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Ecological Supply Chain: Tools For Evaluating E-Waste – World Perspective

Ekologiczny łańcuch dostaw: narzędzia do oceny E-odpadów – globalna perspektywa

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Abstract

When a company's supply chain has achieved a desirable degree of eco-friendliness in all regards, from a sustainability perspective, its performance will be satisfactory. Since the closed-loop e-waste supply chain's operations are primarily focused on achieving sustainability objectives related to the manufacturing, distribution, reusing, and discarding electrical components, it is crucial to evaluate its success in this area. In order to monitor the performance of supply chains and enhance the processes, the supply chain operations reference model offers suggestions and benchmarking tools. In this study, a conceptual framework is illustrated to show how these standards could be used in the E-waste supply chain to link business processes, metrics, industry standards, and technology in order to enhance the relationship and coordination between the supply chain members and to increase sustainability throughout the supply chain. Insufficient attention so far has been paid to the SCOR model's sustainability criteria, according to an assessment of the literature. Consequently, in the wake of portraying the structure of Supply Chain Operation Reference model, we make sense of which credits should be included in Supply Chain Operation Reference so to reflect manageability and which cycles and practices are related with every standard or should be remembered for Supply Chain Operation Reference to lay out the connection between execution, cycles, and practices.

Key words: SCOR model, reverse supply chain, E-waste management, sustainable supply chain, Green Supply Chain Operation Reference

Streszczenie

Kiedy łańcuch dostaw firmy osiągnie pożądany stopień przyjazności dla środowiska pod każdym względem, z punktu widzenia zrównoważonego rozwoju, jego wyniki będą zadowalające. Ponieważ operacje łańcucha dostaw E-odpadów w obiegu zamkniętym koncentrują się przede wszystkim na osiąganiu celów zrównoważonego rozwoju związanych z produkcją, dystrybucją, ponownym użyciem i utylizacją komponentów elektrycznych, kluczowe znaczenie ma ocena jego sukcesu w tej dziedzinie. Aby monitorować wydajność łańcuchów dostaw i ulepszać procesy, model referencyjny operacji łańcucha dostaw oferuje sugestie i narzędzia do analizy porównawczej. W tym badaniu nakreślono ramy koncepcyjne, aby pokazać, w jaki sposób standardy te można wykorzystać w łańcuchu dostaw elektrośmieci w powiązaniu z procesami biznesowymi, wskaźnikami, standardami branżowymi i technologią w celu wzmocnienia relacji i koordynacji między członkami łańcucha dostaw i aby zwiększyć poziom zrównoważonego rozwoju w całym łańcuchu dostaw. Jak dotąd, co potwierdza dokonany przegląd literatury,

kryteria zrównoważonego rozwoju modelu SCOR nie poświęcano wystarczającej uwagi. W związku z tym, po przedstawieniu struktury Modelu referencyjnego operacji łańcucha dostaw, rozumiemy, które kredyty powinny zostać uwzględnione w referencyjnej operacji łańcucha dostaw, aby odzwierciedlić łatwość zarządzania oraz które cykle i praktyki są związane z każdym standardem lub należy o nich pamiętać w odniesieniu do łańcucha dostaw, co umożliwia ukazanie związku pomiędzy wykonaniem, cyklami i praktykami.

Słowa kluczowe: model SCOR, odwrócony łańcuch dostaw, zarządzanie elektrośmiecami, zrównoważony łańcuch dostaw, Green Supply Chain Operation Reference

1. Introduction

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 wellspring of waste because of the far and wide utilization of electronic items, which has changed individuals' ways of life in the present society. 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. E-waste production is expected to rise by 500% in some locations in the upcoming years (Rehman, 2021). At present, a lack of scientific recycling of a significant amount of e-waste is a source of environmental pollution and health hazards that are having a detrimental effect on sustainable development goals (Ghosh et al., 2022). Addressing this current socio-environmental issue, especially in developing countries, has been significant to achieve some of the United Nation's sustainable development goals (SDGs), such as clean water and sanitation (Goal 6), sustainable cities and communities (Goal 11), responsible production and consumption (Goal 12), and life below water (Goal 14), by 2030 (Yong et al., 2019). As it is a global issue from the pollutant production and transportation perspectives, multinational negotiation as well collaboration is realistically the only way to achieve sustainable development goals (Hossain et al., 2015).

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. In this point of view, firms ought to want to quantify their social and ecological effect and their monetary exhibition. This adjusts the association toward 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 own issues* (WCED, 1987). Auditing the objectives in e-squander the board shows that maintainable objectives, like reusing significant materials, lessening the arranged waste, diminishing fossil fuel byproduct, and making many work open doors, are conspicuous (Jain, Kumar, Mostofi, & Momeni, 2022). Thus, concentrating on the presentation of e-squander exercises is more qualified with regards to manageable store network execution assessment.

A supply series is a network of interconnected amenities, including dealers, production sites, and distribution hubs, that manages the logistical, 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 chain. 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. Besides, when both the forward and reverse streams in a production network are coordinated, the subsequent design results in closed loop supply chain that mingles an ongoing flow of manufactured goods (Khokhar, Zia, et al., 2022).

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 discard things. E-waste has a few distinctive properties and features, including as a short item lifecycle and the 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). The muddled cycles of 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 amount, quality, and season of brought items back. Right off the bat, there are three principal wellsprings of e-squander 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. 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).

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.

Additionally, a few global tools like the Oliver Wight Class a Checklist, Efficient Consumer Reaction, Supply Chain Operation Reference, and Odette EVALOG model have been developed by the dedication of master groups to analyze the topic of supply chain networks. By following these recommendations, it would be possible to pass the main test for production network execution, which is the inability to understand measurements and apply them in a multi-hierarchical environment. Supply-Chain Operations Reference (SCOR) model is a remarkable and comprehensive standard structure for evaluating the display of the production network (Priyadarshini et al., 2022). The SCOR depends in a counseling group's experience containing different associations' professionals. Supply network Operations Reference separates the stock organization processes into Plan, Source, Make, Deliver, and Return. The plan changes the interest and supply to satisfy genuine or organized need and integrate request management, transportation management, and movement administration processes. 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 need (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, & 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. In this study, the SCOR model and related measures are used. The characteristics and indicators used in the suggested PMS of the e-waste supply chain will be briefly explained in the article's methodology section.

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. 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. However, it is vital to determine the performance measures and their importance weight in order to evaluate 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. Second, 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, in order 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). Therefore, another 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 latter topic in the context of the e-waste supply chain. In order 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).

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.

2.1. E-Waste Issues

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. 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 tonnes of e-waste, or 6.9 kg per person (E-Waste Producing Countries – Google Search, 2020.). 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, the least. Moreover, 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).

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. 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 trans-boundary shipment of e-waste. E-waste export from industrialised nations to poor nations is prohibited. 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.

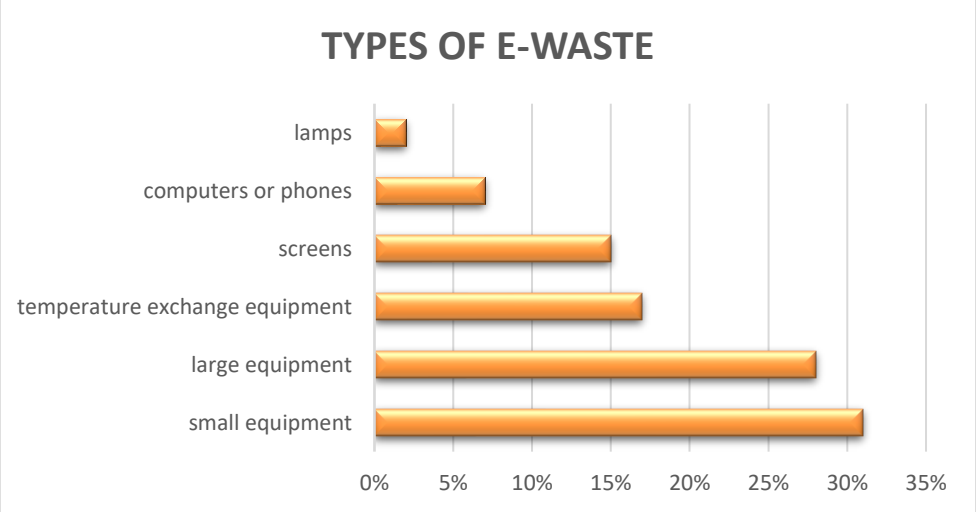

Figure 1. The contribution of electrical devices that are considered as waste, own work

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 the 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 in order to increase the assortment rate for End of Life electronic devices from 65% by 2019 to 85% by 2020. Similarly, the Restriction of Hazardous Substance Directive aims to reduce the use of dangerous elements like mercury, cadmium, lead, and poly brominated 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 WEEE requirement in 2003, the reusing organisations associated with the two frameworks recycled almost 77,000 metric tonnes of e-waste in 2005. 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. An extent of the reusing and transportation charge is covered by purchasers. This charge fluctuates from US$27 to US$65 relying upon 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.

Tempts 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. 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, in excess of 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 really 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 organization ways to deal with lay out an administrative structure to accomplish a proficient arrangement.

Despite the fact that several e-waste legislations has been established 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 vendors, 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 Performance Evaluation Method

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, which 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 implementation of production networks has also been evaluated using a variety of approaches, according to experts. The Analytic Hierarchy Process, Data Envelopment Analysis, Analytic Network Process, Delphi, and recreation procedure are some of these techniques. The executives' presentation frameworks are one of the perspective-based strategies that, in accordance with the Supply Chain Operation Reference model's premise, spotlight a remarkable picture of the production network through the Supply Chain Operation Reference credits, 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.

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 of hazard, consistence with regulations and guidelines, decrease of expenses, expanding proficiency, reinforcing upper hands, working with maintainability announcing, honing functional execution, and supporting the execution of supply network system. As referenced, e-squander affects social orders. In this way, a very much planned Performance Management System for the e-squander supply network can upgrade every one of the advantages of performance appraisal in such manner.

A portion of the authors dissected the sustainable execution assessment techniques for the production network and afterward gave a thorough structure to survey the production network execution by summing up the qualities and shortcomings of past investigations. They ordered techniques to assess the presentation of supply network manageability by utilizing ISO 14001 ecological administration guideline, worldwide announcing standard (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 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 system are undeniably interconnected in their theoretical model for assessing supply network execution. Moreover, the proposed Performance Management System of the e-squander production network additionally falls inside the thorough system since it uses the SCOR technique, as perhaps of 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, number of dynamic techniques has 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 in an effort 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 fulfilment proportion" and *viability of staff developing plans*, they also extended Supply Chain Operations Reference to the social dimension 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 in order 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 spate 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 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 explicit parts or divides of the e-squander store network. The plan of a household e-squander assortment network by arranging compelling public promoting the areas of e-squander 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-squander 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-squander 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-squander 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-squander 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. 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-squander, the management processes is allude to took advantage of the ELECTRE TRI and GIS strategies for arranging areas of development and destruction of waste. The natural presentation of e-squander the board frameworks with four choices of:

- 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-squander. 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 fluffy TOPSIS technique. 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 in detail we should know what 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. Authors made it clear that Reverse Supply Chain has a broader use than Reverse Logistic. 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 2 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's 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.

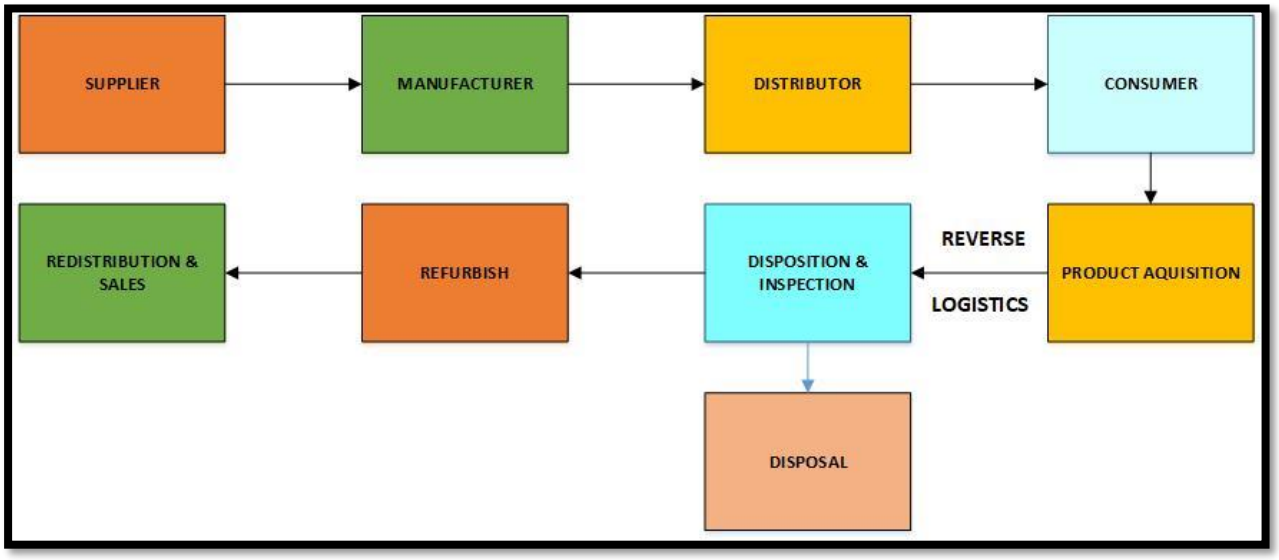

Figure 2. Closed loop supply chain for e-waste, own work

2.4.1. Product Acquisition

According to our research, collecting the used product is a crucial step in building a successful 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. 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 for 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. 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
By removing and refurbishing parts for reuse or by totally re-manufacturing the products for resale, businesses can get value from returned goods. 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. 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. 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 plan 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 demeanor costs, empowering the organization to create a gain on the re-fabricated devices. Indeed, even with reverse supply chains, ground breaking delivers enormous profits.

3. Methodology

In this part, the procedure utilized in the paper is depicted. This procedure incorporates the accompanying stages. To start with, the general system to survey the e-squander inventory network execution is made sense of. A portrayal of the Supply Chain Operation Reference model (SCOR) is given in the subsequent stage. Then, at that point, the ostensible gathering procedure for removing the measures applicable to the examination local area is represented. 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 nuances of 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 nitty gritty 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 Supply Chain Operations Reference model there five fundamental measures: unwavering quality, responsiveness, and adaptability, price, and resource management. These measures have been extended progressively. This implies that we can recognize holes and improvement open doors for the 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 SCOR model following measures are incorporated fossil fuel byproduct, fluid waste produced, air contamination discharge, strong waste created, and reused squander. 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. The arrangement adjusts the interest and supply to fulfill real or arranged need and incorporates request the executives, transportation 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 3. Supply Chain Operation Reference Model, own work

4. Discussion

Electronic items such as DVD players, VCR's, laptops, fax machines, monitors, cell phones, TV's, 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 bio-accumulation 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. Electronic item improvement has been exceptionally fast in the previous years. New 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. Cellphones are famously supplanted each year. In addition, the costs of electronic articles are falling making them generally accessible.
According to the research of 2019 below are the top 15 largest e-waste producing countries, categorized by kg per capita.
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, justification for gathering of waste is that the waste delivered isn't reused. There are numerous regulations particularly in Europe for the legitimate treatment of e-squander. Most nations anyway don't have the offices to manage the volume or poisonous nature of e-squander. Reusing is additionally a costly interaction, particularly when it is done appropriately with secure and safe innovation and conditions. Such countless nations trade squander to Asia and Africa, where the guidelines overseeing e-squander management are careless. In Europe, 48% of the e-squander is exported, and about 55-85% of e-squander 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-squander. Individuals, including kids handle poisonous parts with uncovered hands, prompting medical issues.
Similarly, every year the aggregate sum of electric and electronic hardware the world purposes develops by 2.5 million tons. In 2019 alone, the world created 53.6 million tons of e-squander that is around 7.3 kilograms per individual and comparable in weight to 350 journey ships. Asia delivered the overwhelming majority 25.0 million tons trailed by the Americas (13.1 million tons) and Europe (12 million tons), while Africa and Oceania produced 3.0 and 0.8 million tons individually. Moreover, by 2030, the worldwide total for producing e-waste is probably

going to grow to 74.8 million tons, very nearly a multiplying of the yearly measure of new e-squander in only 16 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.

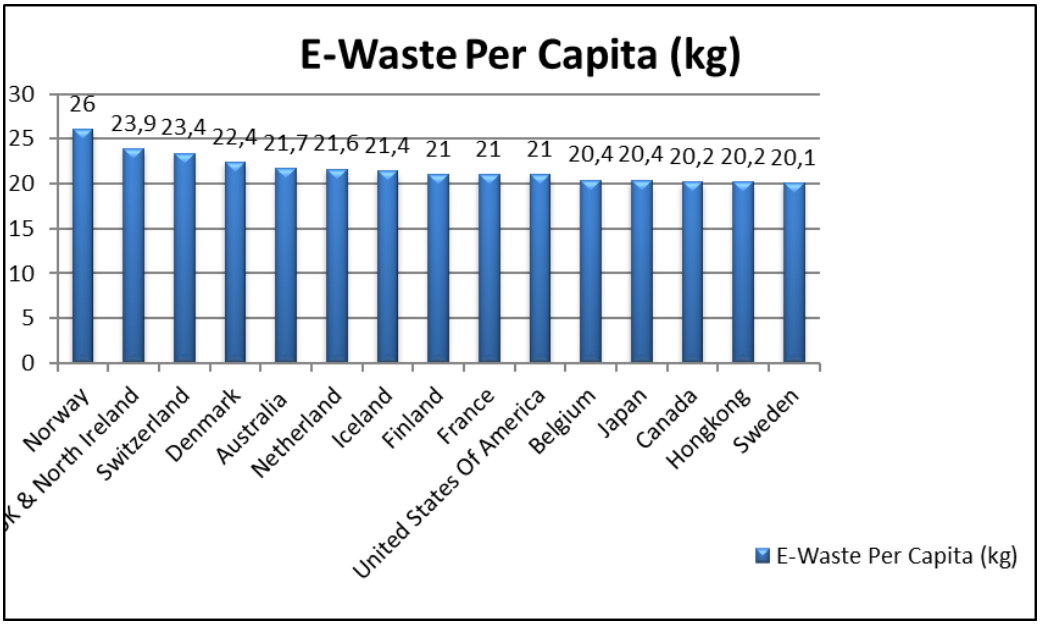

Figure 4. Countries producing e-waste, own work

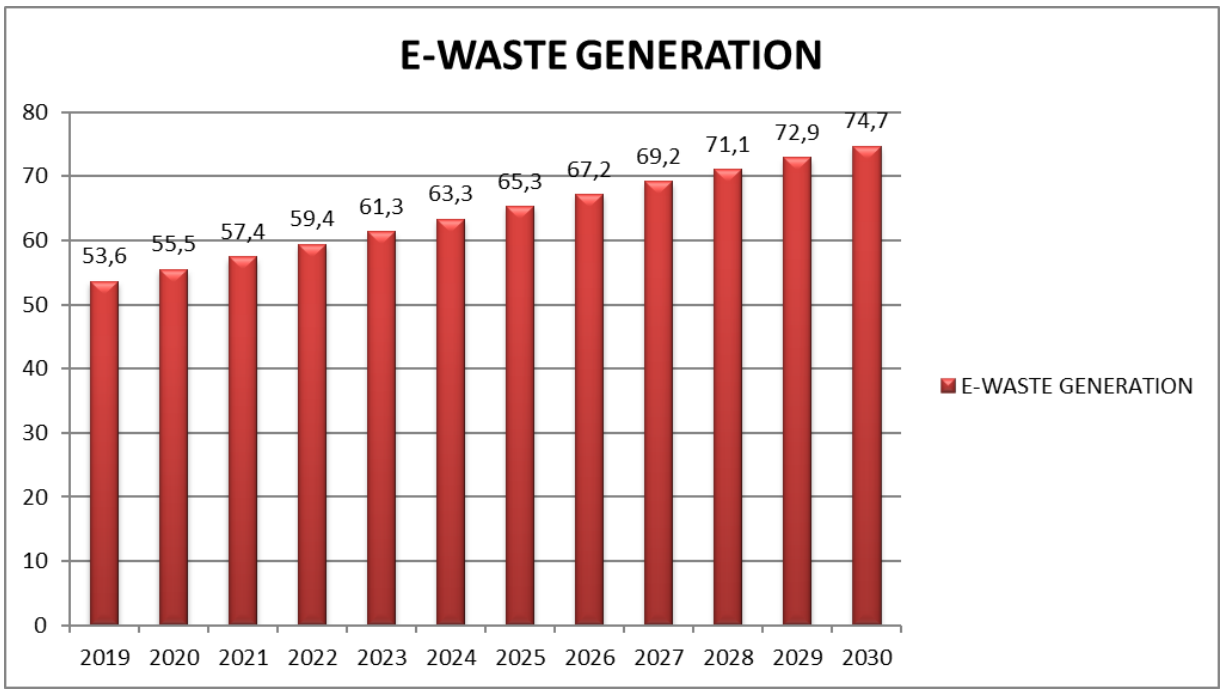

Figure 5. Yearly increases in e-waste, own work

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 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 with regard to 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, aptitudes are expected to prepare the affected individuals. In the wake of directing a written survey, we found significantly that more manageable standards should be considered in Supply Chain Operation Reference method to finish the manageability perspective of the E-squander store network. The additional standards, as well as the referenced models of SCOR, have been displayed in Table 1.

Table1. The proposed qualities and degrees for gauging E-waste supply chain, own work

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 Quality management System
	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	Capability of OHS, EM, BSM Systems
	Research & Development Investment
	Job Satisfaction Ratio
	Wellbeing and security at 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

It ought to be brought up that the proportions of Table (1), are referenced in Supply Chain Operation Reference, and different measures are removed from the E-squander explores, which concentrated on the manageability execution of store network. Notwithstanding, for the actions out of SCOR, an internal and external investigation was done to lay out such relationship. The consequences of the examination, which have been introduced in table (2) till (4), adjust the Supply Chain Operation Reference to a greater manageability centered perspective about the production network execution.

Table 2. The affiliation between the new supply chain operation reference measures with the procedure and characteristics of existing Supply Chain Operations Reference degree, won work

MEASURE	PROCESS	PRACTISE
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. 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.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 and etc. Using Optimization Techniques. BQ.024) Supply Chain Optimization (SCO). 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.
Excellence of perspective taking in 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.	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.

	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.	
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 to Improved Quality or Problem solving effort		BF.003) Shared Investment in Boosting Facility of Supply Chain Network. 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.

Table3. The connection between the new Green Supply Chain Operations Reference measures with the process and features of Supply Chain Operation Reference Model, own work

DEGREE	PROCESS	PRACTISES
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

Table 4. The relation between the new Supply chain operation reference green measures with the procedure and characteristics of existing SCOR degree, own work

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, degassing CFC, HCFC* and *semi-automatic CRT cut and cleaning.*
Proficiency of 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 with practitioners for implementing standards. BF.015) insurance of employee against threat regarding e-waste reusing.
Job satisfaction ratio	E.2) Performance management E.7) Managing Supply Chain Network.	B.014) Generate decent employ, 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 workplace	E.9) Manage Supply Chain Risk. N.7) Corporate Transparency and Social Responsibility.	BF.019) Delivers back ground 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.

The procedures of Plan, Source, Enable, Make, Return, and Deliver are denoted in Tables (2)–(4) 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 (1) through (4) could be used to fulfil the SCOR model's sustainability standpoint. In this regard, by including Cost Measurements and Quality Attributes pertaining to 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 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 (2) till (4) contains data about the related cycles and practices which exist in Supply Chain Operation Reference model and further makes a commitment about tending to supportability according to E-squander points of view.

5. Conclusion

A corporation digging up new ore sources is worse for the environment than having a sustainable source of recycled metal. You are preventing the leaching of dangerous metals into your waterways by recycling your devices. You're also keeping it from happening at another mine, though. Providentially, a workable fix exists. There are several beneficial uses for recycling e-waste. As an illustration, keep those items out of landfills to protect human and environmental health. Alternately, you can recover the components of the devices that are still useful and give producers recycled materials to use in the production of new goods. 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 actually rubbish. But much too frequently, they are discarded.
Moreover, the current study outlines the Supply Chain Operation Reference model's framework for assessing the e-waste supply chain as well as the necessary modifications to this standard to take sustainability into account. Environmental, economic and social sustainability components are defined by sustainability research. We incorporated sustainability standards and metrics that were mentioned in prior Supply Chain Operation Reference studies but were not included in the SCOR standards. However, in order to establish an advanced performance appraisal system, it is necessary to develop supply chain processes along with the supply chain network in order to identify which performance indicators relate to which supply chain processes and which processes require improvement. This is explained in the conceptual framework of the Supply Chain Operation Reference model. Additionally, practitioners and experts from all around the world collaborated to create the SCOR standard, new protocols for enhancing supply chain performance that are 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.

References

1. ARJUNA A., SANTOSO S., HERYANTO R. M., 2022, Green Supply Chain Performance Measurement using Green SCOR Model in Agriculture Industry: A Case Study, *Jurnal Teknik Industri* 24(1): 53-60, DOI: 10.9744/JTI.24.1.53-60.
2. CHOPRA A., GOLWALA D., CHOPRA A. R., 2022, SCOR (Supply Chain Operations Reference) model in textile industry, *Journal of Southwest Jiaotong University* 57(1): 368-378, DOI: 10.35741/ISSN.0258-2724.57.1.33.
3. DURAN F., ZAFEIRAKOPOULOS, İ.B., 2018, Environmental Risk Assessment of E-waste in Reverse Logistics Systems Using MCDM Methods, *Proceedings of the International Symposium for Production Research*: 590-603, DOI: 10.1007/978-3-319-92267-6_49.
4. GHOSH B., MEKHILEF S., AHMAD S., GHOSH S.K, 2022, A Review on Global Emissions by E-Products Based Waste: Technical Management for Reduced Effects and Achieving Sustainable Development Goals, *Sustainability* 14(7), 4036, DOI: 10.3390/su14074036.
5. GOOGLE SCHOLAR, E-waste producing countries, 2020, https//scholar.google.com.
6. HERVANI A., NANDI S., HELMS M., SARKIS J., 2022, A performance measurement framework for socially sustainable and resilient supply chains using environmental goods valuation methods, *Sustainable Production and Consumption* 30(3): 31-52.
7. HOSSAIN M., SULALA M.Z.F. HAMADANI A., RAHMAN T., 2015, E-waste: a challenge for sustainable development, *Journal of Health and Pollution* 5(9): 3-11.
8. JAIN V., KUMAR S., MOSTOFI A., MOMENI A., 2022, Sustainability performance evaluation of the E-waste closed-loop supply chain with the SCOR model, *Waste Management* 147: 36-47, DOI: 10.1016/J.WASMAN.2022.05.010.
9. KHOKHAR M., 2019, Occupational health & safety implementation framework for Pakistani construction industry in Sindh province, *3C Tecnología. Glosas de innovación aplicadas a la pyme* Special Issue: 253-285.
10. KHOKHAR M., HOU Y., RAFIQUE M. A., IQBAL W., 2020, Evaluating the social sustainability criteria of supply chain management in manufacturing industries: A role of BWM in MCDM, *Problemy Ekorozwoju*/ problems of Sustainable Development 15(2): 185-194, DOI: 10.35784/pe.2020.2.18.
11. KHOKHAR, M., IQBAL, W., HOU, Y., ABBAS, M., PROCESSES, FATIMA A., 2020, Assessing supply chain performance from the perspective of Pakistan's manufacturing industry through social sustainability, *Processes* 8(9): 1064.
12. KHOKHAR M., ZIA S., ISLAM,T., SHARMA A., WASIM I., 2022, Going green supply chain management during COVID-19, assessing the best supplier selection criteria: A triple bottom line (tbl) approach, *Problemy Ekorozwoju/ Problems of Sustainable Development* 17(1)2022: 36-51, DOI: 10.35784/pe.2022.1.04.
13. MAHAR A., MALIK N., R., QADIR A., AHMED, T., KHAN, Z., KHAN, M.L., 2007, Review and Analysis of Current Solid Waste Management Situation in Urban Areas of Pakistan, https://www.semanticscholar.org/paper/Review-and-Analysis-of-Current-Solid-Waste-in-Urban-Mahar-Malik/3c16c763d19186cb3e7cb18b4f2548ad5ca3c0d1.

14. OZDEMIR D., SHARMA M., DHIR A., DAIM T., 2022, Supply chain resilience during the COVID-19 pandemic, *Technology in Society* 68: 101847, DOI: 10.1016/J.TECHSOC.2021.101847.
15. PRAKASH C., BARUA M.K., 2016, A combined MCDM approach for evaluation and selection of third-party reverse logistics partner for Indian electronics industry, *Sustainable Production and Consumption* 7: 66-78.
16. PRIYADARSHINI, J., SINGH, R., MISHRA, R., BAG S., 2022, Investigating the interaction of factors for implementing additive manufacturing to build an antifragile supply chain: TISM-MICMAC approach, *Operations Management Research* 15, 567-588.
17. RAZAVI N., GHOLIZADEH H., NAYERI S., ASHRAFI T. A., 2021, A robust optimization model of the field hospitals in the sustainable blood supply chain in crisis logistics, *Journal of the Operational Research Society* 72(12): 2804-2828, DOI: 10.1080/01605682.2020.1821586.
18. REHMAN A., MUHAMMAD S., YAQUB R.M,S., 2021, Determining The Influence Of Green Transformational Leadership, Green Innovation And Green Hrm Practices On Environmental Performance Of Hospitality Industry, *Bulletin of Business and Economics* 10(2): 100-114.
19. RIAHEE M., ZANDIEH. M., 2018, Disassembly line balancing based on the Kano model and Fuzzy MCDM methods, the case: e-Waste Recycling Line, *Journal of Industrial Management Studies* 16(49): 1-36.
20. SABBIR M., KHAN T.T, DAS A.,AKTER S., HOSSAIN A., 2022, Understanding the determinants of consumers' reverse exchange intention as an approach to e-waste recycling: a developing country perspective, *Emerald Insight,* https://www.emerald.com/insight/content/doi/10.1108/APJBA-11-2021-0565/full/html?skipTracking=true.
21. SHAHABUDDIN M., UDDIN M., CHOWDHURY J.I., AHMED S.F., UDDIN M.N., MOFIJUR M., UDDIN MA., 2022, undefined. (n.d.). A review of the recent development, challenges, and opportunities of electronic waste (e-waste), *International Journal of Environmental Science and Technology* 20: 4513-4520.
22. SINGH M., PANT M., 2021, A review of selected weighing methods in MCDM with a case study, *International Journal of System Assurance Engineering and Management* 12(1): 126-144, DOI: 10.1007/S13198-020-01033-3.
23. SUDUSINGHE J. I., SEURING S., 2022, Supply chain collaboration and sustainability performance in circular economy: A systematic literature review, *International Journal of Production Economics* 245: 108402, DOI: 10.1016/J.IJPE.2021.108402.
24. TORTORELLA G., PRASHAR A., SAMSON D., KURNIA S., FOGLIATTO F.S., CAPURRO D., ANTONY J., 2022, Resilience development and digitalization of the healthcare supply chain: an exploratory study in emerging economies, *Emerald Insight,* https://www.emerald.com/insight/content/doi/10.1108/IJLM-09-2021-0438/full/html?skipTracking=true.
25. UDBYE A., 2014, Supply chain risk management in India: An empirical study of sourcing and operations disruptions, their frequency, severity, mitigation methods, and expectations, Portland State University, https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=2813&context=open_access_etds.
26. WANG J., LI W., MISHIMA N., ADACHI T., 2022, Exploring the optimal reverse supply chain for e-waste treatment under Chinese government subsidy, *Waste Management* 137: 128-138, DOI: 10.1016/J.WASMAN.2021.10.031.
27. XU J., HUANG Y., SHI Y., LI R., 2022, Reverse supply chain management approach for municipal solid waste with waste sorting subsidy policy, *Socio-Economic Planning Sciences* 81: 101180.
28. YONG Y.S., LIM Y.A., ILANKOON I.M.S.K., 2019, An analysis of electronic waste management strategies and recycling operations in Malaysia: Challenges and future prospects, *Journal of Cleaner Production* 224: 151-166, DOI: 10.1016/j.jclepro.2019.03.205.