Closed Loop Supply Chain: Evaluating Ecological Footprint

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ABSTRACT

Purpose:
The purpose of this research is to evaluate the success of the closed-loop E-waste supply chain operations, primarily focused on achieving sustainability objectives related to the manufacturing, distribution, reusing, and discarding of electrical components.

Methodology:
The supply chain operations reference model offers suggestions and benchmarking tools to monitor the performance of supply chains and enhance the processes. This study illustrates a conceptual framework to show how these standards could be used in the E-waste supply chain to link business processes, metrics, industry standards, and technology to enhance the relationship and coordination between the supply chain members and to increase sustainability throughout the supply chain.

Findings:
According to an assessment of the literature, insufficient attention has been paid to the SCOR model's sustainability criteria. Consequently, in the wake of portraying the structure of the Supply Chain Operation Reference model, we make sense of which credits should be included in the Supply Chain Operation Reference to reflect manageability and which cycles and practices are related to every standard or should be remembered for Supply Chain Operation Reference to lay out the connection between execution, cycles, and practices.

Conclusions:
When a company's supply chain has achieved a desirable degree of eco-friendliness in all regards, its performance will be improved and satisfactory from a sustainability perspective.

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1. Introduction

1.1. Background of the Study

The world's fastest-growing trash issue is e-waste. Every year, we produce roughly 50 million tons of it. In comparison, this is the same as discarding 1,000 laptops every second. Waste Electrical and Electronic Equipment, known as E-waste, is one of the end of life items that have critical monetary and natural effects (Jain, Kumar, Mostofi, & Momeni, 2022). It is a surprising and developing offspring of waste because of the far and wide utilization of electronic items, which has changed individuals' ways of life in the present society. E-waste production is expected to rise by 500% in some locations in the upcoming years (Rehman et al., 2021).

One of the administration's liabilities is to address ecological and social targets, lay out effective arrangements, and measure exhibitions to financial, natural, and social obligation aspects, i.e., the triple main concern of supportability (Ahmad et al., 2019). In this point of view, firms would want to quantify their social and ecological effect and their monetary exhibition. This adjusts the association towards a manageable improvement that is characterized as "advancement that addresses the issues of despise without compromising the capacity of people in the future to address their issues". Auditing the objectives in e-waste the board shows that maintainable objectives, like reusing significant materials, lessening the arranged waste, diminishing fossil fuel by product, and making many work open doors, are visible (Jain, Kumar, Mostofi, & Momeni, 2022).

A supply chain is a network of interconnected amenities, including dealers, production sites, and distribution hubs, that manages the logistics, production, distribution, and delivery of goods (Arjuna et al., 2022). When these cycles involve both the upstream criticism stream of data (orders) and the downstream feed-forward stream of materials (conveyances), the store network is referred to as a forward supply (Khaskhelly, 2018). The converse creation organization or opposite inventory network, however, becomes important when the flow of materials and information in a supply network is altered to handle the returned and used items of a forward supply chain and create additional value through recovering processes like reusing and remanufacturing (Newaz et al., 2018). Besides, when both the forward and reverse streams in a production network are coordinated, the subsequent design results in the closed-loop supply chain that mingles an ongoing flow of manufactured goods (Khokhar, Zia, et al., 2022). The figure shows the cycle in which a traditional supply chain functions and contrasts it to a closed-loop supply chain network involving multiple usage cycles.

Electronic waste, also known as e-waste, is one of the fastest-growing categories of waste due to the crucial step of redesigning electronic devices. For instance, 85% of cell phones have undergone regular updates, which results in a huge amount of discarded things (Mothafar et al., 2022). E-waste has a few distinctive properties and features, including a short item lifecycle and an immense amount of valuable and hazardous elements included, which need a framework that is different from general Reverse supply chain frameworks (Khokhar, Iqbal, et al., 2020).

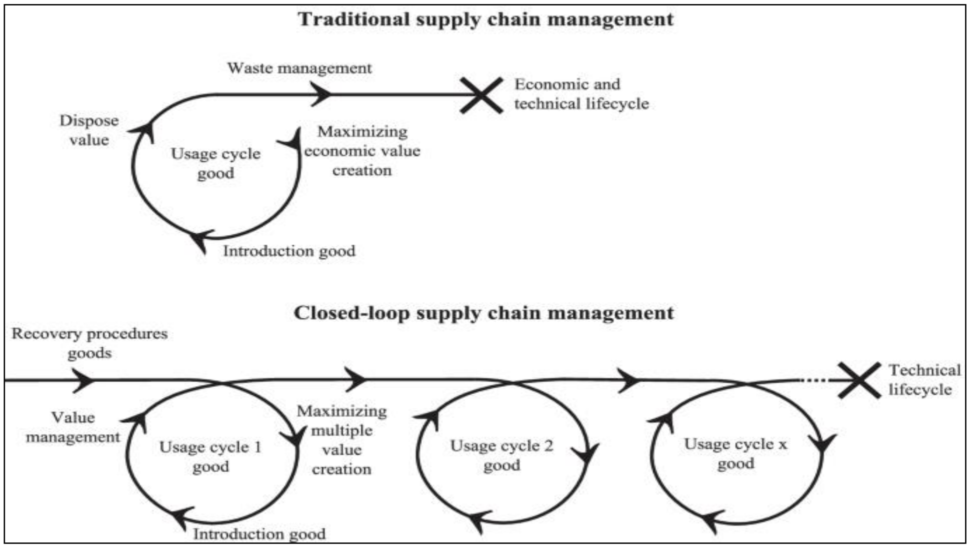

Figure.1. Traditional and Closed-loop SCM
Source: (Coenen et al., 2022)

The muddled cycles of the Reverse Supply Chain for e-waste comes from the removal of e-waste. It is a unique framework with an elevated degree of vulnerabilities in the amount, quality, and season of brought items back. Right off the bat, there are three principal wellsprings of e-waste generation, including households, ventures, and institutional sources (i.e., schools, medical clinics, and legislative offices). Besides, e-waste assortment is gotten from region assortment points, electronic ventures, retailers, and casual and formal reusing areas (Performance Efficiency of Commercial Bank after Privatization: A Case Study of MCB, UBL, and ABL by Najma Shaikh, Faiz Shaikh, Farhan Khaskhely SSRN, n.d.). Casual reusing exercises are normal in non-industrial nations, like India and South Africa, where reusing techniques are simple, and a huge extent of e-waste parts end up in uncontrolled landfills (Arjuna et al., 2022). Figure 2 shows the contribution of electrical devices that are considered waste.

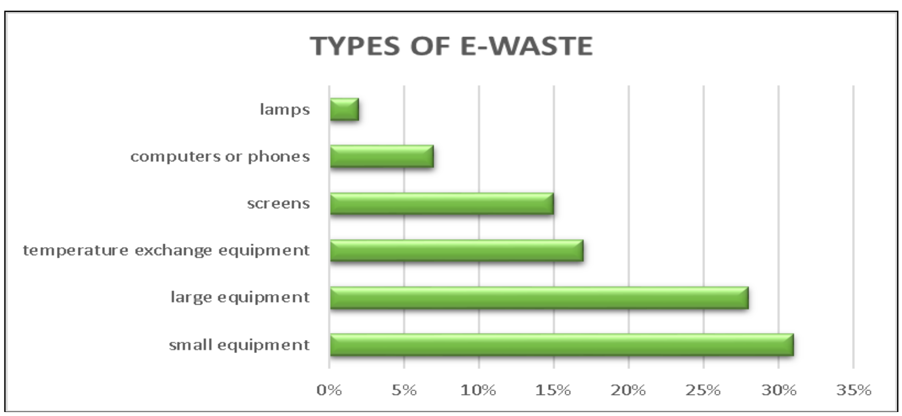

Figure.2. Types of E-Waste
Source: Author's own elaboration

To alleviate the amount of product removal, ventures have been completing 6R ideas (specifically, Reduce, Reuse, Recycle, Recover, Redesign, and Remanufacture) to further develop recuperation execution and limit non-value-added exercises inside end-of-life organization (Razavi et al., 2021). Organizations gain many advantages by carrying out manufactured goods End of life treatment, for example, monetary advantages to organizations, product utilization, expanding market share, competitive advantage, and improved public (Newaz et al., 2018).

Supply-Chain Operations Reference (SCOR) model is a remarkable and comprehensive standard structure for evaluating the display of the production network (Priyadarshini et al., 2020). The SCOR depends on a counseling group's experience containing different associations of professionals. Supply Chain Operations Reference separates the stock organization processes into Plan, Source, Make, Deliver, and Return. The plan changes the interest and supply to satisfy the genuine or organized need and integrates request management, transportation management, and movement administration processes. The source incorporates all cycles associated with setting up the crude parts and other purchased inventories. Making, testing, and pressing are only a couple of the cycles that should happen to satisfy needs (Singh & Pant, 2021). Deliver considers what happens following production and packaging. Return oversees the return and reception of goods for whatever reason and provides customer support following the delivery of goods. It has been noted that SCOR covers the majority of supply chain procedures. Additionally, the Supply Chain Operation Reference Model has developed a set of metrics for supply chain performance (Jain, Kumar, Mostofi, & Arab Momeni, 2022). These measurements, which are based on the knowledge of a consulting team composed of practitioners from various organizations, were eventually incorporated into the current supply chain standards.

The goal of the current study is to enhance the Supply Chain Operation Reference model by utilizing and encompassing the findings of other studies that have addressed the topic of Green Supply Chain in the context of the e-waste supply chain as SCOR hasn't given much thought to the environmental and social aspects of sustainability, despite how significant they are to the e-waste supply chain. Nevertheless, to transition to sustainable waste management, a focused strategy that promotes the use of recycling technologies within a framework that prioritizes resource efficiency is required (Khokhar, 2019). Prioritizing the performance metrics utilized by businesses should also be emphasized, even though Supply Chain Operations Reference provides the required justifications for performance measures and their measurement techniques (Khokhar, Hou, et al., 2020). In this way, SCOR has given up on the idea that businesses should decide whether or not performance measures are important and acceptable for their environment. It is vital to determine the performance measures and their importance and weight to the performance of businesses. Therefore, one of the main goals of the article is to propose a method for calculating the scores of the PMS traits and measurements in the case study of the paper by adopting SCOR. To achieve these goals, the Supply Chain Operations Reference model is adjusted for the Performance Management System of the case under investigation using the Best-Worst Method and Nominal Group Technique (Shahabuddin et al., 2022). Despite SCOR's many benefits for assessing the performance of supply chains, certain extra modifications are needed to be made so that it can be tailored for particular uses, as in the case of the sustainable e-waste supply chain in this research.

2. Literature Review

In this section, earlier literature is observed to facilitate research based on e-waste including the impact of electronic waste issues and sustainable supply chain performance.

E-waste does not have a defined definition, but it generally refers to any electrical and electronic items, as well as their components, that have been abandoned as waste by their owners, without any thought of reuse. Large devices, tiny devices, telecommunications equipment, small IT and temperature exchange equipment, bulbs, screens and monitors, and small devices can all be categorized as e-waste (Sabbir et al., 2022).

2.1. E-Waste Statistics

Because consumers are inclined to purchase the most recent versions with the most cutting-edge features and appealing designs, the production of electronic equipment is expanding quickly in today's competitive business environment. This causes the amount of electronic waste to increase quickly, reaching 24,750,278 tons by 2022 (HOU et al., 2021). When compared to other wastes, the amount of e-waste generated occurs at a rate that is around three times faster. In 2021, it is predicted that there would be 52 million tons of e-waste, or 6.9 kg per person (E-Waste Producing Countries - Google Search, 2022). However, only about 30% of all created e-waste is formally collected and recovered. For instance, India's average new computer lifespan has dropped from seven to four years. Asia creates the greatest electronic trash in absolute terms, followed by Europe and North America. However, with 16 kilograms per person, Europe generates the most e-waste, and Africa, with 1.7 kilos per person, is the least (Hu et al., 2020).

E-waste is full of valuable materials that can be recycled to create new raw materials, including gold, platinum, silver, zinc, copper, palladium, plastic, and other metals. In 2021, the estimated total worth of all raw materials contained in e-waste was 55 billion euros, which is greater than the global GDP of the majority of nations. For instance, three expensive metals, including platinum (37,608 €/kg), gold (35,070 €/kg), and palladium (24,215 €/kg), have the greatest average value (Sultan et al., 2019). E-waste, however, also contains a significant amount of hazardous materials, such as flame retardants (i.e., poly-brominated biphenyls and poly-brominated biphenyl ethers), hexavalent chromium (Cr6), mercury (Hg), and cadmium (Cd) (Hervani et al., 2022). Particularly in developing countries like China and Bangladesh, where the availability of the right recycling technology is restricted and informal recyclers handle precious metals in substandard methods due to economic considerations, these compounds mixed with solid wastes pose a significant concern for environmental degradation. The Basel Convention imposes severe regulations on the transboundary shipment of e-waste an example of such rules is shown in table 1. E-waste export from industrialized nations to poor nations is prohibited (Irshad, Liu, Arshad, et al., 2019). In several emerging nations, illegal activities are seriously harming the environment and public health. Due to the lack of effective treatment methods, a significant amount of e-waste is dumped in landfills, which has harmful effects on the environment and society.

Table.1. Hazardous and Non-hazardous Wastes in the Basel Convention

Annex	Status	Example
VIII	Characterized as hazardous under Article 1(i)(a) of the Basel Convention	Metal waste including lead acid batteries. Ashes from insulated copper wires.
IX	Not characterized as hazardous under the convention	Iron and steel scrap. Ceramic, solid plastic, paper, and textile waste
List C	An informal working list of wastes awaiting classification	PVC waste Residues arising from industrial waste-disposal operations.

Source:(Krueger, 2001)

There are numerous guidelines created and carried out by various state-run administrations and non-government associations overall to forestall the development and unlawful developments of e-waste among countries and, consequently, limit the contamination created.

The Waste Electronic and Electrical Equipment order and the Restriction of Hazardous Substances order are two directives of the European Union that deals with handling e-waste. Since these two mandates handle e-waste administration in the EU, the reusing rate of e-waste in the EU is approximately 35% greater than the reusing rate in the US. The WEEE order was placed to increase the assortment rate for End of Life electronic devices from 65% by 2019 to 85% by 2020 (Saeed Shahbaz Shaheed Zulfikar Ali Bhutto et al., 2019). Similarly, the Restriction of Hazardous Substance Directive aims to reduce the use of dangerous elements like mercury, cadmium, lead, and polybrominated biphenyls in electronic devices (PBB). Additionally, a few other European countries that are not a part of the European Union have also been managing e-waste effectively (Udbye, 2014). For instance, Switzerland has two distinct e-waste frameworks: SENS for household goods and SWICO for office supplies. In comparison to a base rate of 4 kg for every capital directed by the WEEE requirement in 2003, the reusing organizations associated with the two frameworks recycled almost 77,000 metric tons of e-waste in 2005 (Shaikh et al., n.d.). This amounts to 12 kg of e-waste per person.

In Japan, Home Appliance Recycling Law was passed in 1998 to gather four kinds of domestic devices: TVs, coolers, clothes washers, and forced air systems. The extent of the reusing and transportation charge is covered by purchasers. This charge fluctuates from US$27 to US$65 relying on various sorts of electronic gadgets. Purchasers are urged to send e-waste to the store where they purchased the item. Retailers then, at that point, move the pre-owned item to lay out assortment communities, and organizations are expected to reuse e-waste (Ozdemir et al., 2022). The reusing pace of e-waste in Japan is around 76% under this regulation since shoppers have a more prominent finical obligation. Until 2005, a larger number of more than 50 e-waste reusing focuses in Japan have been laid out and they are to some degree upheld by the nearby states or electronic organizations.

Attempts to collect and reuse e-waste from homes and commercial spaces have been made in many US states. For instance, a law has been passed in the State of California to levy purchaser costs, specifically high-level reuse expenses, when products are purchased. For assembling screens, TVs, and PCs, the ARFs cost between US$6 and US$10 (Muhammad et al., 2019). Washington State presented the Electronic Product Recycling Law in 2006. This regulation means to require makers of PC and TV items to carry out a reusing framework all through the state with no charge to private, neighborhood organizations, nearby regions, beneficent associations, and schools. Also, over 900 nearby networks have made e-waste assortment occasions, which is a fundamental job in e-waste the board in confidential houses. Some e-waste assortment strategies are carried out in the US, for example, curbside, specific drop-off places, steady drop-off, and take back and buying focuses (Chopra et al., 2022). As per a specialist, the activities of all states and principal organizations do assume an imperative part in supportable turn of events; however, they are as yet restricted in e-waste the board in the US. The public authority ought to cooperate with organizations in ways to deal with laying out an administrative structure to accomplish a proficient arrangement.

Even though several e-waste legislations have been passed and implemented, the process of e-waste treatment is still quite delayed in Southeast Asian countries. In October 2016, the Indian government released through-e-waste board recommendations (Mahar et al., 2007). The producers, makers, shoppers, distribution facilities, sellers, e-retailers, third-party dismantlers, and recyclers involved in the production, deal, move, buy, assortment, stockpiling, and handling of e-waste have all been required to follow these criteria.

Malaysia, Thailand, Indonesia, and the Philippines are in the last stages of developing their e-waste legislation.

If e-waste is properly handled, urban mining might reap significant rewards from the recovery of precious metals, which are thought to be worth €49 billion. As a result, managing e-waste is a significant challenge for all parties involved, including consumers, the electronics industry, and governments. Thus, Reverse Supply Chain provides a possibility to improve legally gathered and recycled e-waste (Sudusinghe & Seuring, 2022).

2.2. E-Waste Supply Chain Performance Evaluation

The researchers divided the methods for assessing the performance of the supply chain into two things namely: 1) approaches and 2) methodologies. They also separated the three categories of approaches to performance appraisal systems into subgroups:

1) The perspective-based method, which looks at the overall performance appraisal as well as the causal theories that explain how performance metrics are related to one another.

2) The process-based approach, aims to create new strategies for integrating crucial processes into the supply chain while assisting in understanding the crucial operational components of the supply chain.

3) A model with a hierarchical structure that evaluates the supply chain's performance at the tactical, operational, and strategic decision-making levels.

The executives' presentation frameworks are one of the perspective-based strategies that, by the Supply Chain Operation Reference model's premise, spotlight a remarkable picture of the production network through the components, i.e., unwavering quality, responsiveness, adaptability, cost, and resources. The proposed Performance Management System also uses an MCDM model, a best-worst approach, to calculate the presentation credits and measures score (Singh & Pant, 2021). This method provides a consistent assessment of the Performance Management System that will be understood later.

The authors stressed the significance of execution estimation in accomplishing objectives like joint effort, straightforwardness, and profiting from valuable open doors by giving adequate administration devices (Khokhar et al., 2020). Then again, execution estimation gives benefits to the store network like disposal hazards, consistency with regulations and guidelines, decrease of expenses, expanding proficiency, reinforcing upper hands, working with maintainability announcing, honing functional execution, and supporting the execution of the supply network system. As referenced, e-waste affects social order. In this way, a very planned Performance Management System for the e-waste supply network can upgrade every one of the advantages of performance appraisal in such a manner.

A section of the authors discussed sustainable execution evaluation methodologies for the production network and then provided a full framework to survey the production network execution by summarizing the strengths and weaknesses of previous studies (DO 'EMPLOYEE TRAINING PROGRAMS' AFFECT EMPLOYEE PERFORMANCE? | Journal of Business Strategies, n.d.). They ordered techniques to assess the presence of supply network manageability by utilizing ISO 14001 ecological administration guidelines, worldwide announcing standards (e.g; Global Reporting Incentive), SCOR system, Balanced Score Card, Life Cycle Assessment (LCA), Multi-Criteria Decision-

Making instruments (e.g., Analytic Hierarchy Process, Data envelopment analysis, Analytic network process), Rough set hypothesis, Fuzzy-set approach, Composite Indicators, and Conceptual Frameworks. With a conceptual framework, they were able to categorize various evaluation techniques for supply chain sustainability (Prakash et al., 2016). They examined how inside and outer partners, manageability measurements, economical key execution markers, and production network systems are undeniably interconnected in their theoretical model for assessing supply network execution. Moreover, the proposed Performance Management System of the e-waste production network additionally falls inside the thorough system since it uses the SCOR technique, perhaps the most well-known model in this field, and furthermore considers the connection between the PMS credits and measures utilizing the Best Worst Method strategy (Singh & Pant, 2021).

As stated, Supply Chain Operation Reference disregards the weighty execution credits and measurements when evaluating an organization's administrative performance. For this reason, a number of dynamic techniques have now been investigated. The Gray-based Neighborhood Rough Set Theory, the Data Envelopment Analysis, the Fuzzy Inference Systems, and the fluffy DEMATEL approach could all be hinted to in this way (Riahee et al., 2018). Additional research is being done to relate farther-reaching metrics to the SCOR model, notably in the ecological and social elements of manageability. For instance, two informational data were combined into the Green SCOR measurements: source reduction and energy use. By presenting two metrics for "job fulfillment proportion" and "viability of staff developing plans," they also extended Supply Chain Operations Reference to the social dimension and provided a system for evaluating the execution of green development production networks in which evaluation data was categorized into Balanced Scorecard (BSC) perspectives. However, SCOR measurements were obtained to explain the measures used to measure the record. Others focused on the triple-bottom-line (TBL) parts of the exhibition assessment standards of a vehicle spare by taking into account cost, conveyance execution, and quality from the Supply Chain Operation Reference model plus a few green and social guidelines. This fast succession of studies demonstrates that the consolidation of other multi-criteria decision-making strategies with the SCOR system is a relevant methodology in the supply network management studies as concluded in this review. These research results indicate that combining additional multi-criteria decision-making techniques with the SCOR framework is a useful strategy for supply chain management studies as conducted in this study. With a strong emphasis on the reverse and closed-loop operations, this plan improves the performance assessment of the e-waste supply chain (Duran & Bereketli Zafeirakopoulos, 2019).

Rather than inspecting the presentation of the whole chain, a few creators have quite recently centered on a limited handful of explicit part or divides of the e-waste store network. The plan of a household e-waste assortment network by arranging compelling public promotion the areas of e-waste assortments utilizing multi-objective models, the assessment of internet reusing stages utilizing game hypothesis, and the gamble-based execution assessment of progress procedures for maintainable e-waste management are among the investigations that have been finished. Additionally, recent research has examined the presentation assessment of the e-waste inventory network from a wider angle. The author evaluated the closed supply network representation of e-waste using the Fuzzy Delphi and Analytic network process methods in terms of the Balanced Scorecard (BSC) (Duran & Bereketli Zafeirakopoulos, 2019). The aftermath of this white paper recognized key support rules such as green plans, business manageability, and vendor cost savings, and market share. Experts considered presenting the framework of the Waste

Electrical and Electronic Equipment Council on Italian territory, taking into account the Waste Electrical and Electronic Equipment scope goals of the EU (European Union). They emphasized the importance of the e-waste management framework in expanding natural mindfulness, ecological safety, and maintainability. Scientists suggested a deliberate strategy and presented a dashboard of quantitative markers to evaluate a client's spatial admittance to the Waste Electrical and Electronic Equipment organization. Moreover, an unmistakable report was directed to distinguish important and fitting markers for surveying Indonesia's casual e-waste organizations (Tortorella et al., 2022). They have an assortment of execution points of view, each with various markers, including monetary, ecological, partner's qualities, inward business interaction, social and development, and development viewpoints. Like what others have done, they utilized AHP to investigate and survey the imperfection in the e-waste production network. Authoritative necessities, natural prerequisites, handling plant prerequisites, and social requirements are the critical negatives around here.

The Supply Chain Operation Reference model has rarely been used in this inventory network, despite the analysts having offered advanced models for predicting the e-waste supply network. As a result, the structure suggested in this research aligns the Supply Chain Operation Reference-based and sophisticated frameworks that several organizations have acknowledged regarding viability and productivity with the presentation assessment frameworks of the e-waste production network (Irshad, Liu, Wang, et al., 2019). The essay also discusses the need for a more systematic evaluation of the entire value chain of e-waste in terms of realistic goals. In this approach, both the assessment of the e-waste supply network and the comprehensive perspective of that toward manageability have advanced for the suggested Performance Management System.

At last, the use of Multi-Criteria Decision-Making techniques in dissecting various parts of e-waste, the management processes are alluded to take advantage of the ELECTRE TRI and GIS strategies for arranging areas of development and destruction of waste. The natural presentation of e-waste the board frameworks with four choices:

- Landfill removal
- Direct burning with energy recuperation
- Materials recuperation without energy recuperation
- Materials recuperation with energy recuperation was surveyed by utilizing life cycle appraisal (LCA) and material stream examination (MFA) techniques.

Besides, they observed that immediate burning with energy recuperation is the unmistakable choice in Malaysian organizations managing e-waste. The Fuzzy-Analytical Hierarchical Process and Fuzzy VIKOR algorithms are used to investigate the raking of e-waste collection options. Their findings suggest that the most important factors influencing positioning are social awareness and financial viability. For Ghana's barriers and routes to implementing e-waste formalization, management frameworks are evaluated using a combination of the Best Worst Method and the fluffy TOPSIS technique (Muhammad et al., 2019). To decide the association among the e-waste alleviation systems, the Gray idea and DEMATEL procedure have been taken on. As communicated, the BWM technique is to assess the proposed Performance Management System of the e-waste supply network. The main element of this strategy is that it can accomplish reliable decisions with at least well-qualified assessments of public sentiment. Subsequently, for a PMS with many measures and properties, this strategy is by all accounts a decent decision and the consistency of judgment expands the framework's dependability.

2.3. Reverse Supply Chain

In this article, we are covering reverse supply chain concept. Before going into detail, we should know what a reverse supply chain is. RSCs are made up of several tasks required to retrieve, repurpose, or get rid of a user's abandoned goods. There is a small difference between reverse supply chain and reverse logistics, even though both terms are occasionally used interchangeably by different academics in their studies. The authors made it clear that Reverse Supply Chain has a broader use than Reverse Logistics. While the latter emphasizes transportation, warehouse, and inventory management activities, the former also includes coordination and collaboration with partners (Wang et al., 2022). In a nutshell, Reverse Logistics is one of the elements that make up RCS. Reverse Supply Chain operation is expensive from a business standpoint, but it can give companies economic advantages and strategic relevance.

2.4. Reverse Supply Chain Process

Figure 3 illustrates the forward and reverse supply chains that make up a closed-loop supply chain. The acquisition of raw materials from various vendors initiates a forward supply chain flow. The production of numerous pieces that are then put together to create final goods takes place in manufacturing facilities, which are well-designed and equipped with the appropriate technologies. These products are then sent to end users by distribution facilities. In contrast, the flow of a reverse supply chain starts with the purchase of the goods and ends with redistribution and sales (Xu et al., 2022). The five main steps of the reverse supply chain are product acquisition, reverse logistics, inspection and disposal, refurbishment, and distribution and sales.

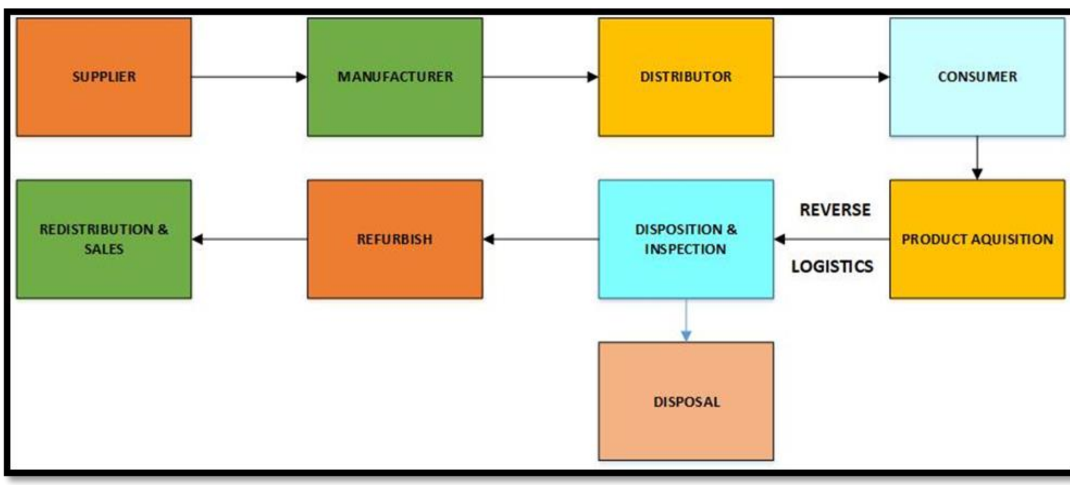

Figure.3. Closed-Loop Supply Chain for E-Waste
Source: (Doan et al., 2019)

2.4.1. Product Acquisition

According to our research, collecting the used product is a crucial step in building a successful supply chain. Carefully controlling the kind, volume, and timing of product returns is necessary. Meanwhile, businesses risk being overrun by returned goods of such varying quality that effective re-manufacturing becomes impossible (Uba et al., 2019). To plan collection, businesses frequently need to collaborate closely with retailers and other distributors.

2.4.2. Reverse Logistics

Products need to be delivered to facilities after collection so that they can be examined, sorted, and disposed of. There is no one "optimal", architecture for a reverse logistics network; instead, each must be customized for the specific items and reuse economics. For example, handling for large, heavy items like tires will be considerably different from handling little, delicate items like cameras. In addition to transportation and storage expenses, businesses should take into account the requirement for product control, the rate at which the value of returned goods will depreciate, and the costs associated with each. It will often make sense to hire a professional to handle the logistics.

2.4.3. Inspection and Disposition

Testing, organizing, and evaluating returned goods require a lot of time and effort. However, the procedure can be accelerated if a business holds returns to high-quality standards and automates tracking and testing using sensors, bar codes, and other technology (Gunasekaran et al., 2004). Generally speaking, a corporation should attempt to make disposal choices based on product configuration, quality, or other factors as early as possible in the returns process. This can reduce various shipping expenses and hasten the release of refurbished goods.

2.4.4. Reconditioning

Businesses can get value from returned goods by removing and refurbishing parts for reuse or by totally re-manufacturing the products for resale. Because the timeliness and quality of returned products can be very unpredictable, reconditioning and re-manufacturing operations are typically far less predictable than traditional manufacturing (Srivastava, 2007). Once more, making wise choices early in the supply chain, especially when accepting and sorting returns, will assist to lower manufacturing unpredictability and, consequently, costs.

2.4.5. Dispersal and Sales

If a company wants to sell a used item, it must first determine whether there is demand for it or whether another market should be created. If it's the last resort, the company should aim to gain significant profits from customer education and other advertising initiatives. The initial purchasers as well as new customers in many organization sectors are anticipated clients for remade goods or components (Sohail et al., 2019). The company might, for instance, need to target customers who can't afford new products but might rapidly take the chance to buy used versions at a lesser price.

By and large, the organizations that have been best with their converse stock chains are those that intently coordinate them with their forward supply chains, making what we call a closed-loop framework. For instance, they settle on item plans and assembling choices considering possible reusing and reconditioning. Bosch is a genuine model, it incorporates sensors into the engines of its power instruments, which demonstrate whether the engine merits reconditioning. The innovation decisively lessens investigation and research costs, empowering the organization to create a gain on the re-fabricated devices (Waseem et al., 2022). Indeed, even with reverse supply chains, groundbreaking delivers enormous profits.

3. Research Methodology

In this part, the procedure to conduct the study is explained. This procedure incorporates the following stages. To start with, a survey to examine the e-waste inventory network is studied and explained. A portrayal of the Supply Chain Operation Reference model (SCOR) is given in the subsequent stage. Afterward, the assumptions on the gathering procedure for removing the measures applicable to examine the local area are given. Thus, we have used Supply Chain Operation Reference model to carry forward the research.

3.1. Supply Chain Operations Reference (SCOR) Method

Three tiers are included in the Supply Chain Operations Reference model to address the variations in cycles. The principal level describes how large an association is. The configuration and the type of production network are examined in the following level, and the third level characterizes the nuances of the cycle components, including the exhibition pointers. At this level, strategies for gaining the upper hand are seen as a response to shifting business conditions. Reference measures for supply chain operations are coordinated across time. As the layers of measurements are extended to the lower level, a more intricate execution is estimated. Calculating lower-level measurements that take into account a few distinct cycles is a supplement to higher-level data. Supply Chain Operations Reference also uses execution ascribes and execution measures. These characteristics describe inventory network traits and give managers the ability to evaluate and see how a supply network exhibits with competitors. Standard credits must be shown and compared to benchmarks in an inventory network. However, SCOR doesn't provide pertinent data for a variety of supply chains. The entire supply network will be advanced through SCOR. Thus, the bullwhip effect of the store network is now extended to the presentation evaluation.

In the Supply Chain Operations Reference model there are five fundamental measures: unwavering quality, responsiveness, adaptability, price, and resource management. These measures have been extended progressively. This implies that we can recognize holes and improvement open doors for significant level measures by assessing low-level standards. Accordingly, the diagnostics highlight upgrades the underlying driver examination capacity in Supply Chain Operations Reference.

3.2. Significance of Manageability Rules

With the rising significance of manageability rules particularly ecological standards, more current forms of SCOR (rendition 8 or more) have likewise evolved greenness models. In variant 11 of the SCOR model following measures are incorporated fossil fuel byproduct, fluid waste produced, air contamination discharge, strong waste created, and reused waste. A few creators have likewise evolved social standards for the SCOR model; however, they think that it is troublesome. The justification for its trouble can be made sense of by the comparability or cross-over of a portion of the rules in the SCOR model with the manageability standards.

In Supply Chain Operation Reference model these five elements are considered important namely: Plan, Source, Make, Deliver, and Return which are shown in a cycle in Figure 4. The arrangement adjusts the interest and supply to fulfill the real or arranged need and incorporates requests the executives, transportation of the board, and conveyance management processes. The following justifies the use of the Supply Chain Operations Reference model in this paper: First off, rather than evaluating how well the supply network functions on its own, this standard's main focus is on the execution assessment of the overall production network. Second, SCOR's scope is much wider and encompasses almost all inventory network jobs, in contrast to other recommendations like Efficient Consumer Response, which focus on transportation duties. Last but not least, more than 900 companies have adopted this model as the reference model for their production network activities because it has been demonstrated in numerous examinations as the fundamental Supply network management model.

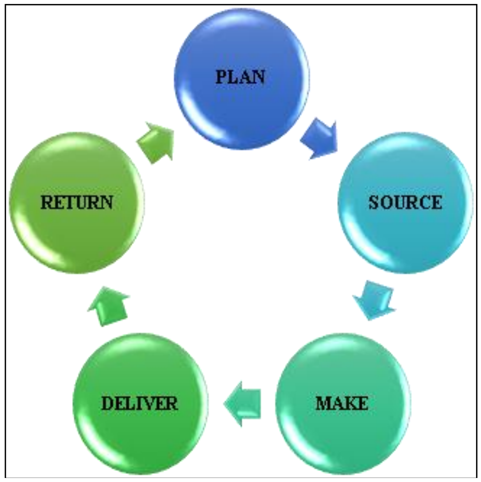

Figure.4. Supply Chain Operation Reference Model
Source: Tutorialspoint.com

4. Results and Discussion

Electronic item improvement has been exceptionally fast in the previous years. Innovation makes past items out of date. For instance, VCRs were supplanted by DVDs, which were supplanted by Blue-beam players. Innovation changes, however a steady improvement of items prompts new models consistently, similar to TVs and cellphones. Cell phones are famously replaced each year. In addition, the costs of electronic articles are falling making them generally accessible. However, older electronic items such as DVD players, VCR's, fax machines, monitors, cell phones, TVs, and printers all contribute to the production of electronic garbage, or e-waste. About 65% of e-waste is not recycled and is instead disposed of in landfills. When placed in landfills, poisonous metal components like mercury, lead, beryllium, or cadmium pose a risk to the environment. When e-waste is burned, highly harmful dioxins and furans are released from burning plastic, polluting the air. Aside from being released into the air, heavy metals including lead, cadmium, and mercury can also linger in the ashes. They can cause bioaccumulation of dangerous metals, which poses a health risk, when they enter the food chain, particularly through aquatic life. There are many purposes behind this wastage.

According to the research 2019 below are the top 10 largest e-waste producing countries, categorized by kg per capita shown in figure 5.

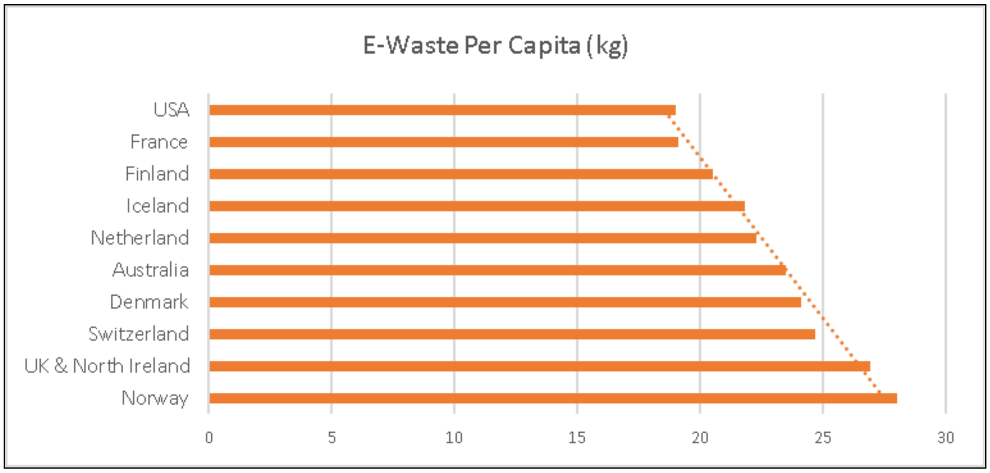

Figure.5. Countries Producing e-waste
Source: (Herat & Agamuthu, 2012)

The above mentioned are the European countries these are rich developed nations, with a consumerist culture. With more than adequate discretionary cash flow, individuals update their innovation much of the time as it opens up and every now and again own quantities of an item. Moreover, the justification for the gathering of waste is that the waste delivered isn't reused. There are numerous regulations particularly in Europe for the legitimate treatment of e-waste. Most nations anyway don't have the offices to manage the volume or poisonous nature of e-waste. Reusing is additionally a costly interaction, particularly when it is done appropriately with secure and safe innovation and conditions. Such countless nations trade waste to Asia and Africa, where the guidelines overseeing e-waste management are careless. In Europe, 48% of the e-waste is exported, and about 55-85% of the e-waste trade is viewed as unlawful. The Asian and African nations, in any case, don't have satisfactory innovation or the necessary resources to deal with the e-waste. Individuals, including kids, handle poisonous parts with uncovered hands, prompting medical issues.

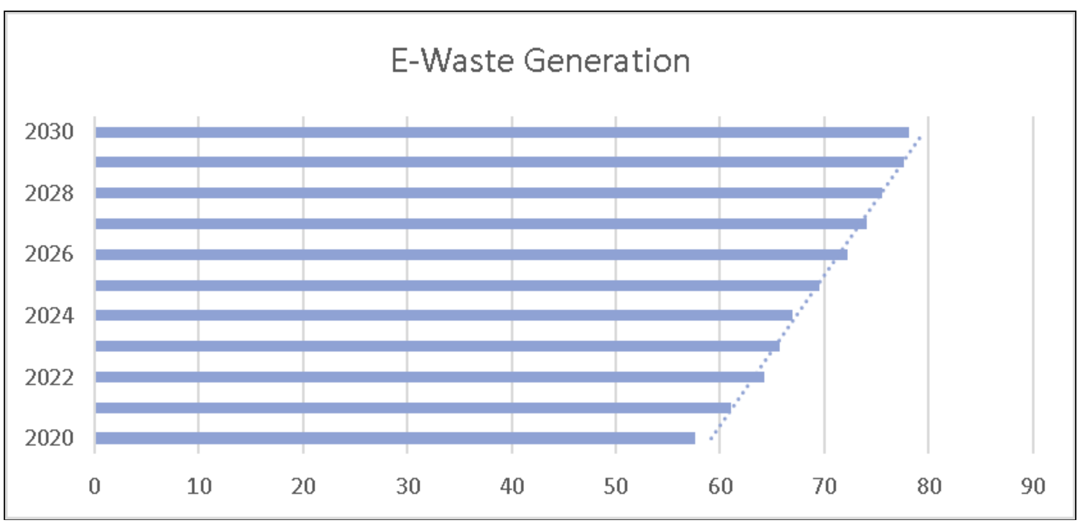

Figure.6. Yearly Increases in E-Waste
Source: (Herat & Agamuthu, 2012)

Similarly, as shown in figure 6, every year the aggregate sum of electric and electronic hardware in the world purposes develop by approximately 2.5 million tons. In 2020 alone, the world created 57.6 million tons of e-waste which is around 9.3 kilograms per individual and comparable in weight to 360 journey ships. Year on year an upward trend is observed in the e-waste generation. Moreover, by 2030, the worldwide total for producing e-waste is probably going to grow to 78.1 million tons, very nearly a multiplying of the yearly measure of new e-waste in only 10 years. This makes it the world's quickest developing homegrown waste stream, fueled primarily by additional individuals purchasing electronic items with more limited life cycles and fewer choices for restoration and companies implementing planned obsolescence in their products.

4.1. SCOR Model Evaluation against E-Waste

The SCOR approach for assessing supply chains could be summed up as follows: This paradigm states that process identification and classification come first. As a result, the processes used throughout the entire supply chain to achieve supply chain objectives are decided. The main SCOR processes Plan, Source, Make, Deliver, Return, and Enable should be highlighted once more. These fundamental operations are divided into two further layers. The second step is the identification of the performance measuring systems, together with their characteristics and metrics. Durability, Responsiveness, Agility, Cost, Portfolio management Efficiency, and Green Supply Chain Operations Reference are the key characteristics of the Supply Chain Operation Reference model. To enable a more thorough analysis of the supply chain performance, these key characteristics are additionally divided into two additional tiers. To provide a quantitative depiction of the supply chain's state concerning each attribute, one or more measurements have been proposed for each one. The originality of SCOR is that it specifies which processes each characteristic belongs to because its primary goal is to measure the performance of the supply chain. Thirdly, the strategies that support the supply chain's operations and activities and contribute to its perfection are highlighted. The relationship and dependence of each strategy on processes and performance measures have been established by SCOR. The last step stresses the job of individuals and divisions in directing the business. In SCOR, it is expressed that in each cycle, what individuals play a part furthermore, what encounters, and aptitudes are expected to prepare the affected individuals? In the wake of directing a written survey, we found signs that more manageable standards should be considered in Supply Chain Operation Reference method to finish the manageability perspective of the E-waste store network. The additional standards, as well as the referenced models of SCOR, have been displayed in Table 2.

Table.2. The Proposed Qualities and Degrees for Gauging E-waste Supply Chain

Performance Elements	Performance Measures
Responsiveness	Order Fulfilment Cycle Time
Reliability	Perfect Order Fulfilment
Agility	Upside Supply Chain Adaptability Upside Supply Chain Flexibility Downside Supply Chain Adaptability
Asset management efficiency	Return on supply chain Fixed Assets Cash-to-Cash Cycle time Return on working capital
Costs	System feasibility System efficiency Total cost to serve

Quality	Partnership level
	Compliance with the Quality Management System
	The excellence of Perspective-Taking in Supply Chain Networks
	Excellence and Incidence of Exchange of Logistics Info Between Partners
	Degree of Joint Planning Cooperation Leading to Value-added Quality and Problem-solving Efforts
Social	The capability of OHS, EM, and BSM Systems
	Research & Development Investment
	Job Satisfaction Ratio
	Wellbeing and security at the workplace
	Corporate Acceptability and Reputation
	Customer satisfaction
	Innovation
	Opportunity for Professional Development
Green SCOR	Life cycle assessment
	Green technology innovation
	Strategic planning for Environmental management
	ISO certification
	Landfill reduction
	Solid Waste Generated
	Reusing utilization rate
	Air pollutant emission
	Liquid waste generated
	Carbon emission
	Energy usage
	Source reduction

Source: (Jain, Kumar, Mostofi, & Arab Momeni, 2022)

It ought to be brought up that the proportions of Table (2), are referenced in Supply Chain Operation Reference, and different measures are removed from the E-waste explores, which concentrated on the manageability execution of the store network. Notwithstanding, for the actions of SCOR, an internal and external investigation was done to lay out such a relationship. The consequences of the examination, which have been introduced in the table (3) till (5), adjust the Supply Chain Operation Reference to a greater manageability-centered perspective about the production network execution.

Table 3. The Affiliation between the New Supply Chain Operation Reference Measures with the Procedure and Characteristics of Existing Supply Chain Operations Reference degree

Measure	Process	Practice

System Viability	P1.2) Categorize, Line up, and Aggregate Supply Chain Resources. P3.2) Assess, classify and Aggregate Manufacture Resources. P4.2) Aggregate delivery resources identify and assess. E5) Manage Supply Chain Assets. P5.2) Identify, Assess and Aggregate Return Resources.	BQ.019) Demand Planning. BQ.021) Sales and Operations Planning BQ.031) Stock keeping Unit (SKU) Rationalization/Cost of Sales Analysis. BQ.035) Business Rule Review. BQ.104) Facility Master Planning BQ.017) Distribution Planning BQ.134) Supplier Evaluation using Robust Evaluation Tool.
Partnership level	P.1.1) Identify, Prioritize and Aggregate Supply Chain Requirements P.2.1) Identify, Prioritize and Aggregate Product Requirements P.3.1) Identify, Prioritize, and Aggregate Production Requirements P.4.1) Identify, Prioritize and Aggregate Delivery Requirements P.5.1) Assess and Aggregate Return Requirements P.2.2) Identify, Assess and Aggregate Product Resources. D3.2) Negotiate and Receive Contract. E.8) Manage Regulatory Compliance. E.3.5) Publish Information. E.6.1) Receive Contract/Contract Updates. E.6.2) Enter and Distribute Contract. E.6.6) Identify Resolutions/Improvements. E.6.7) Select, Prioritize and Distribute Resolutions.	BQ.086) Supply Network Planning. BQ.096) Logistics & Warehouse Planning. BQ.122) Vendor Managed Inventory. BQ.017) Distribution Planning. BQ.145) Vendor Collaboration. BQ.098) Mobile Access of Information. BF.002) Reach Agreement Based on Proportional Contract. BQ.126) Supply Chain Visibility System. BQ.012) Lot Tracking. BQ.167) Electronic Returns Tracking. BQ.042) Regular Review of Procurement Terms and Conditions. BQ.162) Long-Term Supplier Agreement/Partnership. BQ.145) Vendor Collaboration. BQ.148) 3-Way Delivery Verification. BQ.156) Collaborative Planning, Forecasting, and Replenishment (CPFR). BQ.166) Document Management System.
System Competence	P.1.3) Balance Supply Chain Resources with Supply Chain Requirements. sP.2.3) Balance Product Resources with Product Requirements. P.3.3) Balance Production Resources with Production Requirements. P.4.3) Balance Delivery Resources and Capabilities with Delivery Requirements. sP.5.3) Balance Return Resources with Return Requirements. S.1.1) Schedule Product Deliveries. M.1.1) Schedule Production Activities. SR3.4.) Schedule Excess Product Shipment. DR.22) schedule MRO Product. SR.1.4) Schedule Defective Product Shipment.	BQ.014) Supply Network Planning. BQ.024) Supply Chain Optimization. BQ.028) Inventory Optimization. BQ.041) Transportation Optimization. BQ.053) Manufacturing Reliability Improvement. BQ.056) Supplier Raw Material Quality Improvement. BQ.134) Supplier Evaluation using Robust Evaluation Tool. BF.001) Design Coordination Contract Such as Buy Back Contract, Revenue Sharing Contract, etc. Using Optimization Techniques. BQ.024) Supply Chain Optimization (SCO).

	SR.2.4) Schedule MRO Shipment. E.6) Manage Supply Chain Network. E.6.4) Manage Supply chain Contract. E.7) Manage Supply Chain Network. E.7.3) Develop Scenarios. E.7.4) Model/ Simulate Scenarios.	BQ.123) Return Load Optimization. BQ.156) Collaborative Planning, Estimating, and Replenishment. BQ.160) Lean BQ.131) Alternative Supplier Benchmarking. BQ.163) Optimized Supplier Count. BQ.082) Incessant Development. BQ.157) Just In Time Production BQ.106) Predictive Maintenance. BQ.017) Distribution Planning.
The excellence of perspective taking in the supply chain network	D.1.13) Receive and verify Product by Customer. SR.1.1) Identify Defective Product Condition. SR.2.1) Identify MRO Product Condition. S.2.2) Receive Product. S.2.3) Verify Product. M.1.3) Produce and Test P.3.3) Balance Production Resources with Production Requirements. P.4.3) Balance Delivery Resources and Capabilities with Delivery Requirements. P.5.3) Balance Return Resources with Return Requirements.	BQ.054) Industrial Quality Improvements for Return Discount. BQ.127) Programmed Alerts for Material Management. BQ.056) Supplier Raw Material Quality Enhancement. BQ.147) Receiving Goods Inspection. BQ.125) Automated ID/Disposition of Over shipments
Excellence and Frequency of Exchange of Logistics Information among Partners	E.7) Manage Supply Chain Network. P.1.4) Inaugurate and Communicate Supply Chain Plans. E.1.4) Communicate Business Rule. E.3.1) Receive Maintenance Request. E.3.2) Determine/Scope Work. E.3.3) Maintain Content/Code. E.3.4) Maintain Access. E.3.5) Publish Information. E.3.6) Verify Information.	BQ.145) Vendor Collaboration. BQ.167) Electronic Returns Tracking. BQ.159) Electronic Data Interchange. BF.004) Performing Industry Tools to Enhance Quality of Information Sharing Systems. BQ.093) Publish Production Plan. BQ.098) Mobile Access of Information. BQ.111) Electronic Technical Orders and Product Specifications. BQ.126) Supply Chain Visibility System
Acquiescence with Value Management System	E1) Manage Supply Chain Business Rules. E2) Manage Performance. E3) Manage Data and Information. E5) Manage Supply Chain Assets. E6) Manage Supply Chain Contracts E7) Manage Supply Chain Network. E.7.1) Select Scope and Organization. E.1.2) Interpret Business Rule Requirement. E.1.3) Document Business Rule. E.1.4) Communicate Business Rule. E.1.5) Release/Publish Business Rule	BQ.016) Supply Network Planning. BQ.023) Business Rule Management. BQ.035) Business Rule Review. BQ.082) Safety Stock Planning. BQ.129) Return Policy included with Shipping Document. BQ.166) Document Management System.
Degree of Mutual Planning Collaboration Leading		BF.003) Shared Investment in Boosting Facility of Supply Chain Network.

to Improved Quality or Problem-solving effort		BQ.034) Extend Inventory Planning using Collaboration (Key Suppliers) BQ.023) Business Rule Management. BQ.108) Return Policy Conformance Integration. BQ.054) Manufacturing Quality Improvements for Return Reduction BQ.056) Supplier Raw Material Quality Improvement

Source: (Weyers, 2017)

Table.4. The Connection between the New Green Supply Chain Operations Reference Measures with the Process and Features of Supply Chain Operation Reference Model

Degree	Process	Practices
Energy usage	N.2) Manage Energy Use P.2) Plan Source	BQ.024) Supply Chain Optimization BF.005) Usage of Renewable Energies. BF.006) Enhance Energy Use. BQ.104) Facility Master Planning
ISO certificate	E.2. Manage Performance E.9) Manage Supply Chain Risk. N.1) Survey of Supply Chain Through Legislation Standards	BQ.155) Standard Operating Measures. BF.006) Consult with Practitioners for Executing Standards.
Source Discount	N.1) Mange Source Use P.2) Plan Source	BQ.104) Facility Master Planning BQ.024) Supply Chain Optimization BQ) Optimize Source Use
Life Cycle Valuation	E.2. Manage Performance N.4) Measure Product Footprint for Various Environmental Aspects.	BF.013) Register to LCA Database System for Gauging the LCA of Numerous Facets of Products
Strategic Development for Environmental management	G.3.014) Plan Air Releases G.3.015) Source Air Emanations G.3.016) Make Air Emissions G.3.002) Plan Source Carbon Emissions G.3.003) Plan Make Carbon Emissions	BF.011) Define an Integrated Agenda to Progressively Collect, Store and Dispose of E-Waste in the Pacific Region. BF.012) Provides Guidance on Best-practice in E-waste Handling and Disposal Options Fuzzy Delphi Method and Analytical Network Process
Green Technology Novelty	P.1) Plan Supply Chain	BF.010) Purchasing Used Computers to Bridge the Digital Divide, Even when These CPUs Easily Collapse and Need to Be Cast-off.
Landfill Reduction	P.2) Plan Source N.3) Manage Landfill Use	BF.007) Bring It to the Recycler. BF.008) Layout Optimization BQ.104) Facility Master Planning BQ.024) Supply Chain Optimization BF.008) Define a Combined Framework to Progressively Gather, Store and Dispose of E-Waste in the Pacific Region BF.009) Optimize Layout

Source: (Weyers, 2017)

Table.5. The Relation between the New Supply Chain Operation Reference Green Measures with the Procedure and Characteristics of Existing SCOR Degree

Measure	Process	Practices
Innovation	P.1) plan supply chain E.1) manage supply chain business rules. N.5) manage innovation	BF.017) Encourage innovations throughout the supply chain BF.016) Includes the pre-processing technologies “manual dismantling or sorting of fractions”, “de-gassing CFC, HCFC” and “semi-automatic CRT cut and cleaning
Proficiency in EM, BSM, and OHS	P1) strategic supply chain E1) manage supply chain commercial rules. E9) Manage Supply Chain Risk N.1) review supply chain through legislation standards such as ISO.	BF.006) Refer to practitioners for implementing standards. BF.015) insurance of employees against threat regarding e-waste reusing
Job satisfaction ratio	E.2) Performance management E.7) Managing Supply Chain Network.	B.014) generate decent employment, income opportunities, and other positive communal impacts
Chance for professional growth	E.4) Manage Supply Chain Human Resources E.2. Manage performance	BF.025) Job Promotion Training. BF.026) Worker rewards and promotions for effective proposals
Customer gratification	P1) plan supply chain. E1) manage supply chain business rules. E7) Manage Supply Chain Network. P5) Plan Resource N.9) Manage customer relationship system D) Deliver	BF.024) Online Collection of E-waste from Customer by Offering a Discount for Purchasing a Brand New Which Help the Company to Estimate the Future Demand Even. BQ.048) Inventory Incentives or Promotions for Customers BQ.050 Customer Inducements / Promotions for Large Inventory Purchases BQ.046 Accelerate Outbound Customer Consignments
Health and security at the workplace	E.9) Manage Supply Chain Risk. N.7) Corporate Transparency and Social Responsibility	BF.019) Delivers background information on health risks associated with E-wastes BF.020) Incessant Evaluation of blood lead levels
Research and development speculation	P1) plan supply chain E1) manage supply chain business rules. N.6) Manage and Conduct Research and Development Activities	BF.018) Use cooperate research and development with universities or Knowledge Based Companies
Corporate acceptability and reputation	P1) plan supply chain E1) Manage Supply Chain Business Rules. N.8) Manage Customer Relationship System	BF.023) Proposing Good After Sales Services. BQ.050 Customer Incentives / Promotions for Large Inventory Purchases BF.021) Investment on Social and Public Facilities. BF.022) Supplier Social Responsibility Improvement.

Source: (Weyers, 2017)

The procedures of Plan, Source, Enable, Make, Return, and Deliver are denoted in Tables 3 to 5 by the notations P, S, E, M, SR, and D, respectively. We also use the letter N to represent the new and suggested approach. Although this will be a general process that encompasses all Plan, Source, Enable, Make, Return, and Deliver processes, the suggested notation does not specify which process the new process belongs to. The SCOR model's business practices are denoted by the letter BQ. Additionally, BF is for new suggested business methods. The green-related processes are introduced, however, using G notation.

The results of Tables (2) through (5) could be used to fulfill the SCOR model's sustainability standpoint. In this regard, by including Cost Measurements and Quality Attributes about Recent Year Publications, we enrich the cost-related measures of SCOR. By incorporating Source Reduction, Energy Usage, ISO certification, Landfill Reduction, Green Technology Innovation, and Strategic Planning for Environmental Management, we further reinforce the Green SCOR qualities. In the current article, the social aspects of the supply chain which are not covered by the Supply Chain Operation Reference are also taken into consideration to complete the Supply Chain Operation Reference model in response to the growing focus on an organization's social responsibility. Moreover, Tables (3) till (5) contain data about the related cycles and practices which exist in the Supply Chain Operation Reference model and further make a commitment about tending to supportability according to E-waste points of view.

5. Conclusion

Almost all electronic garbage contains recyclable materials in some way. That includes substances like plastics, glassware, and metals, which although being viewed by consumers as "junk" or "obsolete," yet serve an important function. It's quite amusing that these gadgets are referred to as "e-waste" because they aren't rubbish. But much too frequently, they are discarded. Alternatively, recovery of the components of the devices that are still useful and give producers recycled materials to use in the production of new goods. Preventing the drainage of harmful metals into rivers using recycling devices, as well as preventing the process from occurring at another mine, provides proof that a practical solution exists. A firm mining for new ore is worse for the environment than a sustainable supply of recycled metal. There are several beneficial uses for recycling e-waste such as keeping items out of landfills to help protect human and environmental health.

Furthermore, the current study defines the structure of the Supply Chain Operation Reference model for analyzing the e-waste supply chain, as well as the necessary changes to this standard to account for sustainability. The components of environmental, economic, and social sustainability are studied under sustainability research. We included sustainability requirements and indicators that had been suggested in previous Supply Chain Operation Reference studies but had not been included in the SCOR standards. However, to establish an advanced performance appraisal system, it is necessary to develop supply chain processes along with the supply chain network to identify which performance indicators relate to which supply chain processes and which processes require improvement. Additionally, practitioners and experts from all around the world collaborated to create the SCOR standard, new protocols for enhancing supply chain performance that is presented for each process and in each performance indicator. As a result, the associated processes and best practices for each newly proposed criterion were introduced, in keeping with other performance indicators outlined in Supply Chain Operation Reference, this could also help develop a generic model to positioning supply chain competitiveness. The results show that individually, each decision area has a positive impact on both customers-facing supply chain quality performance and internal facing firm level business performance. Collectively, ‘Plan’ and ‘Source’ decisions are more important to customer-facing supply chain performance (reliability, response, and flexibility), and ‘Make’ decisions positively affect internal facing performance metrics (cost and asset).

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