

Transforming Food Waste into Value Added Products: A Circular Economy Analysis of Malaysian Fisheries Sector

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Abstract: Food waste is recognized as a certain issue occurring globally and it is particularly severe in developed countries. This shows that there is still lacking of approaches in managing the food waste especially in fisheries sector. Fisheries based food wastes which are mainly generated during the production process could turned out to be useful according to the Circular Economy (CE) concept. As the CE concept proposed that the resource materials should be in the circularity flow, the disposal of food wastes into the landfill can be reduced and thus provides the positive outcome to the environmental, economic and societal impact. This paper basically tends to investigate the root cause of the food wastes, the effectiveness of the adoption of CE in improving the profit margin and also to provide the best practice of CE adoption. CE is analysed using the VOSviewer software, and then the t-test is performed to compare the profit margin before and after CE implementation. This resulted to the fact that CE implementation can improve the financial performance of a company by turning the fish waste into a value added product, which is fish pellet.

Keywords: Circular economy, food waste, circular economy analysis, value-added product, best practices

Introduction

Food waste management is said as a severe problem the world is facing now. A proactive step is really needed as this problem could lead to serious economic, environmental and societal issues. A study showed that most of the food producer companies are measuring the food waste in their daily operation but somehow only 20% of these companies had taking the initiatives to reduce the food waste. The food system which exists today has boost the rapid growth of population and the economic development and urbanisations. Even though it is seen as a good sign, this productivity is associated with the cost, and the linear model is not relevant anymore to be used for longevity needs. Shifting to the circular economy (CE) especially for food system, provides attractive model that encapsulate economy, health and environmental advantage across the food value chain and society more widely (EMAF, 2019). Yet, there is a huge number

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of companies that are still immerse and implement the traditional linear economy which is not sustainable based on the principles of take, make, use and dispose (Ormazabal et al., 2018). The cooperation of suppliers and consumers within the supply chain management, the ecological of products design, the use of renewable materials, clean production and the willingness to actively involved in the secondary raw material markets are essential for implementing CE ideologies (Ghisellini et al., 2016). In addition, companies that adopt the CE principles are required to integrate ecological criteria into their supply chains and management activities that include, but are not limited to the reduction, reuse, recycling and substitution of materials (Masi et al., 2017).

Different from the current linear industrial model which is mainly based on the take, make and waste principle, CE emphasizes on restructuring the growth, focusing on the positive benefits for the society where it includes in dissociates the economic activities that are generated from limited resources and designing waste out of the system. The goal is not only to reduce harmful activities, CE is noteworthy as it also aims to build the economic, environmental and societal capital. It is a concept of industrial and social evolution that follows the holistic sustainability goals through a culture of no waste which also discerns as a ‘close-loops’(De los Rios & Charnley, 2017). The concept of CE was introduced by the policy maker from China and the European Union and since then it has become very popular as a solution that enables the organizations, consumers and countries to reduce the harm to the environment and close the loop of product life cycle (Prieto-Sandoval et al., 2018).

As already mentioned, food waste is recognized as a huge problem occurring worldwide and it is particularly severe in developed countries. Based on Figure 1, apparently there are large quantities of food waste in daily business and consumption.

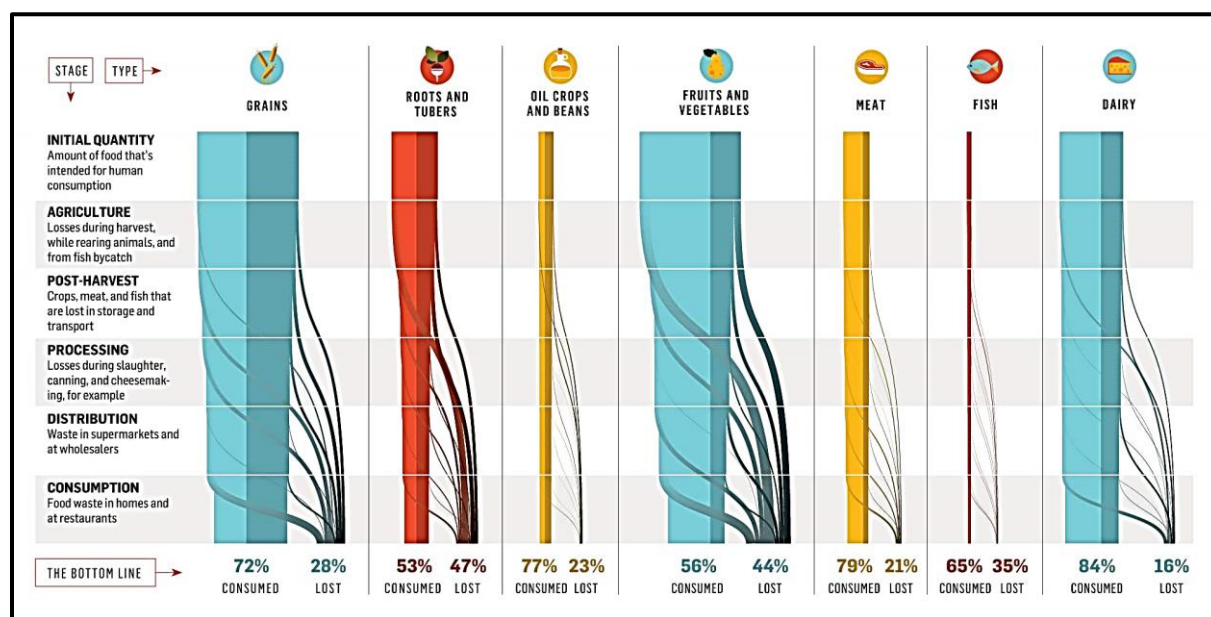


Figure 1: Food waste, by production stage and food type (Source: FAO)

For example, in the United States, food waste at the retail and consumer levels have been calculated to 188 kg per capita per year. Among Europe and the North America, the food waste was estimated as high as 280-300 kg per capita per year (Garrone et al., 2014). In Southeast Asia, it is estimated that 33% of food is wasted in the region (Yang et al., 2016). One of the top contributor of the food waste is because of the insufficient storage capacity. When the fresh food and vegetables are exposed to inappropriate temperatures, it will undergo degradation that results in low quality. A standard cold storage capacity is essential to deliver fresh food and

vegetables to market with minimal spoilage. Food products in particular, fluctuate in price over its freshness. Fresh food often comes with high price but once the food has become less fresh or waste, then it will end up being dispose. A better design of products could be a valuable starting point in managing waste. Many of industry players often do not fully understand the concept of CE which captures the value of keeping products in circulation longer or reusing it. In order to convince them regarding the benefits and advantages of CE, a proper analysis to compare the food waste processing before and after the adoption of CE is needed.

Implementing CE could be described as a challenging task. In China, the intervention of governmental institutions concerning CE, has clearly facilitated both the implementation of circular business practices and the measurement of their effectiveness (McKinsey, 2015). However, this is not the case with several other countries around the world especially in Malaysia. For the case of food system specifically on food waste, there is limited academic literature that deploy the adoption of CE in managing food waste particularly in Malaysia. The research questions and research objectives of this study are as follows:

1. What are the root cause of food waste?
2. How effective is the adoption of CE to improve the profit margin?
3. What are the best practice of CE adoption?

This study adds a better understanding of CE concept where it sheds light on the best practice of CE adoption which could provide a huge benefit to the company in terms of profitability. As many of the company in Malaysia is still immersed in the linear economic model in their business and unaware regarding to this CE principle and its benefits, the contributions of this study may facilitate the decision of employing the CE adoption on the behalf of the business.

Literature Review

There are 114 definitions of CE which was lack of consensus (Kirchherr et al., 2017). Among those, CE is defined as a concept of reuse which can be implement at three levels including the product level, component level and material level. Product level comprises of refurbish and repair, component level is for remanufacturing whereas material level is mainly for recycling (Zink & Geyer, 2017). CE principle is regarded as a circular model where it increases the efficiency of the resources used by keeping it in the circularity flow. Apart from being reduced, food waste is used as a source for making another product by the companies which are organized in a network that unlikely to be a linear economic model in terms of resource consumption, production and disposal (Kruglianskas et al., 2018). According to EMAF (2015) CE is defined as an economy which is regenerative by design, an economic system where products and services are traded in closed loops or cycles, or as a way to overcome the current production and consumption model based on continuous growth and increasing resources throughput. In most classical definitions, CE is basically about maintaining or increasing economic value while decreasing or maintaining the raw materials used and limiting environmental maltreatment.

The ultimate goal of the CE is an increase in the quality of life for all stakeholders, achieved by eliminating waste and leakage from the traditional economic supply chains through reduction, reusing and recycling at every step of the way, thus closing the loop and maintaining the value inside (Botezat et al., 2018). As the call for a new economic model based on systems-thinking grows louder, an unprecedented favourable alignment of technological and social factors today can enable the transition to a circular economy (EMAF, 2015). The vision of the future economy, based on resource productivity, environment protection, capitalization of economic

opportunities in relation to social aspects and smart waste management, can become a reality given that the paradigm of thinking about the relation between economy, society and environment will change (Botezat et al., 2018).

The aspect of cultural, politics and social has influence the evolution of CE concept. This can be seen as for China, CE is adopted as a top-down strategy of development and also as a control instrument. Meanwhile for European Union as well as North America and Japan, CE is adopted as a bottom-up strategy. In 1990, China has included CE in their public initiatives to support research, articulation between the stakeholders and the establishment of eco-parks where the main focus is waste recycling. The next expansion phase was based on the lesson learned from the technical unfeasibility and economic problem that shifted the focus of CE to industrial structure. As for the early adoption of CE, China was one step ahead in term of publications, whereas in Europe's publications, CE term is used widely after the European Commission addressed the waste issues in 2014 (Kruglianskas et al., 2018). Although there are differences in governance paradigm and context, China and Europe are the pioneer in implementing the CE and the other countries could observe and learn on how they implement the CE concepts and thus follow their steps by applying CE. China can be a good example where they encourage and coordinate the development of CE according to the zones, regions and cities. Companies and institutions act as centres for the administration programs like experimentation and management coordination. Furthermore, the approach of CE in China is including the land-use planning (McDowall et al., 2017).

There are three elements which make up CE concept including design out waste and pollution, keeps products and materials in use and regenerate natural systems. For designing out waste and pollution, CE is an economic model which exposes and reform the negative effects of economic activities that could harm the people's health and also the environment. Thus it will cause to bigger problems such as the emission of greenhouse gases, harmful substances, water, air and soil pollution, and structural wastes including buildings and cars that are underutilised. For keeping products and materials in use, CE promotes the activities which maintains the value in form of energy, materials and labour where it designs the recycling, reusing, remanufacturing in order to ensure that the products, materials and components are always retain in the economic circularity. The circular economic model increases the effectiveness of using the biological based elements while boosting the use of diverse economy before the nutrients are returned to the natural system. While in the context of regenerate natural systems, by following the CE principle, it prevents the use of non-renewable resources so that the renewable resources could be maintain and increase therefore, the valuable nutrients can be returned to the soil for promoting the natural regeneration (EMAF, 2019).

As can be seen today, some food products contain the ingredients which can make it unsafe for their by-product to be an input for making a new product. For instance, the high concentrations of some additives which contain in food products may not suitable to be organic fertilizers as it returned to the soil. In CE for food, the ingredients that are unsafe for the cycle are designed out during the earlier product design stage. In order to enable the food by-products to use as input for making new products in bio economy, the food by-products that is generated during the productions and consuming process are essential to be safe. By promoting and producing foods which are suitable for safe cycle, the marketing and food design could support the desire to make the most of food (EMAF, 2019).

The scenario of food system today can be described whereby there are high demands for the good quality of foods along with the increasing cost and the availability of raw materials keeps

decreasing with much worries regarding to environmental pollution. As a result, there is great pressure with regards to recycling, recovery and upgrading of wastes. This specifically for the food processing industries where the wastes, by-products and residues can be recovered and thus increase their value as a useful product. Most of the wastes are produced from food industries either in forms of solid or liquid, generated during the production, preparation and consumption of food. Those wastes contribute to the increasing of disposal to the landfills and create severe problem of pollutions and the vanished of valuable nutrient and biomass. Previously, those wastes are usually being thrown away or being used without treatment as fertilizers or animal feeds.

However, for the past few years, new methods and policies for waste treatment and handling has been introduced in forms of bio-conversion, recovery, and the use of valuable elements from the food wastes processing. This step was made due to the growing needs of considering the important aspects which mainly intend to prevent the environmental pollutions and economic motives, and also the necessity for energy conservations. Apart from the pollutions and harmful aspects, in most of the cases, the wastes from food processing might having the potential for recycling the raw materials or convert into useful products such as by-products, or could be as raw materials for other industries, or as feeds. There is rising attention on the facts that these wastes represent the resources which might and can be used to convert into useful products especially the bioconversion of wastes from food processing (EMAF, 2019).

CE constitutes the concept whereby the main purpose is to establish a restorative industrial system. Luckily the industry players nowadays are becoming aware regarding to that matter and CE is considered as a mechanism which can be used to create competitive advantage. The new business model has encouraged the design for reuse and increase the materials recovery resulted from the shifting of historic production and consumption system. Furthermore, the traditional economic theory illustrates the unbalance of production patterns that represents the natural outcome since it drives the creation of wealth through the economic activities (Genovese et al., 2017). The environmental economy is mainly concerning about identifying and solving the problems regarding with the damage and pollution which are related with the flow of wastes. However, in CE principle, it proposes that by following the close loops system, the amount of resources depleted is the same as the amount of waste generated in the same particular period.

The CE paradigm tends to constantly sustain the circularity of the resources and energy in a closed system where the necessity for the new raw materials input into the production system can be reduced accordingly. CE principle supports the idealistic ambition for encouraging the sustainable supply chain practices. This practice is particularly concerns to the reduction of negative impacts to the environment which are unfavourable resulted from the cradle-to-grave flow system. Since CE principles has been introduced, thankfully, some of the company are already adopted CE concept as a mechanism for solving collective problems. CE paradigm provides the framework for the business operations in the same supply chain network and thus it promotes the sustainable activities, where it could be the best practices for the company to adopt (Genovese et al., 2017).

As of today, there are limited papers that study the food waste management under the CE approach. Some are focusing on transforming the food waste into energy sources and the other studies focused on how to reduce the food waste through food sharing principle (Ingrao et al., 2018). This paper specifically focuses on the food waste, which is fish waste from a CE perspective by transforming it into a value added products, where in this case it is transform into a fish pellet. This paper also intends to analyse the CE principle by looking at the important

aspects of the CE as most of the food waste could be reused or recycled for the sake of environmental, economic and societal impact. Most importantly, this paper tends to prove that by implementing the CE approach, companies could increase their financial performance (Principato et al., 2019).

The Case of Company

This section elaborated the ways in which the data are analyzed and what methods that are being used in the study. There are three parts comprises of Ishikawa diagram, VOSviewer and t-test. Company B is currently the largest fresh produce and packed foods processing, packaging and distribution centre that located in Kajang, Malaysia. Built on a 25,000 squares meter piece of land, this distribution centre has officially operated in September 2018 where previously Company B has started their operations in Balakong, Selangor. Consisting of more than 200 staff members, its mission is to give their customers across Asia a store they trust by delivering quality, service and value. From getting the very best local products from farm to fork, ensuring the highest standards of cleanliness at every point and bringing consumers value in every purchase, this new distribution centre is said as the gateway for freshness for Malaysians. It focuses on energy efficient operations, rainwater harvesting, heat recovery technology, integrated and automated processes, temperature-controlled environments, and improved handling and logistics processes to improve and brings Malaysians the freshest food and fresh products in the country. Dedicated to products which fall under the fresh category, this company procures and distributes items such as fresh fruits, vegetables, meats and seafood to store locations nationwide. The method for data collection of this study is mainly based on interview and observations. For the interview, there are two respondents that represent Company B whose are the operations manager and the assistant operations manager.

Ishikawa Diagram

When it comes to problem solving strategy, most of the times the cause and effect diagram which is commonly called the Ishikawa diagram or fishbone diagram is used in order to conduct a cause and effect analysis. It is a tool that helps to elucidate the root causes of the problem. Ishikawa diagram is widely known back then in 1960 and it was introduced by Kaoru Ishikawa, a pioneer in the quality management field (Baumgarten et al., 2016). Eventually, this tool makes it easier and effective for making the desirable decisions based on the root causes of the problem which is often misinterpret as the symptom. Basically, the Ishikawa diagram comprises of two parts, the left side and the right side. On the left side, all the causes related to the problem is described. Whereas on the right side, is the effect of the causes where the problem is indicated. By applying the Ishikawa diagram, all the potential causes of the problem for this study is defined and listed to display the relationship clearly and logically.

VOSViewer visualization software

This study analysed the interview transcript that was interpret based on the voice recording during the interview session. The analysis of the co-occurrence of keywords was done through visualization technique by using VOSviewer software, version 1.6.11. This software functions as its name, VOS which stands for visualization of similarity. It is useful for providing the graphical representation of bibliometric network and explicitly mapping the relationship between the keywords, presenting the most common term in detail explanation regarding the bibliographic record and displaying the cluster group that has been analysed (Lulewicz-Sas, 2017). The earlier phase included an interview with the representatives from Company B which are the operations manager and also the assistant operations manager. This interview is in form of verbal communication and it is recorded using voice recorder. The next phase was to transcribe the voice recorder into a transcript. The interview transcript is then being converted

into a text format so that it is compatible to be used in VOSviewer software. The final phase is to perform the analysis of the interview transcript using the software mentioned. By using VOSviewer, this paper tends to generalized the finding and also to ensure the data collected is reliable and valid.

T-test

An independent samples t-test analysis was performed to compare the profit margin before and after the implementation of CE. Before performing the t-test by using SPSS software, two hypothesis statements were constructed as below.

1. H_0 : There is no significant difference in profit margin before and after the implementation of CE.
2. H_1 : There is significant difference in profit margin before and after the implementation of CE.

This T-test was performed based on the details of production activities before and after the implementation of CE. In this study, the CE implementation approach that was practiced in the company was producing the fish pellet by using the fish waste generated during production process. The data was collected from the company's financial reports through content analysis process and then it was analysed by using SPSS software to evaluate how the company's performance measure in terms of profit margin behaved before and after the implementation of CE.

Result

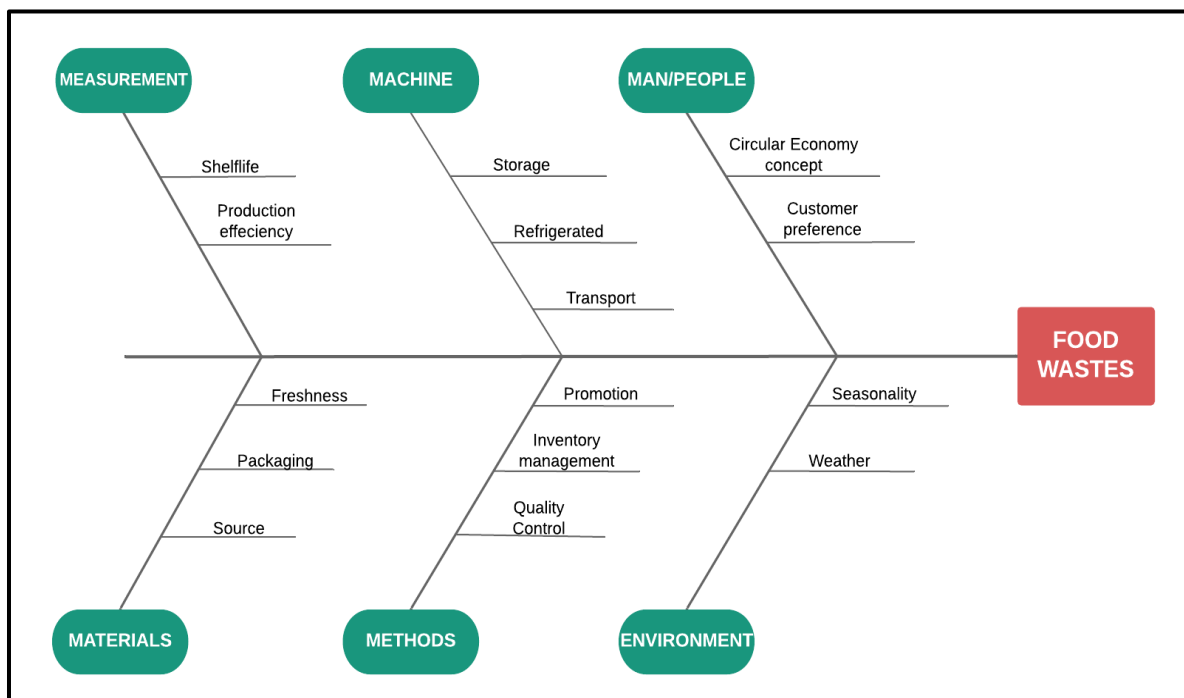


Figure 2: Fishbone Diagram of food waste

There are six categories which has been identified in contributing to the problem of food wastes. These six categories comprise of man/people, machine, measurement, materials, methods and environment. As cab be seen in the figure, under each category, there are several causes that leads to the main problem. For man/people category, the potential causes are circular economy concept and customer preference. Some of the company in Malaysia are lacking of knowledge

regarding to the CE. Because of the CE concept is not familiar yet, thus this resulted to the poor food waste management and eventually the food waste will end up in the landfill. For the customer preference, the food which are not in their preference will be left unsold and become waste. For machine category, the potential causes are storage, refrigerated and transport. When there is insufficient storage, the food is exposed to the environment and therefore reducing its quality. Especially for the food which required the designated temperature using the refrigerated storage. Food waste also could occur during the transportation process.

For measurement category, the potential causes are shelf life and production efficiency. Food that is organic has a shorter shelf life than the other food. Most of the foods are perishable thus making it easier to be wasted. Lower production efficiency could generate the food waste during the production process. In materials category, freshness, packaging and source are recognized to be the potential causes of food waste. When the food is not fresh anymore, no customer will buy it. Same goes to the packaging, if there is no proper packaging for the food, then the food will be spoiled. Furthermore, the source of the food needs to be checked so that the food will always in the quality standard. Under methods category, the potential causes are promotion, inventory management and quality control. When the quality of food is high, the price will be higher but once the quality become lower, it will be sold in lower price. The foods that are stored in a warehouse should follow the First in First Out (FIFO) method and should not be stored for a longer time as it is likely to turn into waste. For environment category, the potential causes consist of seasonality and weather. It is essential to forecast the customer trends of buying as it can avoid the excessive inventory where this could lead to the obsolete inventory. Exposing food products to inappropriate temperature will make it faster to be spoiled.

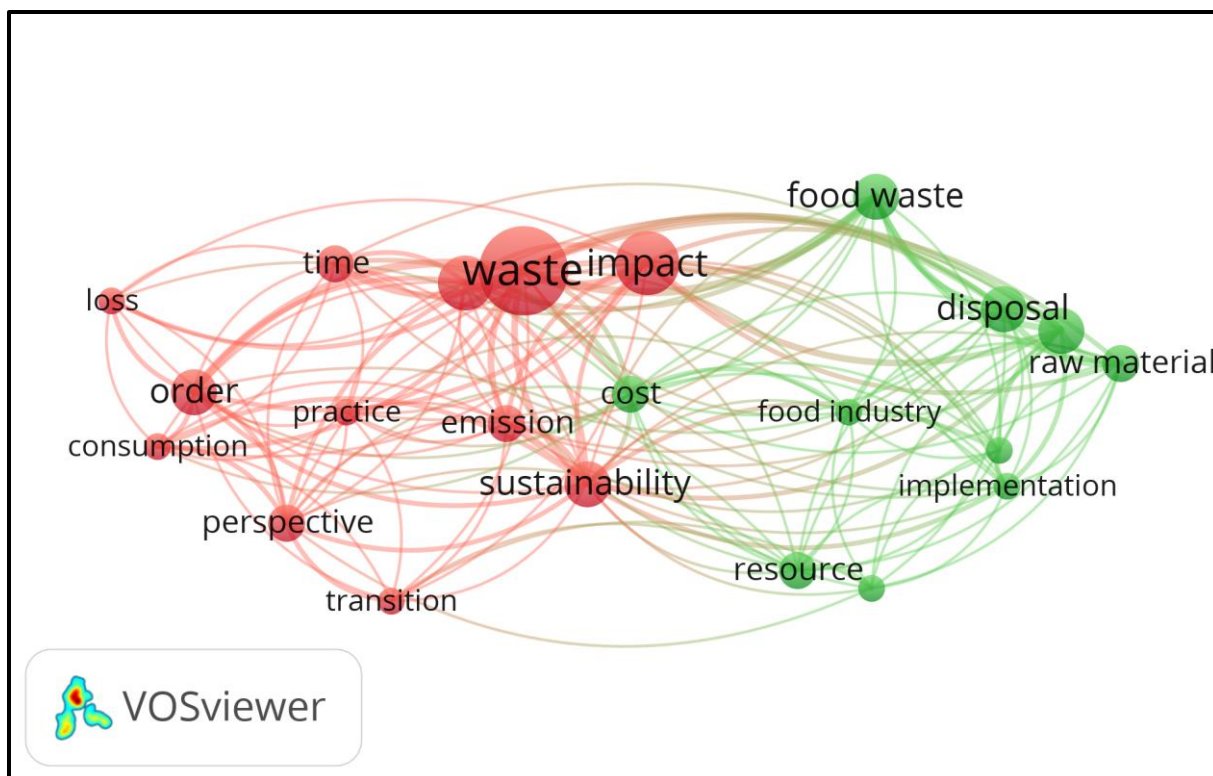


Figure 3: Network visualization of CE

By using VOSviewer software, the network visualization was used to provide the information regarding the incidence of co-occurrence of keywords in form of suitable arrangement of the elements. The color of the elements is showing the cluster of closely related keywords. The size and simplicity of the labels of keywords indicates the incidence in the analyzed transcribe. Meanwhile for the distance of the location between the elements illustrates that the more frequent co-occurrence of the keywords. There are elements that located on the edges of the visualization. This is because they are categorized by a small number of links between them. While the elements that is located in the center indicates that they have a large number of links and relationship with more numerous of other keywords. As can be seen in Figure 3, waste is the keyword that has the biggest number of links and strong relationship with the other keywords. This means that waste is the most important keyword and the company was focusing the most on the waste and its management within the company and how it can impact their performance in terms of financial particularly.

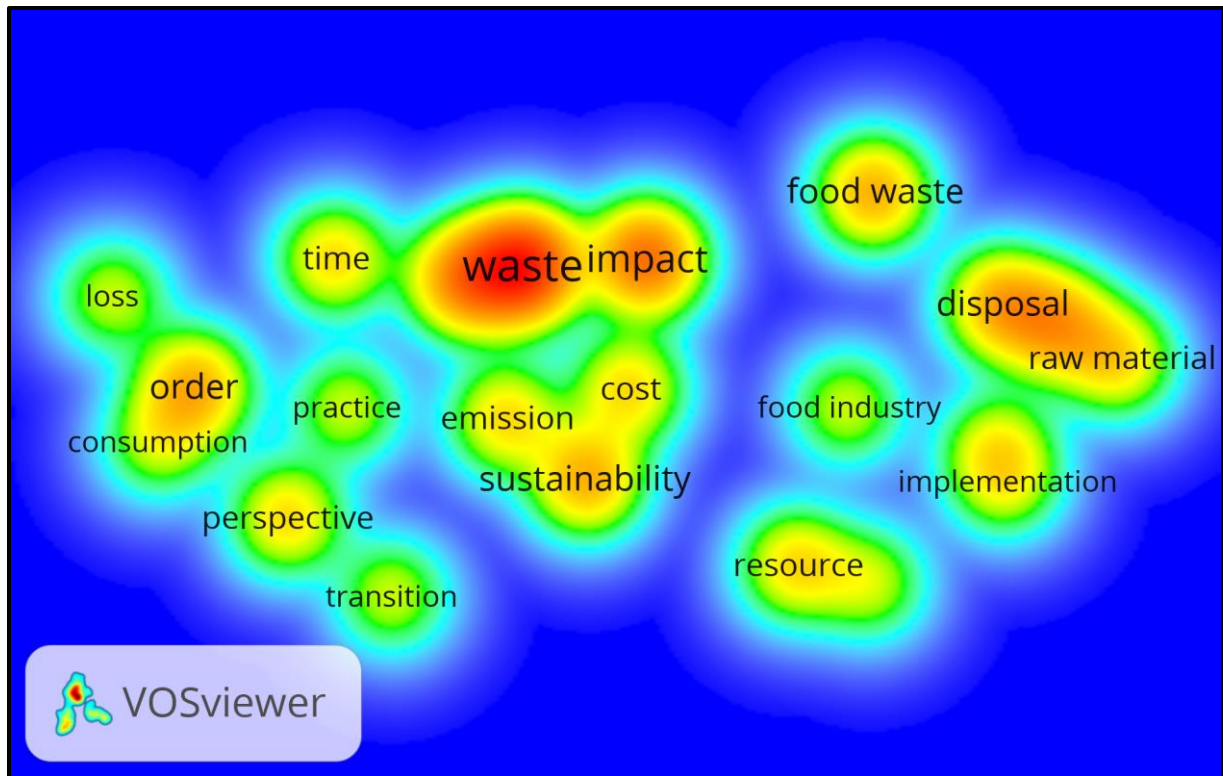


Figure 4: Density visualization of the analyzed keywords

The density of the visualization of the analyzed keywords shows that the most frequently keywords in the interview transcribe were waste, impact, disposal and food waste. Based on Figure 4, the company should focus more regarding the waste generated and also the other initiatives in managing the food waste rather than straight to disposal.

Table 1: Paired samples statistics
Paired Samples Statistics

| | | Mean | N | Std. Deviation | Std. Error Mean |
|--------|----------|------------|----|----------------|-----------------|
| Pair 1 | AfterCE | 23507.6000 | 10 | 26926.12428 | 8514.78813 |
| | BeforeCE | 3014.9000 | 10 | 3719.59097 | 1176.23794 |

A paired samples t-test was conducted to examine the impact of CE adoption on profit margin of a company. There was a statistically significant decrease in mean values and standard deviation values where after CE, the mean is 23507.60 and the standard deviation is 26926.12. Meanwhile, for before CE, the mean is 3014.90 and the standard deviation is 3719.59.

Table 2: Paired samples test

Paired Samples Test

| | | Paired Differences | | | | t | df | Sig. (2-tailed) | |
|--------|--------------------|--------------------|----------------|-----------------|---|-------------|-------|-----------------|-------|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | | | | Upper |
| Pair 1 | AfterCE - BeforeCE | 20492.70000 | 27329.36190 | 8642.30306 | 942.45223 | 40042.94777 | 2.371 | 9 | .042 |

Based on Figure 5, the Sig (2-tailed) value or commonly known as the p-value is 0.042. this value is less than 0.05. The cut-off value for p-value is 0.05. If the p value is less than 0.05, H_0

is rejected and H_1 is accepted. But if the p-value is more than 0.05, H_0 is accepted and H_1 is rejected (Fritz & Berger, 2015). In this case, since the p-value is less than 0.05. So, we reject the H_0 statement and accept the H_1 statement. Because of this, it is concluded that the mean difference in profit margin before the CE implementation is significantly different than the profit margin after the CE implementation. That is, there is improvement on profit margin of the company.

Conclusion

Generally, CE is about government leadership, producer responsibility and consumer education and awareness that will enable market mechanisms that drive higher resource productivity, innovation and economic growth. Products and packaging are designed to last longer and be more durable, using more sustainable materials that can be easily recycled at end-of-life. Retailers could play their roles by offering products that can be easily reused and refurbished, offering end-of-life take back or maintenance and repair services, and support producers in providing education and awareness to consumer. There are many ways consumers can contribute to CE, like making greener buying choices, sharing assets, and repairing them or offering them to others for reuse and refurbishing.

After all, producers are fully responsible for recovering materials from their products and packaging throughout their lifecycle. Material recycling can improve cost-efficient collection and treatment systems which then lead to fewer and fewer materials ending up in landfill and support the economics of circular design. In aquaculture, fish meal is the main source of proteins in animal diet because of their balanced fatty and amino acid contents, easy digestibility and a good sensorial characteristic. Due to that, the production of fish pellet from fishery wastes will bring a great potential and economic advantage for aquaculture industry. Based on the evidence generated in this study, it is proved that the implementation of CE can affect the company financial performance. Therefore, by performing the t-test, the result shows that the profit margin before CE implementation was lower when compared to profit margin after CE implementation. Overall, it is therefore essential for the company to implement the CE approaches to proactively increase their financial performance especially on profit margin.

For the limitations, this study performs the t-test solely on one company. Although the result is showing that the profit margin is improved after implementing the CE approaches, it might be different when it is performed using data from multiple companies. Future research might perform the similar t-test by collecting data from a number of companies. Furthermore, the impact of CE implementation on other company's performance such as operational performance can be examined.

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