UAE economy and tries to find out the triggering factors that help in the adoption of this innovation of EOL management design thinking. This study should help industrialist to determine how to make this transition faster and efficient. The information gathered from this research will help them to be better prepared and to assess themselves regarding their current status. International markets have already developed requirements for such provisions to be mandatory in their project specifications. Thus, this transition will help them to compete with the international companies on an equal platform. UAE companies having transitioned its products with a developed EOL managed design will also help other companies and clients from underdeveloped countries get access to such products faster as these are the markets these countries generally tend to resort for solutions. This could also work as a base for governments to understand where to place checks to ensure better waste management or where incentives would be required to help SMEs transition better. Finally, this research hopes to serve as an initial study for further research in other similar or bigger companies by other researchers who would wish to pursue further study related to innovation adaption.

1.4 Key definitions

Circular Economy - A circular economy is an economic system aimed at eliminating waste and the continual use of resources. Circular systems employ reuse, sharing, repair, refurbishment, remanufacturing and recycling to create a closed-loop system, minimising the use of resource inputs and the creation of waste, pollution and carbon emissions.

GCC - Gulf Cooperation Council; The GCC consists of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE).

SME – Small Medium Enterprise

1.5 Aims and objectives of the research

The study will target the following research objectives:

- Identify the key influences that affect implementing sustainable policies at the end-of-life stage in the product life cycle of an SME in UAE.
- To discover the enablers and barriers that influence this process.

1.6 Research questions

The following research questions are formed to meet the research objectives of this study:

- What are the influences that affect implementing sustainable policies at the end-of-life stage in the product life cycle of an SME in UAE?
- What influencing factors act as enablers and barriers towards adoption of sustainable policies at the end-of-life stage in the product life cycle of an SME in UAE?

1.7 Outline of study

Chapter 1 gives an introduction into the research and the need for this case study is established. A review of related literature is explained in Chapter 2. In this section after establishing a comparative study between linear and Circular economy, UAE's effort in this transition is described. The importance of green manufacturing and its relevance to End of life management is also clarified. This chapter then concludes with supporting innovation adaption theories. Chapter 4 presents the research design and methodology used in conducting this study along with the tools/techniques applied for data gathering. Data analysis is performed in chapter 5. Here all the influencing factors are identified before further analysing them into enablers and barriers towards EOL management design thinking adoption. Chapter 6 then concludes the research after discussing the findings to prove the various hypothesises and answer the research questions.

Chapter 2. Theoretical background and literature review

2.1 Linear economy and its impact on GCC

From the dawn of industrial revolution, the founders of our economy have developed a “take-make-consume and dispose of" growth pattern, which is a very linear model assuming that resources are plenty, obtainable, easy to source and cheap to dispose of. But the truth is, valuable materials are leaking out of our economies. The pressure on resources is causing more noticeable environmental degradation and instability. This is especially significant with the demand and competition of finite and mostly scarce resources continuing to increase.(European Commission, 2014)

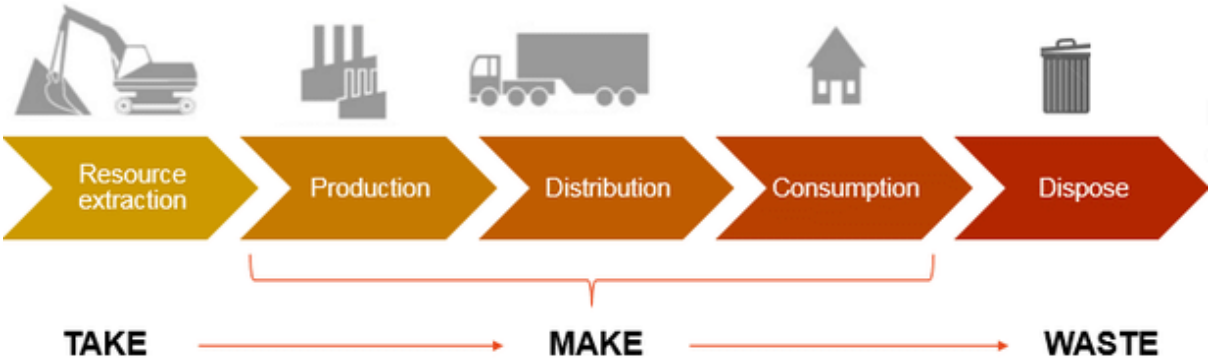


Fig. 2.1: Linear Economic Model (Wautelet, 2018)

Many natural resources under the linear model that are vital for today’s industries are facing the challenge of depletion. For instance, the 8 metals at high risk of depletion, that are noted by the European Union (EU) to be significant for such technologies like electric vehicles, wind and solar energy, and lighting. These metals include gallium, which is used for making LCD and LED screens and photovoltaic solar panels.(*Eight metals used in low-carbon energy technologies under risk of shortages | EU Science Hub*, 2013)

Gulf cooperation countries have a very fast growth rate and to maintain this pace, there is no doubt they will have to shift their economic thinking from the present linear model which is just "take, make, use, waste". This kind of economic model not only places a large amount of strain on finite resources but also generates a large quantity of waste. Few of the significant weaknesses with this model is that: lack of optimization of material-used in the production phase, product life not maximized, and no reuse of waste produced from the production and post-consumption phases. (Bejjani et al., 2019)

Price volatility caused by disruptive supply become a daunting issue for companies and economies that rely on such scarce natural resource. This results in economic risk for such countries and damaging competitiveness among companies. GCC, likewise, are not immune to depletion of its natural resources, as present consumption rates are undeniably unsustainable. The region’s households have one of the highest consumption rates of

electricity in the world. while their gasoline consumption per capita equals that of North America. (Bejjani et al., 2019)

Increasing agricultural and domestic demand are pushing these countries to pump groundwater to surface extensively. Water consumption rates are the highest among both Kuwait and Saudi Arabia, reaching over 300 Litres per capita per day.(Ismail, 2017; Lovelle, 2015)

A study measuring the ratio of water withdrawals to water supply for each country was done by the World Resource Institute. Six out of 9 countries were GCC states that were predicted to be "extremely highly stressed" in relation to water by 2040. (Maddocks et al., 2015)

Economies, the environment, and people are negatively impacted by the large quantity of waste generated by this linear economic model, and this waste includes discarded or unused materials, as well as emissions. According to the World Bank, the total municipal solid waste generated globally in 2012 was 1.3 billion tons and could reach 2.2 billion tons per year by 2025 (Hoornweg & Bhada-Tata, 2012). The International Energy Agency (IEA) reported that global energy-related carbon emissions rose to a record level of 32.5 gigatons in 2017, due to higher energy demand and the slowing of energy-efficiency improvements (Chestney, 2018). The carbon footprint of the GCC is one of the largest in the world, with five of the GCC countries ranking in the top 10 (out of 142 countries) in 2015 when measured on a per capita basis as per the international energy agency. The entire regions waste is expected to jump from 94 million tons in 2015 to 120 million tons by 2020 (*GCC Waste Management Industry to Present Untapped Opportunities, notes Frost & Sullivan*, 2016), and this rise will have material consequences. Municipalities are not equipped to manage these high levels of waste generation through the present landfill strategies. (Bejjani et al., 2019)

Thus, the need for a shift from this linear to a more circular economic model is today undeniably vital.

2.2 Circular Economy helping to achieve sustainability

Circular economy systems try to keep the values in products as far as possible and work towards eliminating waste. When a product has reached the end of its life, they keep resources within the economy, so that they can be productively used repeatedly and hence create further value.

How can this shift be achieved? The transition from a linear to a more circular economy required transformation throughout the value chains, from product design to new business and market models, from innovative ways of converting waste into a resource to new modes of consumer behaviour. This implies a complete holistic change, and innovation not only in terms of technology but also in the organisation, society, finance methods and policies.

This does not mean that this would completely solve the problem. Even in a highly circular economy, there will definitely still remain some features of linearity where virgin

resources are required, and residual waste need to be disposed of.(European Commission, 2014). But will undoubtedly help move towards a more sustainable future.

Industry has already understood the strong business case for resource productivity improvement. It is estimated for European companies, that resource efficiency improvements in all parts of the value chain could reduce material inputs needs by 17%-24% by 2030(Report, 2011) and efficient utilization of resources could result in an overall savings potential of €630 billion per year. (*Resource efficiency — European Environment Agency*, 2018)

Moving to more circular economic models promises a much brighter future not just for the European economy but the world over. It would enable countries not just in Europe to rise to the current and future challenges of global stress on resources and rising supply insecurity. Pumping resources back into production again and again, cutting on waste generation and reducing dependency on uncertain supplies is a direct method to improving resilience and healthy competitiveness. By enabling to detach economic growth from resource use and its impacts, could foster sustainable growth that is truly sustainable. (European Commission, 2014)

2.3 Design and innovation for a Circular Economy

Circular economy covers innovation throughout the entire value chain, and not just on solutions at the end of life of a product. It also approaches 'design out' waste. For example, they may include:

- Minimising the number of raw materials used (Light-weighting)
- Decreasing the measure of material and energy used during production and use phases (Efficiency)
- Expanding product's productive life (Durability)
- Reducing or entirely eliminating the usage of materials that are hazardous or difficult to recycle in products and production processes by replacing it with other materials (Substitution)
- Creating markets for secondary raw materials (Recyclates) with the help of public procurements, standards etc.
- Designing from the conceptual phase products that are simpler to maintain, repair, upgrade, remanufacture or recycle (Eco-design)
- Developing the necessary services for consumers to support them through the life cycle of the product (Maintenance/Repair services, etc.)
- Incentivising and supporting waste reduction and high-quality separation by users
- Incentivising separation, collection systems that minimise the expenses of recycling and reuse
- Enabling the grouping of activities to prevent by-products from becoming wastes (Industrial symbiosis)
- Urging wider and better consumer choice through renting, lending or sharing services as an alternative to owning products, while safeguarding consumer

interests (in terms of costs, protection, information, contract terms, insurance aspects etc)

An important starting point could be the design of production processes, products and services. Products instead of being thrown away can be remodelled to be used longer, repaired, upgraded, remanufactured or eventually recycled. Production processes can be structured to be more focused on the reusability of products and raw materials, and the restorative capacity of natural resources, while innovative business models can create a new relationship between companies and consumers.

The conceptual diagram below illustrates the main phases of a circular economy model. Each of them presents opportunities in terms of reducing costs and dependence on natural resources. It will boost growth and jobs, along with reducing waste and harmful emissions into the environment. The different phases are interconnected, for instance; industry exchanges by-products, products are refurbished or remanufactured, or consumers choose product-service systems. The ultimate aim of the entire model is to minimise the resources escaping from the circle so that the system functions in the most optimal way.(European Commission, 2014)

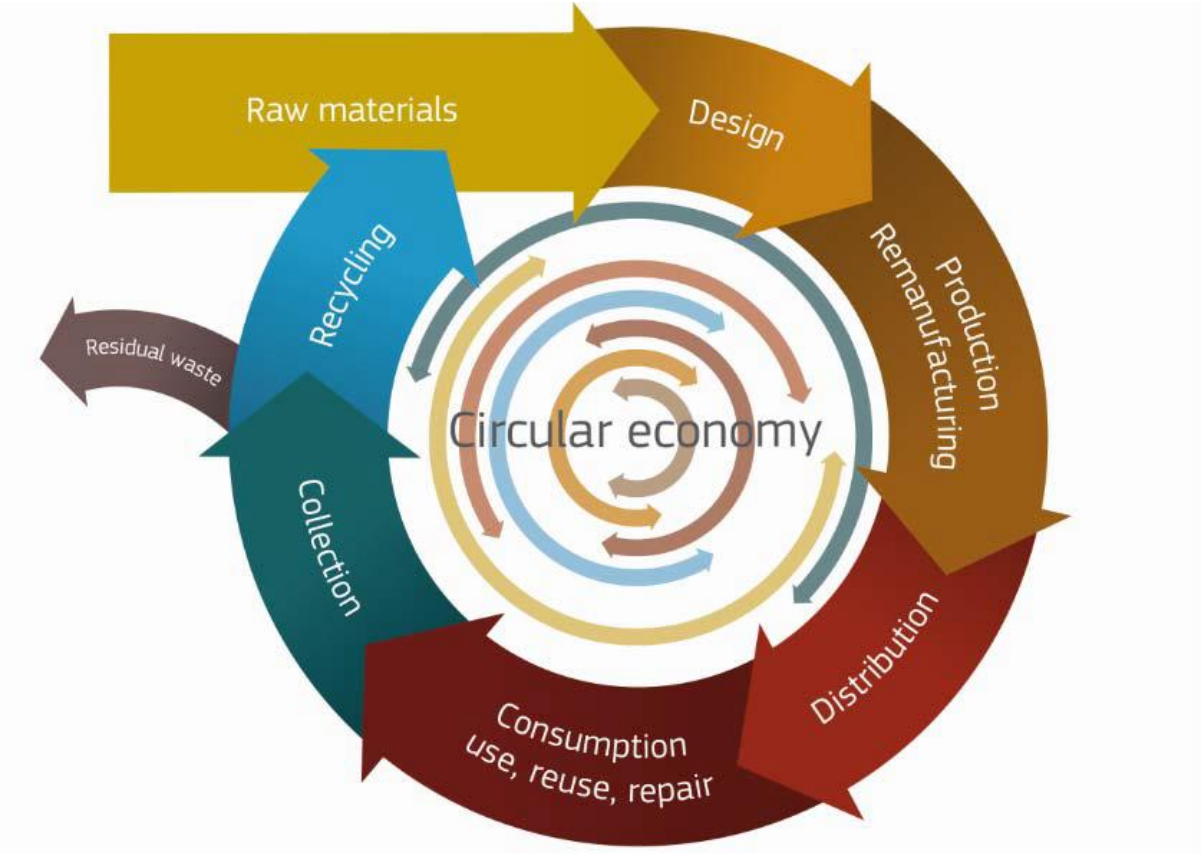


Fig. 2.2: Circular economy model (European Commission, 2014)

2.4 Circular Economy In UAE

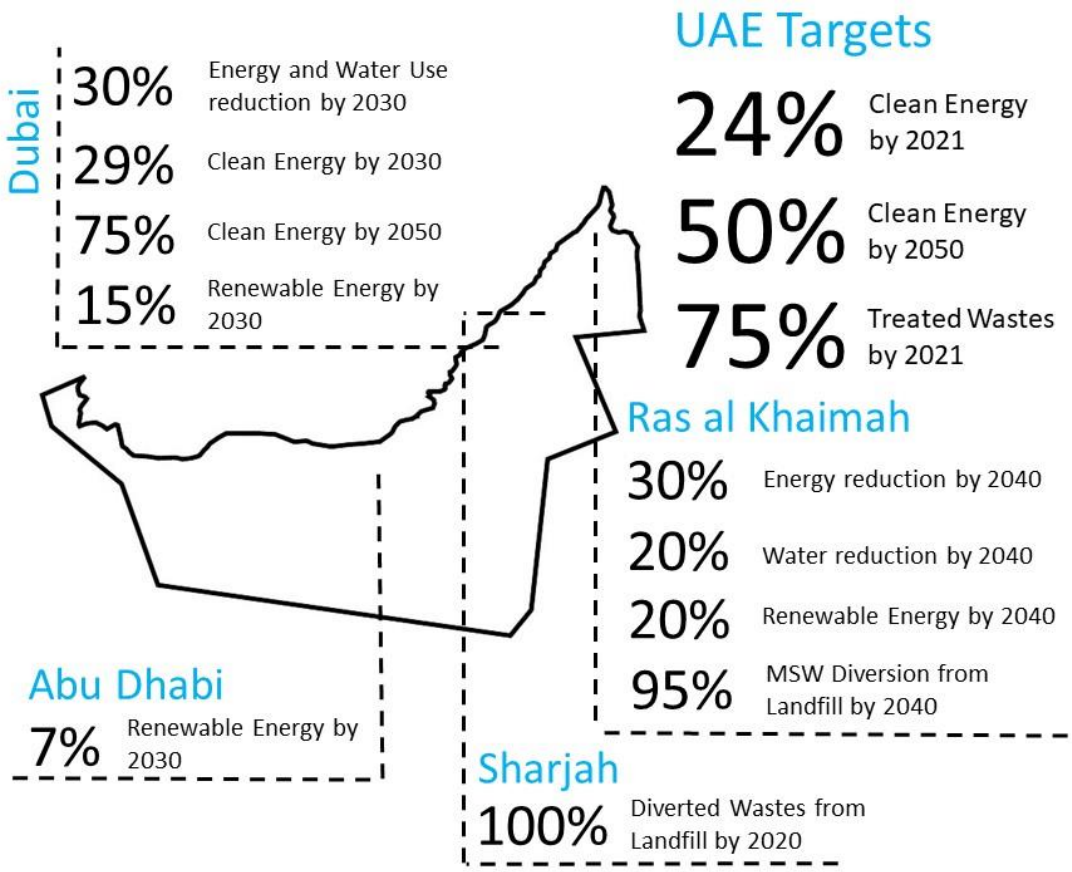


Fig. 2.3: UAEs Circular economy implementation strategy (*The Circular Economy in the Workplace: Business & the Environment*, 2019)

UAE has taken it seriously to work towards circular economy model. All major global environmental initiatives have been signed by the UAE government. Along with promoting environmental issues globally, UAE has placed stern environmental targets into its federal plans. Some of this is evident in the environmental objectives of Abu Dhabi, Dubai, Sharjah and Ras Al Khaimah.

In April 2019, Thani Bin Ahmad Al Zeyoudi, Minister of Climate Change and Environment, commented that the UAE's pledge to develop circular economy reassures the UAE's standing as a global and open laboratory for economic and technological innovations. This is fully in alignment with UAE Vision 2021 and the Centennial Strategy 2071. The Scale 360 initiative is centred on using the latest technologies, including AI and IoT, to help design recyclable and reusable goods, reduce waste and protect the environment. The UAE government Omar bin Sultan Al Olama, UAE minister of state for artificial intelligence, said: “Artificial Intelligence is a major contributor to the sustainable development efforts and recycling initiatives. We seek to emphasise the need to adopt artificial intelligence in development strategies.” (WAM,

2019). A total of $ 1 Million has already been pledged by the government towards programmes that help reduce pollution.

Similarly, the Ministry of Climate Change and Environment formed a coalition of government agencies, NGOs and global and local private companies to advance a circular economy approach (*Abu Dhabi bodies commit towards circular economy | United Arab Emirates | Construction | ArabianIndustry.com*, 2019). This alliance in Abu Dhabi has initiated a pilot project to test the economic and environmental impact of plastic and other packaging materials on circular economy. It plans on building a 'closed-loop recycling model' for plastic bottles, beverage cartons, and others. They hope to use the outcome as a basis of recommendations in Abu Dhabi for accelerating improving waste management and sustainability initiatives (WAM, 2019).

For example, in Ras Al Khaimah, the government as an innovative use of the concept of the circular economy, is using more than 50 tonnes of camel manure produced by close to 9000 camels daily as fuel in cement production. Since the launch of the project in May 2018, more than 100,000 tonnes of camel manure have been converted into fuel resulting in saving up to 18,000 tonnes of carbon emissions and decreasing fuel expenses for the partaking cement factories. (Zacharias, 2019)

The UAE's strategies and initiatives including the UAE Vision 2021 and the Centennial Strategy 2071 aims to push sustainable growth and place them at the top of the list in the world.

These are some examples of how the UAE leaders are steering the country toward a sustainable future. However, it is important to acknowledge the action being taken to adopt circularity and continue to play a important and innovative role in closing the loop. When managing waste like the saying that "necessity breeds creativity" acts as an important element to adopting circular model and using it to produce products that one can consume and utilise in a practical and responsible manner.

One such creative use of waste materials is in the UAE fashion industry. Over 500,000 kg of PVC material is destroyed every year in Dubai alone, which is comparable to over 3 million kg of CO2 emissions produced. ETUIX, a luxury goods producer, has been using PVC (polyvinyl chloride) from advertising posters to create luxury goods such as purses, shoes, belts, bags and other items (Galli, 2020).

As per Fayyad and Hogali,(2019) UAE's aim is to reduce landfill waste by 75 per cent by 2021 is an ambitious one and one can be positive that strides are being taken toward achieving these targets (EmiratesGBC, 2019). Adopting a circular economy model will play a major role in decreasing landfill. Also, the thinking towards End of life management in its product life cycle will undeniably help reduce the amount of waste as well as the hazardous materials entering the environment.

2.5 End of Life Management

Equipment gets to its end-of-life once it becomes dysfunctional for the owner/user, becoming what some categorize as waste for the particular purpose the user wished to fulfil (Morselli et al., 2006). The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (the 'Basel Convention') defines waste as substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law.

The equipment does not necessarily mean that it is in poor operating condition or has become obsolete even though it no longer meets the initial user's need. There could be a possibility for its life to be extended by either giving it to another user to be used for the same purposes whose needs could be satisfied with the same equipment, or by reusing the equipment or its parts and components, for which it might have to be dismantle so as to recover its parts. It is also possible to extend the use of the elements contained within it through part, component or material recovery and recycling, better known as the end-of-life (EOL) management.

The decision to extend the life of equipment or selecting a provider of EOL practice belongs to the owner or possessor. They finally must decide whether this work must be carried out by himself or commission a specialized company. Whether the equipment life is extended or it is decided to proceed with recovery and recycling, it must be performed while adhering to environmentally sound management practices and techniques. In this regard, it is vital to ensure that the service provider possesses high environmental performance capabilities.

Thus, it is crucial, the best available techniques and environmental practices are employed for EOL management of equipment. This will, without compromising economic goals, determine the success of an environmentally responsible and sustainable outcome. This also equally applies to the end-user equipment, which finally needs to enter the collection system for the environmentally sound management reuse, recycling and disposal.(Laura Reyes (Datec), Shannon West (Verizon) et al., 2012)

There are three basic strategies in End-of-Life Management (the "3-R" possibilities): Reduce, Reuse and Recycle(United Nations Environment Programme, 2009). "Recover" can also be added to improve the method to a "4-R" theory: Reduce, Reuse, Recycle and Recover. Recover relates to energy recovery throughout the waste stream (Kopacek, 2014). This is an essential element and should not be left out. Finally, if no other option remains, landfills should be considered as part of the strategy. This is not the best option of waste management, but it is still imperative in the waste treatment process.

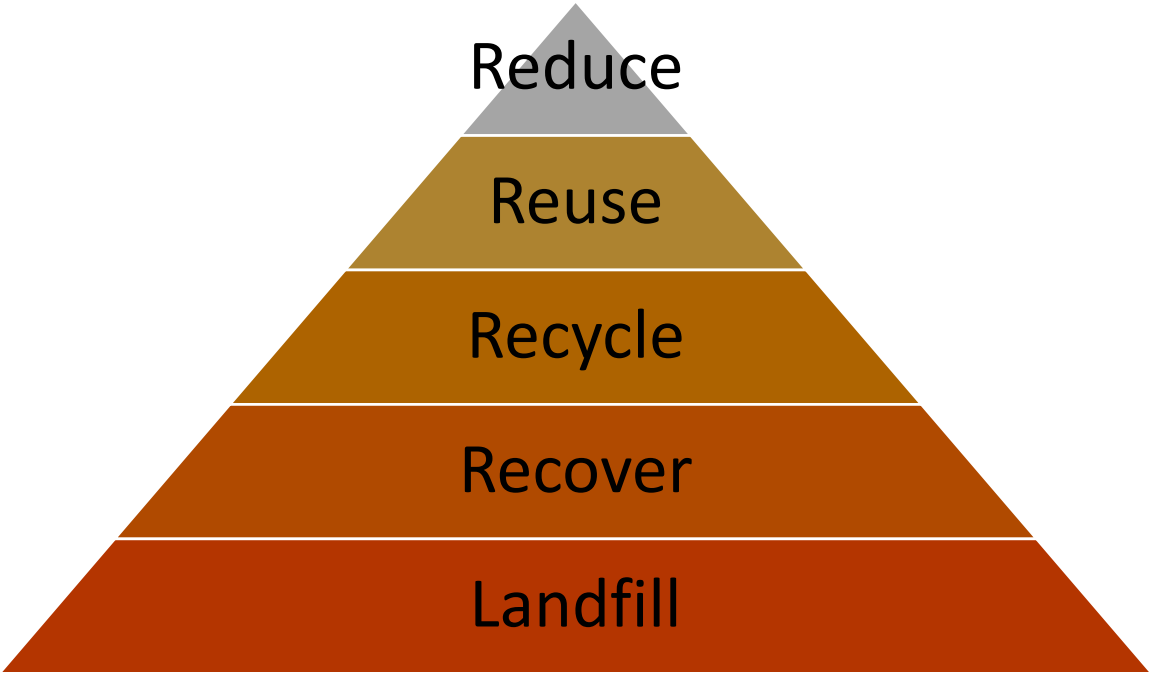


Fig 2.4 EOL Management Strategy Pyramid

On the top of the pyramid are the more desirable strategies, while the least preferred options are located at the base of the pyramid. (European Union, 2008).

2.6 Green Manufacturing design thinking in SMEs

One of the most important steps to implement any of the EOL management strategies to bring a transformation into the present manufacturing process. The greener the designing and manufacturing process becomes the closer we get towards making the entire system circular. Green Manufacturing (GM) definitions, meanings, approaches, applications, interpretations and modelling vary with industries, size, nature, sectors and even country-specific setups. (Seth et al., 2018)

GM suggests a new manufacturing model that includes various green strategies (objectives and principles), techniques (technology and innovations) and drivers (motivators and critical success factors) to become more eco-efficient (Deif, 2011). GM includes making or creating products/systems that consume less materials, low energy, substituting input materials (non-toxic for toxic, renewable for non-renewable) reducing unwanted by products, emissions, wastes and converting outputs to inputs (recycling).

GM involves the green design of products, use of environment-friendly raw materials and packaging, distribution, and reuse after the end of life of the product. It considers the 6 R's, i.e. reduce, reuse, recycle, recover, redesign and remanufacturing resources conservation, waste management, environmental protection, regulatory compliance, pollution control, and other related needs.(Seth et al., 2018)

SMEs in the UAE has proven to be the strategic industries across the country and are expected to play a much stronger role in the years to come. According to the UAE Ministry of Economy, SMEs sector represents more than 98 % of the total number of companies running in the UAE and contributes towards 52 % of the non-oil GDP. By 2021 the ministry is targeting 60 % contribution of SMEs. These SMEs contribute majorly to growth, innovation and job creation. (Alafeefi, 2019)

From GM implementation point of view, SMEs have a greater advantage than larger firms, as SMEs can adapt easy because of their adaptable structures which results in abilities to handle specialized and local markets (Moore & Manring, 2008). Individually, the impact of SMEs on the environment may be limited, but collectively, can be significant.

The new millennium progresses, productivity, profitability and environmental consciousness are progressively viewed as fundamental goals of manufacturing(Sarkis, 2001). Regulatory pressures is undeniable and will become even more stringent with the coming time and therefore, organizations whether SMEs or large, will have to implement enlightened and strategic viewpoint towards manufacturing as a whole so that the stakeholders could gain both competitive advantages and healthier social image.

All manufacturing industries, contribute to GHG emissions and influence the environment drastically (Sen et al., 2015). Inefficiency in terms of energy, supply chain management and manufacturing also lead to increased emission and wastes affecting the environment and financial performance.

Thus, it is become vital to implement Eco-design strategies in SMEs, which would eventually help towards EOL management.

Branger conducted a review of eco-design strategies (Branger, 2003) to identify and compare different approaches to the design and development of eco products.(Veshagh & Li, 2015) Few of the most relevant design factors affecting EOL management are discussed briefly in the following sections.

2.6.1 Design for Recyclability

The use of recycled material can considerably decrease consumption of raw material, energy and water. The use of recycled materials can reduce waste, consumption of virgin materials, air and water pollution, and energy consumption according to Thompson (Thompson, 1997). Graedel and Allenby (Graedel & Allenby, 2003) suggests that one of the important rules of design for recyclability is to avoid the mixing of materials in assemblies. Billatos and Basal (Billatos & Basal, 1997), in addition to this indicated that, so as to enhance product recyclability the number of different plastic and non-plastic materials used in a product should be minimized.

2.6.2 Design for Remanufacturing/Reuse

Designing for remanufacturing returns components to an acceptable performance level for re-assembly. This enables reuse of materials in their highest value state, thus reducing resource use and preventing waste. Generally, many components are dumped during a products life cycle with minor degradation due to wear or thermal or environmental exposure. Design to enable disassembly with provision to replace or repaired worn parts will increase product life and can enable substantial savings. This is true even when the cost of removing and returning the discarded part to the point of remanufacturing is included in the agreement. The viability of remanufacturing will depend on effective disassembly, ongoing demand for standardised parts and a positive perception of remanufactured content as suggested by Billatos and Basal (Billatos & Basal, 1997)and Lewis and Garstka's (Lewis & Gertsakis, 2001).

2.6.3 Design for Disassembly

The purpose of design for disassembly is to ensure that a product system can be disassembled at minimum cost and effort. As stated by Fiksel (1996), adopting design for disassembly strategy in the conceptual phase will contribute to speeding up the disassembly process and recovering a larger proportion of system components.

2.6.4 Design for End-of-Life

In Europe the End-of-life Vehicle Directive (DC, 2002) requires car manufacturers from 2002 onwards to withdraw all newly registered vehicles that need to be disposed. Designing for EOL at this final stage of the product life cycle is to ensure that, whatever disposal method is applied, the materials in the product should not create a hazard. This could mean to avoid any form of heavy metals and toxic substances that might lead to pollution of any form. For example, vehicle airbags are functioned using between 50 and 150 grams of sodium acid which converts into harmless nitrogen gas on impact. But if scrapped unused, this chemical can easily turn into highly toxic acid. The vehicle manufacturer or the solid waste collector should, therefore, ensure that the airbags are properly disposed of before the vehicle is shredded (Graedel and Allenby, 1998). These kinds of aspects must be considered to prevent further damage to the environment.

2.7 Innovation adaption theories

2.7.1 Defining Innovation

Before examining how a particular innovation is adopted, in our context EOL design thinking into product manufacturing process, one must establish the meaning of the term innovation. At the broadest sense, innovation can be any new idea to a population. Rogers (1995) defined innovation as "an idea, practice or object that is perceived as new by an

individual or other unit of adoption" (p. 11)(Rogers, 1995). According to Straub (2009), is not necessarily important that the idea, practice, or object is objectively new; rather, it is the perception of originality. In addition, he states that innovation also does not have to be more beneficial to an individual or that the new idea is better. Whereas innovation according to him can refer to something abstract, like an idea, it can also be concrete, like a new piece of technology.(Straub, 2009)

2.7.2 What Are Adoption and Diffusion Theories?

Straub explains adoption theory as what examines the individual and the choices an individual makes to reject or accept an innovation. In certain models, adoption is the extent to which that innovation is integrated into the applicable context and not only the choice to accept an innovation. Adoption theory, therefore, is then a micro-perspective on change, focusing on the pieces that make up the whole and not on the whole. On the other hand, diffusion theory explains how an innovation spreads through a population. To explain the process of how a population adopts, adapts to, or rejects an innovation, it may consider factors like social pressure and time. Diffusion theory has a macro-perspective on the spread of innovation across time.(Straub, 2009)

2.7.3 Adoption and Diffusion Models

There is no one specific model for understanding the method in which an individual behaves before adopting an innovation. Historically, adoption is understood in terms of behaviour change. For example, adoption and diffusion of new health behaviours, like smoking cessation or weight loss programs, have been studied in the medical and healthcare fields ("Theories of change and adoption of innovations: The evolving evidence-based intervention and practice movement in school psychology," 2005). Other models have been seen coming out of sociology (Deffuant et al., 2005), education (Pennington, 2004), and computer science (Venkatesh et al., 2003). As explained by Straub (2009), though the results of adoption theory are measured in terms of behavioural change, the predictors of that behavioural change can be understood through contextual, cognitive, and affective factors. Existing theories deal individualistically with these factors, but no one theory considers for all three.(Straub, 2009)

2.7.4 Institutional Theory and Technology adoption

According to Stapleton (2011) the technology acceptance model (TAM) is a popular theoretical model for understanding technology adoption in terms of technological features. TAM was explained by Davis (1989) in which technology-features which influence the adoption or otherwise of technology are organised according to factors which affect the perceived ease of use of the technology or factors influencing the perceived usefulness of the technology (Davis, 1989). Important examples of developing country case studies using Technology acceptance model can be seen in Gupta, Dasgupta

& Gupta (Gupta et al., 2008); Furuholt & Kristiansen (Furuholt et al., 2005) and Anandarajan, Igbaria & Uzoamaka (Anandarajan et al., 2000). (Stapleton, 2011)

On the other hand, Institutional theory sees organisations as social structures. (Selznick, 1949, 1957) was the first to use institutionalism to study organisations, and his approach is now commonly called „old institutional theory" (Selznick, 1949)(Publications & Publications, 2014). Selznick defines institutionalization as "the process by which an organization develops a distinctive character structure". Individuals have the potential to bring other types of commitments to the organization that can restrict rational decision-making (Fouopi Lemouchele & Stapleton, 2011). As per Scott (2007) organisations are shaped by the influences and limitations imposed from the exterior environment, highly adaptive and the particular attributes of the members of the organisation internally(Scott et al., 2007). This is juxtaposed with „new institutional theory" or „neo-institutionalism" developed by Meyer & Rowan (Meyer & Rowan, 1977) and expanded by DiMaggio & Powell (DiMaggio & Powell, 1983).

2.7.5 Neo-Institutional Theory

In Selznick's old institutional theory, certain values are instilled in organisations through institutional processes, but it was unclear in the theory of how this instilling happens (Scott et al., 2007). Neo-institutionalism emerged to address the weaknesses of the old institutional theory. Stapleton states that organisations are believed to be shaped by phenomena in their institutional context and then gradually become isomorphic with these phenomena (Meyer & Rowan, 1977). This process of isomorphism is very important for the success and survival of the organisation. He further explains that the organisations increase the commitment of both their own members as well as external actors through the incorporation of externally legitimated structures and procedures. An organization can demonstrate that it is acting according to jointly held and valued goals and purposes in an suitable way by designing the formal structures and practices of the organization that adhere to the various myths and dominant narratives in the institutional environment,.(Stapleton, 2011)

The neo-institutional theory consists of two main concepts: the isomorphic process (isomorphism) and the institutional process (institutionalisation).

Organizations tend to become more like each other over time by adopting similar formal norms, rules, procedures, organizational practices and structures. Isomorphism illustrates how external practices and structures affect organizations, and then, how institutionalized structures and practices propagate across organizations and within and across supply chains. DiMaggio and Powell (1983) refer to three isomorphic processes.

1. Coercive isomorphism: formal and informal pressures are exerted on organizations and decision-makers to follow certain institutionalized rules and practices by other organizations.

2. Normative isomorphism: when managers, supervisors etc. are professionalized (i.e., they have similar educational background and training and participate in some professional communities), they tend to implement similar ideas across the firm (DiMaggio & Powell, 1983).
3. Mimetic isomorphism: organizations imitate other organizations, especially in uncertain contexts, where it can significantly reduce the risks associated with adopting new practices and structures. Mimetic isomorphism can have potential economic benefits, for example, through the reduction of the cost associated with finding viable solutions or alternative methods when organizations are faced with similar problems.

Stapleton stresses that external connectedness of the firm with outside institutions is an important aspect of isomorphism and is referred to as „system openness". Russell & Hoag (2004) noted that system openness was, theoretically, a positive determinant of the adoption of technologies and related innovations such as processes and structural arrangements. External connectedness to other organisations can work in mostly three main routes: Through relations with other trading partners, Through the influence of a host organisation of which the local organisation is a subsidiary & through the influence of large, non-business institutions. (Stapleton, 2011)

In Institutionalisation members corporately accept different formal structures as both important and relevant within that organisational context, and this serves to legitimate organisations. In this type of view, the adoption of innovation within the formal structure of an organization depends largely upon how the adoption will improve its internal processes. Once the innovation has been recognized for a while, because the adoption has now achieved social legitimacy, changes in the formal structure are generally adopted by members of the organisation. The organisation then comes under considerable pressure to incorporate the innovation into its formal processes and structures to maintain its legitimacy. In this way, Stapleton explains that an organisation can demonstrate that it is collectively acting according to a set of shared values and purposes in an appropriate way.

Institutional theories are used in technology adoption literature for developing countries to explain national differences in adoption rates, or differences between the adoption rates of different technologies, e.g. (CORRALES & WESTHOFF, 2006). Molla & Taylor (2004), to examine particular influences of civic authorities and their interference in the adoption of e-commerce technologies in Barbados used a neo-institutional framework.(Taylor et al., 2006)

2.8 Synthesis of Hypotheses

Based on the literature review done in this chapter, an attempt can be carried out to define and suggest what the participants would perceive in the case study being performed regarding the influencing factors that would affect the end of life deign thinking from being implemented within the company. As it is apparent that system openness of the company is necessary for its survival, in a highly competitive environment such as the

one that persists in the middle east, trade partners have a significant influence on all levels of company functioning, for example in the adoption of new technology like electronic data interchange(EDI) as explained by Stapleton (Stapleton, 2011). He also stated that that level of available internal knowledge could act as a barrier. Internal institutionalised procedure and process would, on the other hand, help towards innovation adoption. It was also learned that local government support could act as a strong influencing factor along with trade partners towards EOL design thinking implementation in developing countries like seen in a case study conducted to implement EDI in Cameroon.(Fouopi Lemouchele & Stapleton, 2011; Stapleton, 2011)

Research Proposition

H1.1: Participants will perceive that trade partners are an influence towards adopting EOL management design thinking concept

H1.2: Participants will perceive that competitors are a strong influence towards adopting EOL management design thinking concept

H2: Participants will perceive that that Internal institutionalised procedure and process are an influence towards adopting EOL management design thinking concept

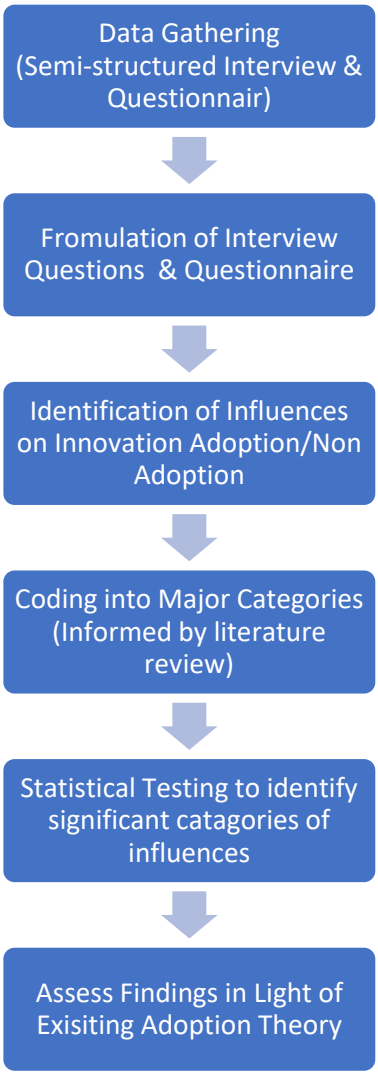
H3: Participants will perceive that level of available internal knowledge are a barrier towards adopting EOL management design thinking concept

H4: Participants will perceive that the host government support is an influence towards adopting EOL management design thinking concept

Chapter 3. Research Design/Methodology

3.1 Introduction

This chapter presents the research methodology, data collection instruments that are planned to be used, study participants, and how the analysis of the data collected was performed. From the start is was decided that this would be an exploratory study. The purpose of the study was to find the influencing factors that determine the adoption of EOL design thinking in SME's in the UAE. Hence It was understood that this research needed to be a qualitative exploratory method rather than a quantitative one, as a qualitative approach is more suitable when analysing a company as a case study.



3.2 Research method

The present study is a descriptive survey of the top management and decision-making personals of a company using questionnaires and informal interviews. There is no metrics or variables that are measured or monitored, which would mean that the entire study is purely qualitative. Participants in the research were given a questionnaire of 21 questions which are subdivided into 3 sections. This was sent beforehand by email to all the relevant participants but was encouraged to fill out alongside the interview period as certain terminologies and the purpose of the research was needed to be explained in person. The questionnaire was aimed to uncover in a detailed but short manner the thought process behind the designing of their product and most importantly the influencing factors, whether enablers or barriers, that help SMEs, like their own company, in UAE to implement EOL design thinking into their manufacturing process. The questionnaire was also designed to find out if the design strategies of EOL management, (reuse, recycle, remanufacture and disassembly) are implemented and how.

Through the informal interview, a set of 9 questions were asked in 2 sections. A general overview of the company, the personals experience and the impact of the company's products to the environment were also discussed. The interview would help reveal in a descriptive manner what the company is doing to reuse, remanufacture, recycle and disassemble its products. The core of the interview is meant to circle around the influences that affect the company's decision to implement EOL design thinking in its product manufacturing.

3.3 Data collection instruments

As discussed earlier, for this research, a questionnaire was distributed to the top management and the manufacturing decision-makers of the company beforehand through email. Furthermore, an informal interview was conducted with all the participants to enrich the data collected. This was done after an appointment schedule was created and conducting one on one meeting at the company premises.

3.4 Questionnaire format

The participants were sent across a questionnaire with 21 questions by email in advance to get familiarized with the purpose of the research and the topics to be covered. They were requested to fill in the questionnaire beforehand but was also encouraged to complete it, during the interview session. This helped them to clarify any doubts or misunderstood terminologies. The questionnaire was purposefully made to be short and to the point so as not to take too much time of the participants and to keep their attention in check. The purpose of the research was explained to them in advance through email

and stated on top of the questionnaire. The questionnaire was divided into 3 sections. The first section covered demographic data like the participant's age, gender, education level and number of years of work experience in the UAE. The second section covered 9 general questions related to, if the company considers eco-design strategies like design for reuse, recycle, re-manufacturability, disassembly and end of life in their manufacturing process. The participants expressed their disposition towards the statement by either selecting yes or no. The final section goes deep into the research where 7 questions are asked to probe into the various influencing factors, identified from literature review, that could affect the company to either think towards as an enabler or think away from, as a barrier, implementing EOL design thinking in its processes. Here the participants select each influence as either an enabler, barrier, both or non-applicable if found irrelevant. The participants are also given the freedom to decide not to answer any question they felt unrelated or beyond their scope of work.

3.5 Informal interview format

Once the list of interviewees was decided, an interview schedule was created based on the availability of the participants. During the interview, the scope of the research was explained to them and all relevant terminologies were defined. It was important to keep it informal as this would help participants to point out important dimensions and aspects that could be of interest, without the stress of a strict agenda. Discussions and informal interviews were necessary to obtain details and examples of how the company works towards creating products through its eco-design strategy. This also gave the participants the opportunity to express their opinion through project references on how different influences affect their design thinking approach.

3.6 Participants

All participants that took part in filling the questionnaire also attending the interview. They were employees of the same company, who were key decision-makers of various departments who were directly involved in influencing the design, manufacture or commissioning of the product. Managers from the engineering, projects, operations, production, quality, proposals and Top management were considered for the research. The participants comprised of 6 Males and 1 female who were from varying education levels and ages. Anonymity was offered to the participants to make sure that they would feel at ease to express their honest opinion without the pressure of being documented as in a formal interview.

3.7 Analysis and interpretation of questionnaire results

The data provided by the participants were collected and interview transcripts were formulated. All the data was then processed through a content analysis software called NVIVO. Content analysis uses words and phrase frequencies and inter-correlations to identify the relative importance of terms and ideas (Robson, 2003). Using this coding technique, the qualitative data were organised according to the main themes in the responses. This was performed in two stages. During the first stage, the data was coded into the primary causes using traditional content analysis (without any templates or a-priori categories). In the second stage, the data were classified into major themes or categories of causes or influence. In this stage of coded literature was reviewed. This was done according to a form of templating. However, if reported causes from stage one of this process conform into the templates developed from the literature, new categories were created (e.g. Ovaska & Stapleton, 2010). Next, results were processed through Microsoft excel to cross-tabulate categories of influence as enablers or barriers to this innovation adaption.

Chapter 4. General observations and data analysis

4.1 Introduction

Before stepping into the analysis of the collected data, it is important to understand the context, scope and background of the company under investigation. The information shared in the first part of this chapter is the result of reviewing company literature, procedures, informal discussion with top management and personal work experience in the company. The second part of the chapter covers the analysis of the data collected from all sources.

4.2 Background and context: The company

The company under investigation is a water-wastewater treatment plant manufacturing company with its head office in UAE. They are specialized in designing, manufacturing, installing, operating and maintaining containerized and civil constructed water treatment solutions. This includes treating river water, industrial effluents, sewage water and even saltwater to high quality treated water. This treated water could then be used either for irrigation, washing, cooling, other industrial applications or even be enhanced to drinking water standards. They also handle sale and servicing of the various parts within the treatment plant.

The company has been in the middle east market for the last 12 years and have become one of the leaders in the sector within this short period of time. They are an SME with around 110 employees working full time at the head office in Sharjah.

Most of their projects revolve around the middle east and north Africa with project sizes ranging from 20 cubic meter per day (CMD) to 2000CMD. All the designing and manufacturing of the plants take place at the head office after which the entire containerized plant or the different parts are transported to the site either through trucks or ships, where they are assembled and later commissioned for usage.

The company implements circular economic model as far as possible in most of its processes. They are ISO 9001, 14001 and 45001 certified. All their procedures are documented and adhere to strict quality and HSE standards. They have a dedicated engineering department and a production floor equipped with state-of-the-art machinery to help manufacture and fabricate containerised treatment plants within the stipulated time period as agreed with the client.

4.3 Data findings

Demographic features of the participants

This section, along with figures 4.1 to 4.3 explains the demographic features of the research participants, and more specific information on gender, age, education qualification and years of experience in UAE.

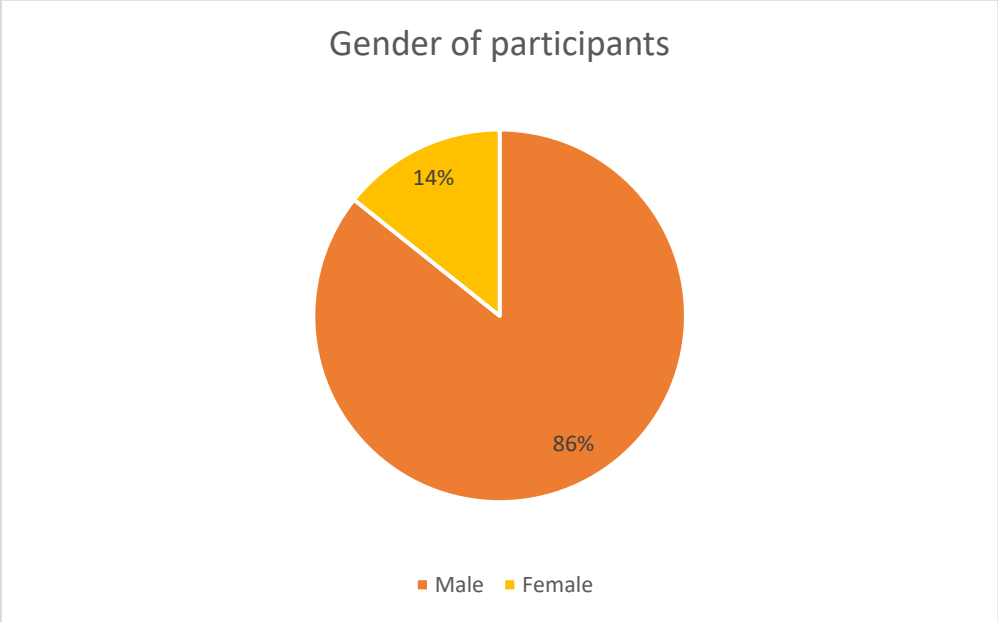


Fig. 4.1: Percentage of the gender variable of the participants

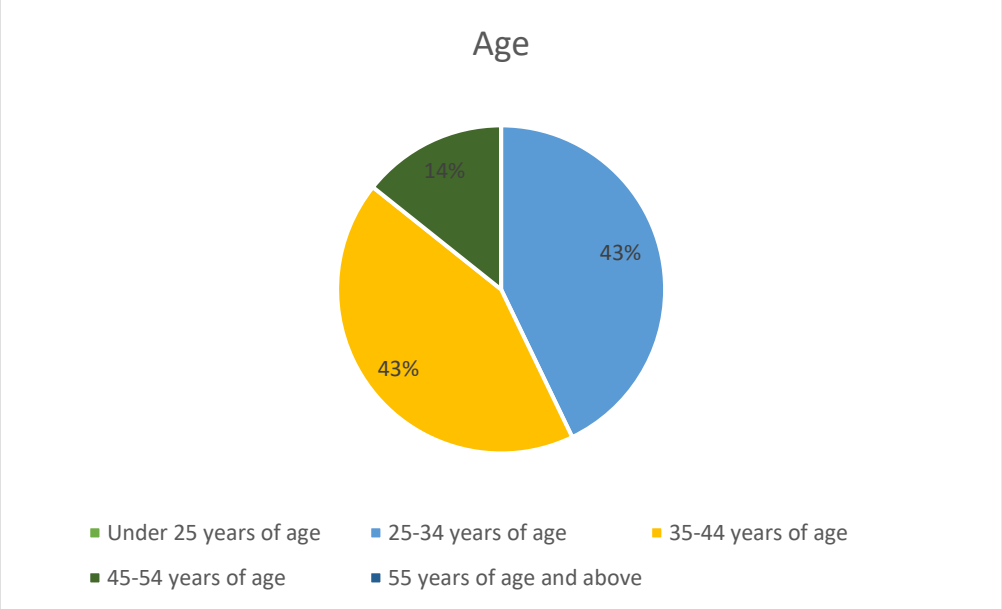


Fig. 4.2: Percentage of the age variable of the participants

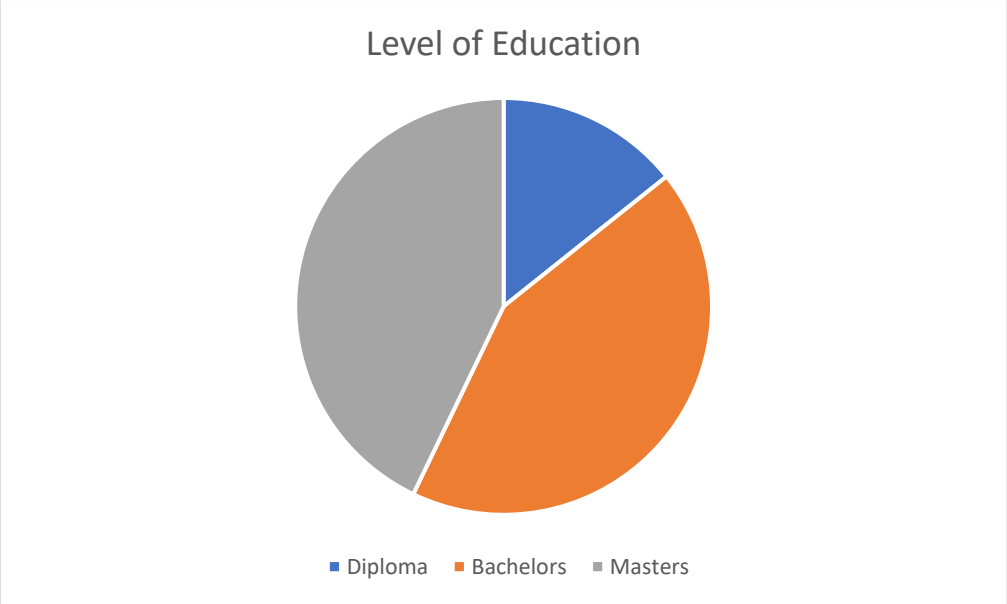


Fig. 4.3: Percentage of the education level variable of the participants

All the participants selected to part take in the research were key personals or managers from various departments within the company, involved in either designing or responsible for adding value to the manufacturing of the product anywhere from the conceptual phase till the handing over of the project to the client .6 out of the 7 participants were males. Most of them were between the age group of 25-44, with only one person above 45 but below 55 years of age. This shows that most of them were either in the middle of their careers. The majority and an equal number of people were bachelors or master's degree holders. All of them were from the engineering background. Thus, it could be concluded that all of them had relatively high levels of education. Also, the participants working experience in the UAE ranged from 7 years to 15 years. This reveals that they are aware of how the UAE market functions and are informed of its trends and features.

4.4 Circular Economy thinking inside the company

From the interview, it was clear that all participants understood and implemented circular economy thinking in their various spears of work within the company. The participants were asked about what the company does in terms of implementing a circular economy through various strategies of green manufacturing and below mentioned are their comments and observations.

4.4.1 Culture of Circular economic thinking

All major departments within the company acknowledge the implementation of circular economic thinking at some level or the other. From screening all suppliers to provide environmentally friendly raw materials to even ensuring all waste from the production floor are reduced, reused or sold as scrap to responsible recycling service providers, the

environmental standard of its process and products are very high. The 2 main core competence of the company is of high quality and durability. This is ensured by the selection of high-quality parts and components and robust design. Continuous improvement is performed on all procedures within the company. Thus, lessons learned during the design, manufacturing and project implementation are recorded and communicated well within the company. This helps significantly to avoid the same mistake from repeating again.

4.4.2 Design for Reuse

The product has a life cycle of 20-25 years, and the company is as young as only 12 years since its conception. Most of its products are currently functioning, and the company is yet to receive a reference project where they could reuse its product. They do have the capacity and provision to repair it's worn out components and reuse it. There also have been times when certain parts of the plant when failing to meet a certain level of functioning are brought back, repaired and used for other purposes. For example, a pump whose throughput has reduced could be repaired and used for draining water out of a reservoir or for cleaning purposes. There are generally 2 challenges when it comes to reusing. One such challenge is regarding the ownership of the plant. Once the plant has been handed over successfully to a client, the complete responsibility and proprietorship of the plant is of the client. They decide what happens to the plant regarding the end of life management and not the manufacturers anymore. The second challenge is with regards to the mental stigma with most clients with regards to using a second-hand product. Since each of these plants based on their size is expensive and are required to work for a long period of time, the clients would be weary on purchasing reused products.

4.4.3 Design for Recyclability

Raw material used for fabrication is either stainless steel (grade 316 or 304) or galvanized mild steel. The speciality of stainless steel is that they have a very long life as they do not corrode easily. This means they can be reused even after the lifetime of a treatment plant. The 20 feet or 40 feet ISO containers used for the purpose of creating the treatment plant are reused cargo containers. This container at the end of its life can either be reused for another plant or even emptied to be used as a storage facility at project sites or even cut down into scrap to be sold and smelted for various other purposes. Only a very few components in the plant cannot be recycled, for example, the membrane modules. Otherwise, close to 90% of the components are either bio-degradable or can be easily recycled without causing harm to the environment. The company does not have any reference yet regarding recycling of its product. This again is mainly because of the ownership of the plant. The client is finally responsible for the disposal of the plant at the end of its life and thus must consider these aspects while budgeting for the project.

4.4.4 Design for Durability or Repair

The company has a maintenance department that helps its clients to keep the plant and its parts functioning at optimum condition throughout its life period. They also provide preventive and corrective maintenance, to ensure continuous functioning of the plant always without any stoppage. The stainless-steel sheets and polyethylene pipes used help increase the life of the plant. All other components fitted are checked to have a high standard of quality, procured from reliable suppliers and hence makes the entire plant durable.

4.4.5 Design for Re-manufacturability

The entire plant, being containerized, have been provided with the provision to be easily upgradable. They could also be brought back to the workshop and remanufactured to increase its capacity. The company is also specialized in the rehabilitation of existing plants to increase its capacity.

4.4.6 Design for disassembly

One of the design strengths of a containerised plant is that the different components are assembled into a 20- or 40-feet container. They are so designed for easy transportation from the workshop to site. Depending on the size of the plant, certain parts are even moved separately but assembled once reached at site. The most significant advantage of such a system is the ability to remove any part at any given time for either repair or replacement, quickly and efficiently. This is achieved by reduced usage of welds and using joints couplings and fixtures instead.

4.4.7 Design for EOL

As mentioned earlier, close to 90% of the components are either bio-degradable or can be easily recycled without causing harm to the environment. Since the plant is meant for treating water, even the chemicals used are non-hazardous and can be even replaced with food-grade chemicals as per the client requirement. Only a very few components in the plant cannot be recycled, for example, the membrane modules.

4.5 Major Influencing factors

Influencing Factors	Number of participants who feel this as an enabling factor (x)	% - Enabler [(x/7) *100]	Number of participants who feel this is a barrier (y)	% - Barriers [(y/7) *100]
Customer/Client	7	100	2	28.57
Supplier	2	28.57	1	14.29
Financial Institutions	3	42.86	0	0
Competitors or others in the same industry	6	85.71	1	14.29
Government	4	57.14	0	0
Internal institutionalised Procedures and Process	5	71.43	0	0
Level and extend of available external knowledge	5	71.43	0	0
Level and extend of available internal knowledge	2	28.57	0	0
Infrastructure	6	85.71	0	0
Influence of international agencies	7	100	0	0
Improve Internal Knowledge of employees	3	42.86	1	14.29
Subsidiarity	2	28.57	0	0

Table 4.1: Influencing factors selected as enablers and barriers by the participants and their percentage

Table 4.1 explains all major categories of influences identified during content analysis of questionnaires and interview transcripts. These were what the participants considered as enablers or barriers for implementation of EOL design thinking into its manufacturing process. The participants could choose from stating whether that a theme was an enabler, barrier, both or not applicable to their scope of activity in the company. The table also states the percentage of participants who thought similar on the same point. If a participant felt a category as both enabler and barrier points were placed on both alike.

4.5.1 Enablers of EOL design thinking

Enablers	Number of participants who feel this as an enabling factor (x)	% - Enablers [(x/7) *100]
Customer/Client	7	100
Influence of international agencies	7	100
Competitors or others in the same industry	6	85.71
Infrastructure	6	85.71
Level and extend of available external knowledge	5	71.43
Internal institutionalised Procedures and Process	5	71.43
Government	4	57.14
Financial Institutions	3	42.86
Improve Internal Knowledge of employees	3	42.86
Supplier	2	28.57
Level and extend of available internal knowledge	2	28.57
Subsidiarity	2	28.57

Table 4.2: Influencing factors selected as enablers by the participants and their percentage

a. Customer/Client (100%)

All 7 participants unanimously agreed that the customer is the strongest influence, enabling towards EOL design thinking. Two of them felt that they act both as an enabler and a barrier. It was expressed that though the client requirements vary from market to market and region to region, most of them are growing in knowledge with regards to the latest technologies and environmental regulations. Majority of the tenders and project specifications published by end clients, either government or big real estate developers from the middle east or developed countries highlight on meeting design requirements like reusability, recyclability, re-manufacturability and disassembly. Especially, if the plant manufactured is meant for treating water to meet drinking water standards all components selected, and chemicals used are non-hazardous thus making the end of life of the product highly environment-friendly and easily manageable. The following quote illustrates this:

"Most of the raw materials used are bio-degradable, all other components are obtained from manufacturers who adopt such similar policies. May be not 100% but 90% of the components for sure, both mechanical and other raw materials.....But again, depends on Client requirement, if it is for drinking water purpose then the grade of raw materials in much higher as compared to Industrial applications." Candidate #2

But it was also understood that lesser developed countries tend to have their focus more on meeting quality and durability over concepts like EOL management. However, the company design process and infrastructure are well established to meet the client requirement and suggest better solutions if not mentioned in the project specification. It was also interesting to note that the obligation of EOL management of the product finally falls on the responsibility of the client. For example, one of the candidates explained:

"The company [under research] as a manufacturer and sub- contractor handle the HSE or quality side of implementation. But the EOL management is the responsibility of the client or main contractor. For example, if any component is damaged or needs replacement, once in operation, it is the responsibility of the client/ plant owner to make the call. Though the government has rules regarding disposal of the plant wastes or its parts, it is his responsibility to ensure its safe disposal and not the manufacturers." Candidate #1

He, being the sole owner of the equipment finally needs to take the call on how the product's end should be managed, whether recycled, disassembled, re-manufactured or scrapped as a whole.

b. Influence of international agencies (100%)

All 7 participants also agreed that international agencies play a vital role as an enabler. Specifically, the International Organization for Standardization (ISO) has really impacted the company procedures and policies. The company is ISO 9001, 14001 & 45001 certified. Evident from the quote:

"Yes, we are 14001 certified [also]. This is causing us to have all procedures standardized." Candidate #4

Which means all their process and procedures are documented and adhere firmly to a well-established integrated management system (IMS). The IMS is a combination of the quality management system (QMS), environmental management system (EMS) and Occupational, health, safety and environmental system (OHSAS). These certifications push the company to follow the industries best practices in terms of quality, environment and safety. UAE market, along with many other international markets make it mandatory to produce these certificates as a pre-qualification measure even during the tender or bidding stages.

c. Competitors or others in the same industry (86%)

"UAE market is fresh, new and aggressive in terms of competition." Candidate #2

From this quote it can be understood that UAE has a very fierce and competitive market. It is always in the company's best interest to be a step ahead of the others. It is not surprising for companies to study one another's technology, mostly to ensure themselves to be growing continuously with the changing market and not fall behind. Hence, six out of the 7 participants felt it as an enabler pushing the company to think towards better solutions and EOL design thinking in its products.

d. Infrastructure (86%)

As mentioned earlier, the company is well established with state-of-the-art equipment and machinery to meet any acceptable client requirement. The company uses the latest versions of the designing platforms for engineering. Most of the activity at the workshop floors is assembly and fabrication using SS or mild steel sheets for various internal fixtures. The company is well prepared with both manpower and machinery to work and meet the client's deadline with top quality. This is uncovered through the quote

"Our company [in terms of infrastructure] have reached the point of providing highly sustainable products; hence it [EOL design thinking] does not give us an additional overhead. So even if the client requires high standards it is easily achievable." Candidate #2

Also, UAE's location and market being highly dynamic make it easier to acquire the latest machinery and technology with ease and at comparatively reasonable pricing, manufactured from anywhere in the world.

e. Level and extend of available external knowledge (71%)

The company keeps a keen eye out on the latest developments, especially in the field of water and waste-water treatment.

"Continuous improvement through Lessons learned. If we find a part corroded or damaged with time, the next time we try to change it to reduce the damage and not have the same problem." Candidate #2

From the above quote it is evident that the continuous improvement of the product is a key objective of the company and has trickled down into key performance indicators of the design and engineering departments. This also ensures that the relevant departments are kept up to date through review of international journals, various newsletters and research documents. They also from time to time affiliate with university personal to assist them in their research work. Suppliers are also an important source of acquiring external knowledge. Though the stress of the market is still on demanding high quality and durability over EOL management, the level and extent of available external knowledge is indeed helping to think towards EOL management design thinking.

f. Internal institutionalised procedures and process (71%)

As discussed in point b, the company is ISO certified and has a well-established Integrated management system (IMS). This system forces the company to align all its process and procedures with the ISO standards on quality, environment and safety of its own process and its surrounding business environment. 71% of the participants voiced the same opinion. An example of this influence is the system for waste recycling inside the company. Apart from ensuring lean production for its manufacturing process, all scrap generated is at first segregated into wood, pipes, metals, bio-waste etc. They are then designated either to be recycled or to be sold as scrap to government authorised scrap handlers.

g. Government (57%)

Almost half of the participants feel the government act as an enabler. The government has 2 sides in this matter. First, as a customer, allocating budgets and publishing projects related to water treatment to which the company participates. The requirements of such projects depend from market to market. From the experience of the participants, the government of developed countries tend to be more inclining towards EOL management but not so much in developing or underdeveloped countries. Secondly, the government of UAE with its aim to reduce landfills by 75% by 2021 (EmiratesGBC, 2019) are becoming more and more stringent with regards to quality, safety and disposal methodology at the end of life of all products.

"Yes. They are strict about safety and Quality. The disposal rules in the municipality are strict hence they are enablers. But could be stricter." #4

From the above quote we understand that, the government of UAE is thus pushing all manufacturers and end clients to make amendments in their design process to meet this national goal. It was understood that the regulations with regards to disposal of products varied from city to city in UAE but are yet to be enforced more strictly in the country as a whole.

4.5.2 Barriers of EOL design thinking

Barriers	Number of participants who feel this is a barrier (y)	% - Barrier [(y/7) *100]
Customer/Client	2	28.57
Supplier	1	14.29
Competitors or others in the same industry	1	14.29
Improve Internal Knowledge of employees	1	14.29

Table 4.3: Influencing factors selected as by the participants and their percentage

a. Customer/Client (29%)

Two participants felt that Customers do act as a barrier towards the adoption of end of life management design thinking. This is most commonly seen with clients who have a very tight budget to work with. This is clear from the quote,

"Price is the biggest problem in the market. Client at times prefer to choose the cheapest solution." Candidate #3

Hence, these clients prioritize on higher quality but cheaper price. Companies, like the one being researched, are thus forced to provide solutions using components or raw materials that might not be as environmentally sustainable as others which might be more expensive. But the company makes it a priority to make the client aware of the design

features that could be modified and the additional cost that would be encountered. The end decision finally still lies with the client who must eventually takes up the complete responsibility of the product once handed over.

b. Supplier (14%)

It was also mentioned during the interview that at times the supplier does act as a barrier. 14% percent of the participants expressed the same. Though the company has a strict screening method for prequalifying and blacklisting non-conforming suppliers, it is not uncommon for a supplier to provide faulty products or parts and thus requiring high level of quality inspections. This could be an indirect result of high competition and tight budget restraints put up by clients.

c. Competitors or others in the same industry (14%)

"At times clients are looking for cheapest solution hence competition sometimes pushes to shift focus from this [EOL design thinking] to more viable solution for the client. High quality product does affect the price." Candidate #7

Like the case with suppliers, competitors sometimes try to bend the price in the market by providing solutions that are less environment-friendly but cheaper. This acts as a barrier for the company to think more towards EOL design thinking. They now must try balancing to keep its stand on quality and durability, at the same time win the project. It is also worth mentioning that most SMEs are more profit-oriented in the UAE market, as the number of competitors is high and winning a project is crucial at times for the sustenance of the company. Thus, competitors do act both as an enabler as well as a barrier towards the adoption of this kind of design thinking.

d. Other barriers

Some other comments were noted from the interviews that do act as barriers. The current government rules and regulations in the UAE are strict towards quality, health, safety and environment. But with regards to EOL policies or regulations though stated, are still to be enforced. Most companies in the market are thus not forced to think in this direction but on the present need for high quality and durability. Hence all conferences, internal training or recruitment of employees are based on enhancing the knowledge of developing products that are of higher quality and durability much more as compared to EOL concepts. These influences thus do directly or indirectly work as both a barrier and an enabler towards EOL design thinking. Another important consideration is the maturity of the company. A younger company would be more profit-oriented while a mature, well established one, would be more comfortable to invest in EOL management development of their products.

Chapter 5. Discussion of findings

The data gathered for this research aim to shine a light on the influencing factors that enable or prevent an SME from adopting EOL management design thinking concepts. This next section examines the hypotheses stated earlier, contrasts and comparing them against the main findings derived from the previous chapter. An attempt to answer the research problems is performed, as well as whether the research objectives were reached is explored. Suggestions for future research and the limitations of the study are also stated.

5.1 Research limitations

Conducting any such research is always accompanied by challenges, several limitations and difficulties which could be inflicted either by internal or external factors. These factors can not necessarily always be controlled. The first limitation was based on the research methodology and technique used in this study. The study relied on a qualitative approach, which, unlike quantitative methods, is more open to researcher interpretation and not so much of a strictly defined method. The data gathered from questionnaires and semi-formal interviews with participants, set another limitation, as the information shared by them depends mostly on the formulation of the question from the researcher. Another limitation could be the limited number of participants who are full-time employees of the company. Deeper analysis in a few more SMEs would also provide richer insight into adoption influences. It must also be understood that all the staff, as well as the participants, are not citizens of UAE. They all have come from different parts of the world to seek employment in this company. Such social and background influences are beyond our scope of the study. Lastly, while similar influencing factors play out in a variety of projects and contexts, other SMEs may have different priorities, and these influences may unfold in different ways. This study therefore, is an initial study of UAE SMEs and further work will be needed to confirm or otherwise the results presented here.

5.2 Examination of the hypotheses

Based on the findings from the previous chapter, an attempt is made to examine whether the stated hypothesis applies to the current case under investigation.

H1.1: Participants will perceive that trade partners are an influence towards adopting EOL management design thinking concept

It was uncovered that the influence of external pressures was the strongest influence on the adoption of EOL management design thinking. But on examining a little more in detail showed that the type of trade partner affected the organization differently. The customer is the strongest influencer among the trade partners acted both as an enabler and a barrier. While suppliers did bring in valuable information on various latest

equipment and parts did at times pose as a barrier. This was mainly because of the high competition in the market and budget constraints of the customer. The financial institution from developed countries funding international projects did require the company to meet strict environmental regulations, but more than often were not applicable as an influence in most cases. Study of competitors is very important for the sustenance of the company, but tight competition also means trying to provide a solution that is most viable for the customer. This tends to push the company at times to compromise on EOL management design thinking. Finally, Government regulations vary from region to region. UAE government has strict quality and HSE regulations. They are yet to enforce stricter regulation on the disposal of waste, thus not so much of a strong influencing factor.

It can, therefore, be concluded that the external pressure from trade partners do act as a strong influencing factor, but the type of trade partner makes a difference in the direction of influence.

H1.2: Participants will perceive that competitors are a strong influence towards adopting EOL management design thinking concept

From the findings, it is apparent, that competitor is a strong influence towards adopting EOL management design thinking. The company takes caution to study its partners mainly to have a competitive edge over them in the market. As mentioned earlier, UAE being an aggressively competitive market, more than often, price becomes the criteria for selection. This pushes all the participants to prioritise on winning the project over sustainability. This is very evident, especially with smaller clients working on a very tight budget. Hence, this hypothesis is partially true as the competitors can also act as a barrier to EOL management design thinking.

H2: Participants will perceive that that Internal institutionalised procedure and process are an influence towards adopting EOL management design thinking concept

ISO certificates are a mandatory requirement for participating in all major international and local projects. It is also one of the criteria for UAE companies to have their commercial and trade license issued or renewed. Hence all the internal procedures and processes are well in alignment with the international QMS. EMS and OHSAS standards. From the findings, most of the participants felt that this factor is a strong influencer, and hence this hypothesis is proved correct.

H3: Participants will perceive that the level of available internal knowledge is a barrier towards adopting EOL management design thinking concept

From the demographic study, it is evident that all the participants were with high levels of education. Most of them were either a graduate or a postgraduate from the engineering field. All of them were aware of the concepts discussed. It was evident that most of them had applied their knowledge of the circular economy into their field of work. Though this

was an influencing factor, it was also discovered that not all the staff in the company were either trained or aware of such concepts. Since the main objective of the company has been to provide high quality and durable products, all its internal training and recruitment have been in this direction. Also, it is worth noting that since the company is relatively young with a modest turnover, there was no requirement or framework for an R&D department yet. It can be concluded that this premise is not much of an influencing factor, and hence this hypothesis can be rejected.

H4: Participants will perceive that the host government support is an influence towards adopting EOL management design thinking concept

As discussed in section 4.5.1.g government regulations and requirements change from market to market. For UAE, the government is currently in the push to reduce landfills by 75% by 2021. From the interview, it was understood that though the federal government has stated policies to implement EOL management of all products in UAE, it has not trickled down to the local government enforcement agencies to the expected levels yet. All the participants felt that the support of the government is essential. Though not currently, this could become a strong influencing factor in the near future. One of the participants also expressed that government incentives would help SME's to transition into such design concepts more easily and effectively. Thus, this hypothesis is accepted and will become more and more relevant with the coming time.

5.3 Research objective and questions

At the beginning of this study, the research objectives stated was to answer the research problems posed in chapter 1. Using findings gathered from all the questionnaire, semi-formal interviews and the hypotheses examined in the previous section, the research question has been answered below.

RQ1: What are the influences that affect implementing sustainable policies at the end-of-life stage in the product life cycle of an SME in UAE?

There were many factors discovered during the investigation into the influences that affect the implementation of EOL management design thinking in a small-medium enterprise in the UAE. The most important factor of all was the influence of external pressure on the organization through trade partners. All 7 participants felt the influence of Customer as the strongest factor of influence. This was followed by the unison agreement on the influence of international agency (ISO) as another factor. This influence filters down to internal institutional procedures and processing falling in line with international standards to ensure the ISO certification demands are met. For the UAE and other international markets, this certification is a very important stamp of quality and HSE compliance. Competitors in the market were another strong influence pushing the company to make decisions in their offers to either align themselves to win the contract or give themselves a competitive edge over the other. Level of external knowledge was also a noteworthy influence. Continuous improvement of their product

is a key objective the company stresses on. This may be through the feedback received from internal factors like production floor, project managers and commissioning errors or external ones like the clients, who share their comments identified during the working of the plant. Government influence varies from region to region. But in the future, as the government regulations tighten their influence is going to be paramount.

RQ2: What influencing factors act as enablers and barriers towards adoption of sustainable policies at the end-of-life stage in the product life cycle of an SME in UAE?

Influencing Factors	Enabler	Barrier	Potential Enabler	Potential Barrier
Customer/Client	✓	✓		
Supplier	✓	✓		
Financial Institutions	✓			
Competitors or others in the same industry	✓	✓		
Government	✓		✓	
Internal institutionalised Procedures and Process	✓			
Level and extend of available external knowledge	✓			
Level and extend of available internal knowledge	✓			
Infrastructure	✓			
Influence of international agencies	✓			
Improve Internal Knowledge of employees	✓	✓	✓	
Subsidiarity	✓			

Table 5.1: Summary of Observations

Equally Enabler and Barrier: All the influences identified were further classified into enablers and barriers towards the implementation of EOL management design thinking as mentioned in section 4.5. Some of the influences showed both characters. The strongest enabler was undeniably the client. Elements like the owner ship of the plant and the responsibility of the EOL management falling onto the shoulder of the client is pushing them to think more in this direction and thus is requesting companies to provide solutions that consider these factors. Some clients who do have restrictions on budget do force companies to provide cheaper solutions that overlook EOL management issues. Here the same influencing factor begins to act as a barrier. A similar observation was

seen with competitors as an influencing factor, which though pushes the company under research to make their product better also push them to provide weaker solutions at lower price. This is mainly because of the tight competition created by clients with very tight budgets looking for the cheapest solution.

Enabler: Next biggest influencer acting as an enabler is the presence of ISO certification in the company that aligns all its internal institutional process and procedures according to the international standards of quality and HSE. The company infrastructure is also state of the art to meet any client requirement or specification related to EOL management principles.

Barrier: The biggest influencing factor that stood as a barrier to EOL management design thinking adoption, as discussed earlier is again unquestionably the customer. Second, to this, the influencing factors like suppliers and competitors do act as a barrier.

Potential Enabler: Government is a very important factor that in the coming time will act as a very strong enabler, especially in the context of the UAE market. Also, it was mentioned that improving the internal knowledge of the staff at all levels could certainly act as a future trigger for EOL management design thinking adoption throughout the organization.

5.4 Suggestions for future research

A lot of literature review can be discovered with regards to the implementation of Circular economy into the manufacturing sector of SMEs of various countries. It was quite unexpected to find that though EOL management is a serious topic in the automobile sector and electronic devices, research into core manufacturing industries in this direction is relatively few, especially in the developing countries. There was not much research on influencing factors of EOL management among SMEs in the manufacturing sector. This is the gap in literature this case study hopes to address. This study could be a helpful tool for professionals in manufacturing industries of SMEs who wish to implement EOL management design thinking concepts into their processes and designs. Suggestions for future research would be the following

1. A similar study on several other manufacturing industries, especially in SMEs of UAE, would give a richer insight into the influencing factors.
2. A comparative study between the influencing factors of EOL management design thinking and of new technology concepts like electronic data interchange (EDI) or other ERP system would be a very interesting research
3. UAE market is very different from other markets even within the middle east, hence conducting a similar study in other developing countries would help us understand the common trends and contrast among these influencing factors.
4. A comparative study of this research with companies in other developed countries would also be a fascinating study to find out the differences in innovation adaption trends.

5.5 Summary and conclusion

End of life management is an essential concept that all the products will one day have to implement into its design thinking as the world works towards managing the massive waste crisis. The UAE government, with its limited surface area, has realised the need to control all waste heading to landfills and are now in the process of taking steps to curb this issue in the coming years. As time progresses, it is bound to be enforced not just in UAE but all over the world. Through this brief case-study into one of the SMEs in the UAE, it was possible to uncover a few pressing influencing factors that effects the adoption of EOL management design thinking. These influencing factors were further characterized into enablers and barriers to this innovation adaption. It was also interesting to understand how certain factors acted in both directions, and some remained not applicable at all. Overall, the Coercive isomorphism was found to be the biggest influencing factor. In the UAE market, the company's openness to trade partners such as clients, customers, suppliers and government were highly influential. Clients proved to be an undeniable factor to how their projects are designed and manufactured. This acted in both ways. Government and clients majorly from developed and few developing countries like UAE itself, did demand for EOL management design thinking. While small companies and those from lesser developed countries had different focuses. This was especially due to the tight budget constraints and stiff competition. Institutionalisation was the second biggest enabler. The Implementation of ISO certification ensured all its processes and procedures to be in line with international standards on quality, environment and occupational safety standards. This puts pressure on the company to place objectives like continuous improvement, higher quality and environmental wholeness of its process and products, thus enabling them to move towards EOL management. Of all the barriers, clients where proved to be most influential. Markets and government influences vary from region to region. In UAE the government will soon become a strong influencing factor. Government incentives will in this scenario help companies like SMEs to continue performing and meeting required standards. Currently, all conferences or training attended are towards improving the quality and durability of the company's products. This does indirectly influence them to think in this direction but was not seen as a very strong influencing factor. Improvement of internal knowledge of the employees at all levels regarding EOL management was stated as potential future enabling factor. All the participants acknowledge that the shift towards EOL management of its products is inevitable in the coming time. While, influencing factors may vary for different companies and project contexts, this research was intended as an initial study into what might enable or what might stand as a barrier towards this innovation adaption. Further study will establish a richer inference to the findings uncovered through this research.

Reference

Abdul Kader, B. (2011). *Diversification raises non-oil share of UAE's GDP to 71% | Business – Gulf News*. https://gulfnews.com/business/diversification-raises-non-oil-share-of-uaes-gdp-to-71-1.795268

Abu Dhabi bodies commit towards circular economy | United Arab Emirates | Construction | ArabianIndustry.com. (2019). https://www.arabianindustry.com/construction/news/2019/apr/28/abu-dhabi-bodies-commit-towards-circular-economy-6076265/

Alafeefi, A. (2019). *Helping SMEs in the UAE take on the world | Business – Gulf News*. https://gulfnews.com/business/helping-smes-in-the-uae-take-on-the-world-1.1575258574896

Anandarajan, M., Igbaria, M., & Anakwe, U. P. (2000). Technology acceptance in the banking industry:A perspective from a less developed country. *Information Technology & People*, *13*(4), 298–312. https://doi.org/10.1108/09593840010359491

Bejjani, M., Anouti, Y., Klat, A., & Batal, J. (2019). *Putting GCC cities in the loop Sustainable growth in a circular economy Ideation Center insight*. www.ideationcenter.com.

Billatos, S., & Basal, N. (1997). *Green Technology and Design for the Environment*. Greyden Press.

Branger, M. (2003). *Eco-Product Design, Development and Management*. University of Warwick.

Chestney, N. (2018). *Global carbon emissions hit record high in 2017 - Reuters*. https://www.reuters.com/article/us-energy-carbon-iea/global-carbon-emissions-hit-record-high-in-2017-idUSKBN1GY0RB

CORRALES, J., & WESTHOFF, F. (2006). *Information Technology Adoption and Political Regimes*. 911–933.

Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Quarterly*, 319–340.

Deffuant, G., Huet, S., & Amblard, F. (2005). An Individual-Based Model of Innovation. *American Journal of Sociology*, *110*(4), 1041–1069.

Deif, A. M. (2011). A system model for green manufacturing. *Journal of Cleaner Production*, *19*(14), 1553–1559. https://doi.org/10.1016/j.jclepro.2011.05.022

DiMaggio, P., & Powell, W. (1983). The Iron Cage Revisited: Institutional Isomorphism in Organizational Fields. *American Sociological Review*, *48*(2), 147–160.

Economy of the United Arab Emirates - Wikipedia. (2020). https://en.wikipedia.org/wiki/Economy_of_the_United_Arab_Emirates#cite_note-15

Eight metals used in low-carbon energy technologies under risk of shortages | EU Science Hub. (2013). https://ec.europa.eu/jrc/en/news/eight-metals-used-low-carbon-energy-technologies-under-risk-shortages

EmiratesGBC. (2019). *Adopting Circularity in the UAE*. https://gresb.com/adopting-circularity-uae/

European Commission. (2014). Communication from the Commission - Towards a circular economy: A zero waste programme for Europe. *European Commission*, *398*, 1–14.

Fouopi Lemouchele, A., & Stapleton, L. (2011). The adoption of Electronic Data Interchange in Africa: Country case study of the Cameroon through an institutional lens. *IFAC Proceedings Volumes (IFAC-PapersOnline)*, *44*(1 PART 1), 3118–3123. https://doi.org/10.3182/20110828-6-IT-1002.02471

Furuholt, B., Kristiansen, S., & Wahid, F. (2005). Information dissemination in a developing society: Internet café users in Indonesia. *The Electronic Journal of Information Systems in Developing Countries*, *22*(1), 1–16. https://doi.org/10.1002/j.1681-4835.2005.tb00141.x

Galli, G. (2020). *Etuix - Recycling concept of advertising posters*. http://www.etuix.com/en/#!weare

GCC Waste Management Industry to Present Untapped Opportunities, notes Frost & Sullivan. (2016). Frost & Sullivan. https://ww2.frost.com/news/press-releases/gcc-waste-management-industry-present-untapped-opportunities-notes-frost-sullivan/

Graedel, T. E., & Allenby, B. . (2003). *Industrial Ecology*. Pearson Education, Inc.

Gupta, B., Dasgupta, S., & Gupta, A. (2008). Adoption of ICT in a government organization in a developing country: An empirical study. *Journal of Strategic Information Systems*, *17*(2), 140–154. https://doi.org/10.1016/j.jsis.2007.12.004

Hoornweg, D., & Bhada-Tata, P. (2012). *What a waste* (Issue 7). www.worldbank.org/urban

Ismail, H. (2017). *Kuwait: Food and Water Security*. *September 2015*, 1–7. http://futuredirections.org.au/wp-content/uploads/2015/09/Kuwait_Food_and_Water_Security.pdf

Kopacek, P. K. B. (2014). End of Life Management of Automation and IT Devices. In *IFAC Proceedings Volumes* (Vol. 47, Issue 3). IFAC. https://doi.org/10.3182/20140824-6-ZA-1003.00207

Laura Reyes (Datec), Shannon West (Verizon), F., Magalini and Ruediger Khuer (UNU/StEP Initiative), T. T. (UNEP/Secretariat of the B., & Convention), G. D. (France T. and C. B. (ITU). (2012). End - of - life management for ICT equipment. *ITU Toolkit on Environmental Sustainability for the ICT Sector*.

Lewis, H., & Gertsakis, J. (2001). *Design + Environment Sheffield*. Greenleaf Publishing Limited.

Lovelle, M. (2015). Food and Water Security in the Kingdom of Saudi Arabia. *Future Directions International*, *July*. http://www.futuredirections.org.au/publication/food-and-water-security-in-the-kingdom-of-saudi-arabia/

Maddocks, A., Young, R. S., & Reig, P. (2015). *Ranking the World's Most Water-Stressed Countries in 2040 | World Resources Institute*. https://www.wri.org/blog/2015/08/ranking-world-s-most-water-stressed-countries-2040

Meyer, J. W., & Rowan, B. (1977). Institutionalized Organizations: Formal Structure as Myth and Ceremony. *American Journal of Sociology*, *83*(2), 340–363. https://doi.org/10.1086/226550

Moore, S. B., & Manring, S. L. (2008). Strategy development in small and medium sized enterprises for sustainability and increased value creation. *Journal of Cleaner Production*, *17*(2), 276–282. https://doi.org/10.1016/j.jclepro.2008.06.004

Morselli, L., Cavaggion, S., Maglio, C., Passarini, F., & Galeazzi, G. (2006). *Integrated waste management of special and municipal waste – a territorial case study*. *92*, 511–520. https://doi.org/10.2495/WM060531

Pennington, M. C. (2004). Cycles of innovation in the adoption of information technology: A view for language teaching. *International Journal of Phytoremediation*, *21*(1), 7–33. https://doi.org/10.1076/call.17.1.7.29705

Publications, S., & Publications, S. (2014). *" Old " Institutionalism and " New " Philip Selznick*. *41*(2), 270–277.

Report, F. (2011). * *Final Report * Histopathology Final Report*. *2*(May), 12–13.

Resource efficiency — European Environment Agency. (2018). https://www.eea.europa.eu/airs/2018/resource-efficiency-and-low-carbon-economy/resource-efficiency

Robson, C. (2003). *Real World Research*. Oxford: Blackwell.

Rogers. (1995). *Diffusion of innovations (4th ed.)*. New York: Free Press.

Sarkis, J. (2001). *Manufacturing ' s role in corporate environmental sustainability*. 666–686.

Scott, W. R., Quarterly, A. S., Dec, N., & Scott, W. R. (2007). *The Adolescence of Institutional Theory The Adolescence of Institutional Theory*. *32*(4), 493–511.

Selznick, P. (1949). TVA and the Grassroots. *Berkeley, CA: University of California Press*.

Selznick, P. (1957). Leadership in Administration: A Sociological Interpretation. *New York: Harper & Row*.

Sen, P., Roy, M., & Pal, P. (2015). Exploring role of environmental proactivity in fi nancial performance of manufacturing enterprises : a structural modelling approach. *Journal of Cleaner Production*, *108*, 583–594. https://doi.org/10.1016/j.jclepro.2015.05.076

Seth, D., Rehman, M. A. A., & Shrivastava, R. L. (2018). Green manufacturing drivers and their relationships for small and medium(SME) and large industries. *Journal of Cleaner Production*, *198*, 1381–1405. https://doi.org/10.1016/j.jclepro.2018.07.106

Stapleton, L. (2011). Technology Adoption in post-conflict regions: EdI Adoption in Kosovo after the war. *Journal of Global Information Management*, *19*(3), 65–84. https://doi.org/10.4018/jgim.2011070104

Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research*, *79*(2), 625–649. https://doi.org/10.3102/0034654308325896

Taylor, R., Licker, P. S., & Molla, A. (2006). *E-C OMMERCE D IFFUSION IN S MALL I SLAND C OUNTRIES :* 1–15. https://doi.org/10.1002/j.1681-4835.2006.tb00186.x

The Circular Economy in the Workplace: Business & the Environment. (2019, October 15). https://www.summertown.ae/circular-economy-in-workplace/#_ftn6

Theories of change and adoption of innovations: The evolving evidence-based intervention and practice movement in school psychology. (2005). *Psychology in the School*, *42(5)*(Evidence-Based Work Group), 475–494.

Thompson, B. . (1997). Creative Engineering Design. *Okemos Press*.

United Nations Environment Programme. (2009). *D EVELOPING I NTEGRATED S OLID W ASTE M ANAGEMENT P LAN. 4*.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. (2003). *User acceptance of information technology: Toward a unified view* (27th ed.). MIS Quarterly.

Veshagh, A., & Li, W. (2015). *Survey of eco-design and manufacturing in automative SMEs*. 305–310.

WAM. (2019). *UAE first globally to sign on World Economic Forum's "Scale 360" | Business – Gulf News*. https://gulfnews.com/business/uae-first-globally-to-sign-on-world-economic-forums-scale-360-1.63178513

Wautelet, T. (2018). *Exploring the role of independent retailers in the circular economy: a case study approach*.

Zacharias, A. (2019). *How camel waste is fuelling the UAE's circular economy - The National*. https://www.thenational.ae/uae/environment/how-camel-waste-is-fuelling-the-uae-s-circular-economy-1.877698

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Appendix A

This part of the case study contains the research questionnaire given to the participants:

The purpose of this questionnaire is to achieve the following research objectives:

• Identify the key influences that effect implementing sustainable policies at the end-of-life stage in the product life cycle of an SME in UAE.
• To discover the enablers and barriers that influence this process.

Candidate:

Section 1. General Background Information

Age:
Sex:
Educational Background:
Years of experience in UAE:

Section 2. Adopting Circular Economy and end of life management in Product Life Cycle

a. Is there a Culture of Circular Economy thinking in the company?
Yes ☐ No ☐

b. Does the company reuse its products?
Yes ☐ No ☐

c. Does the company repair its products?
Yes ☐ No ☐

d. Does the company recycle its product?
Yes ☐ No ☐

e. Is end of life design thinking considered during the conceptual phase of the product?
Yes ☐ No ☐

f. Does the company design for recyclability?
Yes ☐ No ☐

g. Does the company design for re-manufacturability?
Yes ☐ No ☐

h. Does the company design for disassembly?
Yes ☐ No ☐

i. Does the company design for end of life?
Yes ☐ No ☐

Section 3. Influencing factors to implement end of life design thinking in product life cycle

(Enablers- Help towards achieving End of life design thinking.
Barriers- That prevent/inhibit the same)

a. **Influence by Trade Partners /External Org.**

	Enablers	Barriers	N/A
Customers			
Suppliers			
Financial Institutions			
Others in the same industry			
Government			

b. **Level and extend of available external knowledge**

Enabler ☐ Barrier ☐

Is the company influenced by international Standards, latest technological advancement, Research etc. related to EOL?

Yes ☐ No ☐

c. **Level and extend of available internal knowledge**

Enabler ☐ Barrier ☐

Is you company influenced by internally experienced staff, R&D, lessons learned related to EOL?

Yes ☐ No ☐

d. **Infrastructure** Enabler ☐ Barrier ☐

Does the present Infrastructure permit for EOL design thinking?

Yes ☐ No ☐

e. **Influence of International agencies**

Enabler ☐ Barrier ☐

Is the company influenced by ISO certifications, international memberships, Associations etc. related to EOL?

Yes ☐ No ☐

f. **Improve Internal knowledge of employees**

Enabler ☐ Barrier ☐

Does the company encourage trainings or attending conferences to help train internal staff toward EOL design thinking?

Yes ☐ No ☐

g. **Subsidiarity** Enabler ☐ Barrier ☐

Is the company influenced when subcontracted by firms?

Yes ☐ No ☐

Appendix B

This part of the case study contains the research questionnaire given to the participants:

The purpose of the interview is to achieve the following research objectives:

• Identify the key influences that effect implementing sustainable policies at the end-of-life stage in the product life cycle of an SME in UAE.
• To discover the enablers and barriers that influence this process.

Section 1. **Background Information Section**

1 Candidate:
2 Please State your job title:
3 How long have you been part of this company?
4 What Opportunities and strengths do you feel your company possesses towards environment management?

Section 2. **EOL Section**

5 Does your company have a culture of circular economy thinking?
If no→ Question 11 If Yes→ Question 6
6 How is your company working towards recycling, reusing and repairing its products?
7 How is end of life of the product life cycle considered in your product design?
If no→ Question 11 If Yes→ Question 8
8 What is the reason for implementing End of life thinking in the product design?
9 What are the problems encountered by the company during implementation of end of life design thinking to their products?
10 What benefits does the company achieve from this kind of design thinking?
11 What are the reasons for not adopting EOL design?

Appendix C

Interview transcript of candidate 1

Section 1. Background Information Section

1. Candidate Number: 1
2. Please Sate your Job title: Project Sales Engineer
3. How long have you been working in UAE: 8 years
4. What Opportunities and strengths do you feel your company possesses towards environment management?
   There is room to enhance some products to have longer life span and be more environment friendly. E.g. using different chemicals which are bio-degradable and not producing residual waste.

Section 2. EOL Section

5. Does your company have a culture of circular economy thinking?
   Yes, we do it through retrofitting of existing plants for multiple purposes, either to upgrade or repair existing plants.

6. How is your company working towards recycling, reusing and repairing its products?
   Yes,
   Reuse: Yes, there is a lifetime for all the components of the product. At times we do bring back components that cannot function fully at site, which we repair and use for other purposes or smaller projects. E.g. a pump whose throughput reduces and is required to be replaced, we would bring it back, repair and use it for other purposes like clearing water from an area.
   Repair: Our Maintenance department handles repairs of our products.
   Recycle: Not so much possible with our products yet as they have a long lifetime. But regeneration is done, for example the carbon media used for capturing bad odour at site can be washed and reused. But this too is only to a certain extent of 6 to 8 times beyond which it also needs to be disposed.
   Design for Recyclability: No, the product we have in not recyclable. Our business is assembly of many mechanical parts. Once they get worn out there is a certain method of disposal which the plant owner must follow. Though we help operate the plant for 1 or 2 years, it is eventually handed over to the client completely, as it is their property.
   Design for Re-manufacturability: Yes, the 40-20-foot containers are designed such that it can be easily remanufactured to increase capacity.
   Design for Disassembled: Yes, all our products can easily be disassembled.

7. How is end of life of the product life cycle considered in your product design?
   Yes. The company as a manufacturer and sub- contractor handle the HSE or quality side of implementation. But the EOL management is the responsibility of the client or main

contractor. For example, if any component is damaged or needs replacement, once in operation, it is the responsibility of the client/ plant owner to make the call. Though the government has rules regarding disposal of the plant wastes or its parts, it is his responsibility to ensure its safe disposal and not the manufacturers. But as a product manufacturer we try to achieve as much environmental requirements as possible as necessary. We try our best to use low energy consuming parts, e.g. low energy pumps, having design set to implement eco-mode, to reduce carbon footprint etc. The aspect of the environmental management that handles waste from the product usage and its final disassemble/disposal is not within our scope of responsibility.
This also depends on the components selected within the plant. A plant life is generally 20 -25 years. Materials we use is as per the industrial standards.

8. What is the reason for implementing End of life thinking in the product design?
Clients: Depends on the market. Developed countries are keep into this direction, while other countries have cost, output and some other factors as concerns.
Supplier: They don't push but do give us options. It depends on the client requirement. Finally relating to cost.
Financial Institutions: Not in UAE as per my knowledge. But is an enabler when it comes to international projects in countries like Africa funded by UNESCO or US Aid, since their environmental requirements are high.
Others in the market: Yes, UAE market is based on competition.
Government: Yes, UAE government is pushing us to think in this direction. Water quality is always monitored, and systems are already in place to check the output. Noise level of different equipment's should adhere to the local law. But again, when it comes to the end of life of the product the responsibility again is of the client or main contractor who owns the product.
External Knowledge: Yes, need to be up to date with others and international standards.
Internal Knowledge: Not yet. We do not have that structure yet. The company is quite young, and we are still growing.
Infrastructure: No, the company does deed a dedicated centre that works on R&D. We have a provision with our mother company, but this needs to be further explored.
International Agency: Yes, ISO certified.
Improve Internal knowledge of employees: In relation to EOL no. The projects we are working on are not at that scale like a whole facility. We are mostly sub-contractors. The focus by the governments are not yet in this direction.
Subcontracting: Yes. International clients yes. But with Local clients, if government, they think about it, but private companies more than often fall short of this aspect.

We do not directly think about this in our design. But rather to meet client demands as primary goal.

9. What are the problems encountered by the company during implementation of end of life design thinking to their products?
It will increase the lead time and manufacturing steps. Whether they are commercially viable is another aspect. To implement a new technology or design requires large amount

of data, research and need to be piloted first. The company is still growing to reach such a stage of direction. Right now, the need is to meet costs and keep the company running.

10. What benefits does the company achieve from this kind of design thinking?
    Not much of reduction in costs due to this kind of thinking. Again, depends on the Client. We do not have a project yet where we have seen results yet, mainly due to the long life of the project. It will reduce energy efficiency in the long run. Finally, it will benefit the name of the company.

11. What are the reasons for not adopting EOL design?
    Hindrances from Area requirement, business, lack of funding, technical capability both inside and outside. Competition is also a big issue where alternative products are available at cheaper price; hence government incentives could help business move in this direction.

Appendix D

Interview transcript of candidate 2

Section 1. Background Information Section

1. Candidate Number: 2
2. Please Sate your Job title: Chief Operations Officer
3. How long have you been working in UAE: 6 years
4. What Opportunities and strengths do you feel your company possesses towards environment management?
   Reliability

Section 2. EOL Section

5. Does your company have a culture of circular economy thinking?
   Yes,
6. How is your company working towards recycling, reusing and repairing its products?
   Yes,
   Reuse: We support complete Rehabilitation. Expanding of product capacity within available boundaries. We supply one container with certain capacity for first project and then increase capacity for the next project within the same boundaries. Also damaged items are brought back, repaired and reinstalled either into the same project or another as required.
   Repair: The company has a maintenance department that check existing plants and repair as stated in contract.
   Recycle: As a product No. But all waste produced from the manufacturing process are recycled. They are either reused back into manufacturing or sold as scrap which brings in additional revenue.
   Design for Recyclability: No,
   Design for Re-manufacturability: Yes, this is a core competence.
   Design for Disassembled: Yes, this is the main concept behind package/module type products. Also, sometimes products used by clients as prototype for 1 or 2 years is such that it can be easily disassembled, shifted to other locations or moved back into the company as stock.

   As the product has a life span of 10-15 years currently the focus is more on using raw materials and parts that would help increasing or maintaining the durability and life of the product and not so much on the end of life.

7. How is end of life of the product life cycle considered in your product design?
   Yes,

Continuous improvement through Lessons learned. If we find a part corroded or damaged with time, the next time we try to change it to reduce the damage and not have the same problem.

It is one of our product advantages. Sales technique- all items/raw materials used to manufacture the product are of high grade, which gives more life to the final product. Also, we are pushing the preventive-maintenance department to maintain the life and educating the department to increase it more. This thinking is bases of our business.
Most of the raw materials used are bio-degradable, all other components are obtained from manufacturers who adopt such similar policies. May be not 100% but 90% of the components for sure, both mechanical and other raw materials.
Most of the Raw materials and parts are manufactured in Europe, hence already meet the criteria stated. But again, depends on Client requirement, if it is for drinking water purpose then the grade of raw materials in much higher as compared to Industrial applications.

8. What is the reason for implementing End of life thinking in the product design?
Clients: Clients are becoming more and more educated. They are enablers but depends from market to market. Some markets we need to achieve the primary goal, but some markets sustainability is like default requirement. Our company have reached the point of providing highly sustainable products; hence it does not give us an additional overhead. So even if the client requires high standards it is easily achievable.
Supplier: Some of them come with such features but focus is more on meeting the client requirement hence it is not an enabler or a barrier. Not applicable.
Financial Institutions: NA
Others in the market: Enabler, it does motivate us to show ourselves better than the competitors.
Government: There are projects looking for sustainability. Client at the end of the day is looking for higher life with lesser cost. But today Government is looking for sustainability. Yes and no for enabler.
External Knowledge: Most information is coming from suppliers. Focus is on changing the system environmental requirements to reduce environmental impact. Our product should help the community of the client where it is installed especially with regards to water treatment. Most information is received from supplier. Not an enabler or barrier.
Internal Knowledge: Focus is more on quality and life improvement. There is continuous improvement.
Infrastructure: Yes, it is an enabler.
International Agency: ISO certified. Yes, an enabler.
Improve Internal knowledge of employees: Yes, internal trainings happen with different agendas and themes, but they indirectly address the issue. But not so much in the external level.
Subcontracting: Depends on the Client. Yes and No. Local projects, if dealing directly with client then it is an enabler, but if dealing through contractor their focus in more on cost.

9. What are the problems encountered by the company during implementation of end of life design thinking to their products?
   Not having enough data to corelate. Every project has different conditions and requirements; hence it is sometimes not possible to combine all exact data to get the perfect product. Not enough Data mining or analytics done.

10. What benefits does the company achieve from this kind of design thinking?
    Reputation in the market in terms of product, also with our supplier. They know how our company works and what we require.
    Yes, it benefits our business, basics of maintenance policy- warranty is additional overhead. To have good reference and confidence of client we ensure the product is of high quality and long life. The client will gladly send more money on spare parts if he knows that it will run for 5 years or more rather than having more faults in the same period.

11. What are the reasons for not adopting EOL design?
    Maturity level of company. If the company is just starting, the focus is more on making profitability. Once you have reached a certain level, established, to expand more, then the company from the top level, start thinking more in this direction. UAE market is fresh, new and aggressive in terms of competition. But companies with tie up with international firms are pushed also to think in this direction.