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Research article

Sustainable reverse logistics scorecards for the performance measurement of informal e-waste businesses

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ABSTRACT

Many countries depend on businesses in reverse chains to tackle the environmental pollution caused by the tremendous amount of e-waste. Furthermore, due to the domination of informal businesses in many developing countries, environmental rules are not considered during operation, and these violations tend to affect public health adversely. The government in these developing countries finds it difficult to manage and utilize e-waste due to insufficient resources properly. The existing performance measures are only appropriate for implementation in developed countries with the inability to assess informal e-waste businesses in developing countries. Therefore, to address this gap, this research proposes sustainable reverse logistics scorecards (SRLS) to identify informal e-waste businesses' performance. Data were obtained through in-depth interviews with eleven experts, questionnaire survey with one hundred eighty-six informal e-waste businesses in Indonesia using the snowball sampling method and by measurement identification using the statistical descriptive analysis such as mean, geometric mean, mode, and sign-test median including experts' confirmation. The results showed that there are twenty-two parameters from six perspectives namely financial, stakeholders' value, internal business processes, innovation and growth, environment, and social. These parameters can be used as a performance measurement following government regulation and adjusting the motivation, strategy, capability, and activities of informal e-waste businesses. They are also useful for practical assessment and decision purposes, such as process safety and economic impact evaluation of businesses with the ability to create job opportunities, satisfy employees, and provide persuasive incentives. The balance between environment, welfare, and e-waste management is realized through SRLS. We suggested that other researchers use these parameters to assess the performance of informal e-waste throughout Indonesia and the government considered these parameters to assess them before deciding to collaborate for handling e-waste problems.

1. Introduction

Rosyadi (2017) stated that there is a tremendous increase in electronic waste (e-waste) in developing countries than their developed counterparts. This growth is triggered by factors such as economic development that encourages consumptive behavior, technology updating due to industrial escalation and people's dependency on electronic products due to their busy lives (Akenji et al., 2011; Maheswari et al., 2019). Therefore, due to the above-listed factors, the amount of e-waste in Indonesia was predicted to reach 430.000 tonnes by the end of 2020 with mobile phone waste dominating (Andarani and Goto, 2013).

In Indonesia, a large amount of e-waste is usually utilized by the uneducated and unemployed to create income. Their activities in operation management theory are included in reverse logistics (RL), which is a process that enables a manufacturer to systematically accept previously chipped products from the point of consumption for possible recycling, remanufacturing, or disposal (Dowlatshasi, 2000). The actors in RL activities are divided into six groups: collectors, dismantlers, dealers, recyclers, smelters, and repair services (Maheswari et al., 2019). They collect, sort, dismantle, and process e-waste to generate huge profits capable of fulfilling their daily needs, building a comfortable home, and buying luxury items such as jewelry and private cars. Andarani and Goto (2013) stated that the welfare level of a village that engages in e-waste

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business is higher than those that operate other types of businesses such as fashion, food, and agriculture. It is a hereditary activity and found in almost all provinces throughout Indonesia, with the majority believing that they do not need the education to become rich. They prefer to carry out these activities rather than spend significant time and money on their children's education. This can be seen by the characteristics of the working population members in Figure 1, with majority grandaunts of elementary school (Berita Resmi Statisik No, 2019). People without special skills and formal education can work in this sector, reducing the unemployment rate in villages that carry out this activity (Damanhuri and Padmi, 2012).

The primary purpose of RL activities is to preserve the environment (Rogers and Lembke, 1998). Unfortunately, most RL actors in developing countries are informal businesses with low awareness of the environment and health issues (Maheswari et al., 2018). This is because they are more concerned with making profits to survive, despite not having the standard equipment due to lack of money. Furthermore, they continue with this activity for the clichéd reason that they have no other means of financing their lives. According to Nakib (2012) and Ezeah et al. (2013), these actors tend to survive in a very hostile social and physical environment due to the government and public's derogatory attitudes. Governments in many developing countries are unable to overcome the large increase of e-waste through the implementation of RL activities. However, for proper implementation, the five aspects, namely regulation and law, institutional, social culture (Vazques et al., 2020), technology, and funding (Ho et al., 2012), need to be fulfilled. The Indonesian government does not have specific regulations to implement RL, which tends to cause environmental pollution and harm effects on humans. The government also faces some obstacles from institutional sectors, such as officers' incapability, insufficient number, lack of organizational commitment, and an inadequate number of technological infrastructures to convert e-waste into energy. At first glance, this aspect seems easy to realize, however it took Japan a developed country ten years to change the behavior of communities, businesses, and officers to be orderly with the ability to support the RL program (Atasu and Wassenhove, 2012).

Most governments in developing countries are unable to address the five basic requirements of e-waste management fully, thereby encouraging its growth (Ho et al., 2012; Cristina and Santos, 2016). Ezeah et al. (2013) stated that informal e-waste business needs to be recognized as an important partner for the achievement of sustainable reverse logistics, rather than being stigmatized as a contributor to environmental pollution. The first sustainable reverse logistics concept emerged in 2008, with significant discussions from 2011 to date. Several studies have been carried out to implement RL to increase organizational performance and competitive advantages of electronic manufacturers (Pfohl et al., 2012; Sudarto et al., 2016). Other studies discussed human resource commitment and the RL system's capability in an enterprise scope (Sutapa, 2009). There is little research that measuring RL performance by using a balanced scorecard (BSC). For instance, Shaik and Abdul-Kader (2012) used the BCS approach to analyze an electronic manufacturer's RL performance. Meanwhile, Agrawal et al. (2016a,b) used it to decide whether the RL activities need to partly or fully outsourced. BCS approaches are used to assess a company's performance from four important divergent perspectives, namely customer, internal business, innovation and learning, and finance (Kaplan and Norton, 1992). However, this approach does not consider environmental and social dimensions as important criteria, with most RL actors in Indonesia being informal businesses. Therefore, this research aims to formulate the appropriate RL performance criteria, including its informal e-waste business parameters, using the sustainable reverse logistics scorecard (SRLS). The results can be used by the government to assess performance of informal e-waste businesses before granting operational permission.

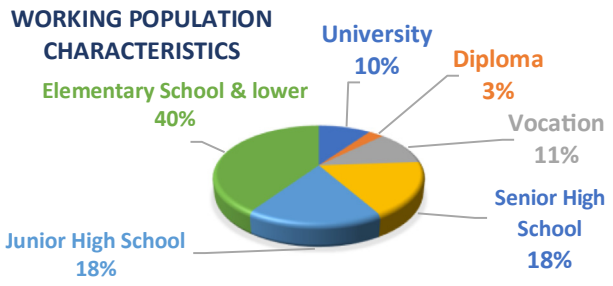

Figure 1. Working population characteristics in Indonesia.

This research is organized as follows: Section 2 consists of a literature review on reverse logistics, and performance measurement, a concept combination of the balanced scorecard and triple bottom line. Section 3 comprises methods and data collection strategies, such as in-depth interview guidelines. Section 4 presents the research findings and discussion. The first step of this section showed performance measures for informal e-waste business from government perspectives. In the second step, the research tried to assimilate the measurement for informal e-waste businesses with a discussion at the end of the fourth step. Section 5 summarizes all the findings and concludes the research. Managerial implication is presented to show how this research works, its limitations, and the future scope of SRLS studies.

2. Literature review

Literature reviews are conducted to find the best parameters for measuring the performance of informal e-waste business. The formulation of performance measurement parameters for an informal e-waste business must consider several important things namely the selection of RL activities, the motivation doing this business, and the understanding of the requirements. Besides, their strategies and capability also need to be considered for the development of SRLS. The literature review is described in the following subsections.

2.1. Reverse logistics activities

RL covers all the usual logistics activities, but they are conducted in the opposite direction (returned goods) (Maheswari et al., 2017a,b). Rogers and Tibben-Lembke (1998) described that several RL activities can originate from the product itself and the packaging used for that product. Some RL activities that originate from using the product i.e. return to suppliers, resell, sell via outlet, recondition, remanufacture, and disposal. While refurbish, reclaim materials, and recycle can be conducted in both categories. The basic RL activities are collection and transportation; sorting, testing, inspecting; disassembly; and disposition options: (reuse, repair, remanufacture, recycle, and dispose of) (Rogers and Lembke, 1998). However, some activities, such as smelting or extracting precious metals from e-waste, are not listed in the first RL theory. Whereas, in developing countries, these activities dominate RL activities and often cause the most damage to the environment (Damanhuri and Padmi, 2012). RL activity is started when electronic products are discarded (Correa and Xavier, 2013). Since the discarded products (electronic waste) still have values although not having the same price as a new one, many people have a strong desire to process it. This desire is mainly triggered by the amount of money generated. Therefore, the collection and sorting of e-waste are favorite activities for people with low education and unemployment that abundant in developing countries. After sorting the components, they usually continue to the next processing i.e. primary processing (disassembly, separating, compacting, and bundling) and secondary processing (chemical and mechanical recycling) (Correa and Xavier, 2013). These are hereditary activities carried out in a traditional or manual process. The original purposes of carrying out RL activities are to decrease e-waste and environmental protection. However, they often fail due to these manual processing methods. Therefore, in this research, these two criteria will be considered as the parameters of informal e-waste business performance.

2.2. Sustainable reverse logistics motivations

RL plays a very critical role in handling the abundant of e-waste. Hence, it needs to be very effective in its implementation. RL is not an easy task, and many practitioners underestimate its difficulty (Rogers et al., 2013). The RL goals must be established and instilled in each business element for the first time operate. In line with the initial goals of RL activities, an e-waste business must have a high awareness of the environment, public health, and other social needs. The RL goals can be reached if all business elements have the same motivations. The initial motivation of most electronic manufacturers in conducting RL is recapturing the value from broken or failed products and recovery their assets. Presently they use RL not only for gaining profit but also as a strategy to win the business competition (Cespon et al., 2009). Although recapturing the value of e-waste and recovery assets of used or broken electronic products are also reached, in fact, the motivation of informal e-waste business is gaining profit for survival. They never thought other goals except for profit when running e-waste business (Damanhuri and Padmi, 2012; Budijati, 2016; Maheswari et al., 2018). The low awareness of most people in developing countries makes nature suffer even more. Quality degradation of soil, air, and water keep happening in line with the growth of the electronic and telematics industry and the flourish of informal e-waste businesses. Therefore, the motivation of informal e-waste business becomes very important and must be considered when developing SRLS. The performance measurements of RL businesses must involve sustainability goals. The business must regard all requirements i.e. environmental protection and government legislation (Kokkinaki et al., 2002). The business should able to lift government image that always wants to be a clean region, free of pollution, having a good quality of life, creates job opportunities, and community welfare. Therefore, this research uses the quattro bottom line (QBL) concept to translate the goals, those are planet, people, profit, and reputation (Maheswari, 2018). It is necessary to motivate e-waste businesses, which are mostly informal, to balance each element following the QBL concept. This concept also has the principle of reducing waste, reusing the components (materials) while generating money, those are called by a circular economy. Reuse and recirculation products and materials are the basis of the circular economy concept (Xavier et al., 2019; Pagliaro and Meneguzzo, 2019). The ability of informal businesses to reduce basic resources consumptions and exploit natural resources, while creating job opportunities to be considered as part of SRL scorecards. To reach these goals through informal e-waste business is not an easy task, but it is possible to realize. A sound government regulation and education approach have a significant impact on informal e-waste business behavior (Tanskanen, 2011) as long as they have the basic requirements to implement SRL.

2.3. Sustainable reverse logistics requirements

There are two basic requirements that must be fulfilled by an informal e-waste business to fit the SRLS performance measures. First, the internal factors, those are: (i) company policy – a more strategic focus on reverse logistics and specific policies of returns management makes reverse logistics operations more effective and efficient (Ho et al., 2012); (ii) top management support – increased awareness of the strategic importance of reverse logistics, support for the strategic decisions of resource allocations for reverse logistics operations (Alvarezgil et al., 2007; Janse et al., 2010); (iii) cross-functional integration – to create value, competitive differentiation, and efficiency in returns management (Mollenkopf et al., 2007); and (iv) the utilization of current resources – cost reduction for reverse logistics operations, integration, and support between forward and reverse logistics (Abdulrahman and Subramanian, 2012). Meanwhile, the external factors are: (i) laws and regulations – supports for efficient reverse logistics implementation; (ii) customer awareness and demand – drivers and support for environmentally-oriented business management, end of life management, and customer returns management; (iii) information technology – support for effective and efficient reverse logistics operations from collection, and recovery to redistribution; (iv) collaboration – an increased share of information, knowledge, resources, and capabilities for effective and efficient reverse logistics operations (Falcone, 2019); and (v) globalization – cost savings due to the standardization and centralization of the reverse logistics services. Next, these two factors will influence the informal e-waste business to design (Akenji et al., 2011) and strategies to implement the SRL concept.

2.4. Sustainable revers logistics strategy

A Business strategy is the set of decisions and actions that result in the formulation and implementation of plans designed to achieve a business's goals (Pearce and Robinson, 2011). In formulating a more effective business strategy in fast-changing environmental conditions, it is necessary to integrate business objectives with the current policies (Andrews, 1980). Dealing with reverse flow activities pushes the businesses to focus more strategically on identifying the roles of returns, the strategy of returns management, and specific policies for different types of returns (Janse et al., 2010). By exploring the development of RL under strategic considerations, the strategy formulation of the SRL program is extracted from the strategic returns management process (Croxton et al., 2001). Based on the strategic returns management process, the main activities for formulating an RL strategy are identified, including developing goals and a product recovery strategy for different kinds of returned products, developing gate-keeping and disposal policies, developing RL networks and transportation options, developing a returns policy and credit rules, and determining appropriate metrics for RL performance. Efficient and flexible long-term capacity planning can be used to anticipate the limitation of the informal business budget (Sudarto et al., 2016). Uncertainties about materials can be overcome by working together in the collecting process (Chopra and Meindl, 2016). Machine and equipment sharing can be used to reduce waste (Morone et al., 2018a,b; Falcone and Imbert, 2017). Thus, in this research, the strategy formulation considers environmental strategic decisions, that is, the availability of facilities, process technology, type and amount of capacity related to the environmental impact, vertical integration, number of suppliers, new greener product design, workforce, quality management, and planning and control system (Angel and Klassen, 1999). Links are established between environmental decisions and strategic decisions in operation management. To satisfy the ‘wants and needs’ of the companies' stakeholders, the RL strategies support their understanding of the product returns process flows. Therefore, this study considers seven strategies that support RL, namely: stakeholder satisfaction, implementing new technology, eco-compatibility, strategic alliances, knowledge management, value recovery (Yellepeddi, 2006); and disposal strategy (Shaik, 2014).

2.5. Sustainable reverse logistics capabilities

To follow the strategies, e-waste businesses require suitable capabilities to achieve their goals. Their capabilities are intended to realize economic, environmental, social, and reputation goals. The capability requirements for e-waste businesses are organizational learning and human resources, relationships; technological resources, process (Pfohl et al., 2012), financial, and innovation (Sutapa, 2009). The organizational learning and human resource capabilities are the ability of individual or organizational to face norms and challenges by building their skill and knowledge through their willingness to learn. The relationship capabilities are the ability of a firm's employees to interact with stakeholders and comprise the degree of involvement, communication quality, long-term relationship orientation, and information sharing between them. The technology resource capability is associated with information technology availability. The processing capability is an important element of a firm's endeavor to implement RL. Enterprises should focus on reducing their costs; building agility and flexibility into their processes and seeking better product and market differentiation. The

financial capability concerns five aspects, namely liquidity, financial leverage, asset turnover, profitability, and market value (Shyh-Rong et al., 2010), as well as specific budget allocation (Sutapa, 2009). The innovation capability is a necessary condition, not only for increasing the firms' competitiveness but primarily to ensure their survival (Capaldo et al., 2002). RL activities are closely related to sustainability concepts with their four perspectives, namely profit, planet, people, and reputation (Maheswari et al., 2017a,b). Businesses face pressure from the government and society to be more responsible for their great impact on the environment globally. Certainly, a business must obtain considerable profit for its survival. We recognize that profit or economic aspects, such as cost, quality, flexibility, and profitability, are the most important goals. Companies are required not to harm the community health and must support the environmental conservation program. Businesses that use materials from used or returned products can improve their environmental, financial, and social performance (Lai et al., 2013). Accountability for the life condition of current and future generations is the primary consideration of internal and external stakeholders.

2.6. Sustainable reverse logistics scorecard

Unlike informal e-waste businesses, world-class e-waste companies are no longer think about profit. They need a more positive perception from stakeholders to foster trust in and loyalty towards the company's products and brand. They make the integration of credibility, greatness, and awareness as the corporate image and the firm's final goals (Ravi and Shankar, 2015). At this time, a producer's reputation regarding an electronic product becomes the first consideration when people making a purchase. In other words, they indirectly buy the company's reputation besides the product itself (Maheswari et al., 2018). Consumers who buy second-hand electronic products will dare to buy products if they are branded. Therefore, this research avoids the triple bottom line approach instead of the QBL concepts for measuring informal e-waste business performance by building a sustainable reverse logistics scorecard (SRLS). SRLS has never been used specifically for assessing the e-waste businesses' performance. Although the balanced scorecard uses four perspectives, specifically the financial, internal business process, consumer, and learning and growth perspectives, recently, the growing concern for the environment, corporate social responsibilities, and legislation in many countries have forced firms to think beyond the conventional measures (Agrawal et al., 2016a,b) and incorporate sustainability into their practices (Gunasekaran and Spalanzani, 2011).

Therefore, this research will consider six perspectives, including the environmental and social dimensions (Shaik, 2014), to be applied for measuring informal e-waste businesses performance in developing countries, as follows:

1) The financial perspective emphasizes on achieving financial success while providing value to the investors and shareholders, increased business profitability, and revenue by reducing costs and expenditures.
2) The stakeholder perspective is oriented towards stakeholders and encourages the decision and policymakers to concentrate on accomplishing the objectives while providing value to the stakeholders such as investors, customers, employees, suppliers, intermediaries, the government, and regulators.
3) The process (internal and external) perspective concentrates on meeting the demands and requirements of the stakeholders while achieving productivity, and efficiency in the workflows. Because of the uncertainty and variability of product returns, the processes help to create and deliver the value proposition to stakeholders; thereby, enhancing the reverse logistics performance.
4) The innovation and growth perspective focuses on bringing efficiency into the operating domain of the business of the enterprise. It is obtained through continuous improvement of the infrastructure via innovation and learning for the achievement of the objectives.
5) The environmental perspective is based upon a heightened environmental consciousness, public policy, and the law. It concentrates on achieving an environmentally reverse logistics meeting the regulations while maintaining efficiency.
6) The social perspective is the ability to lead as a corporate citizen and to promote ethical conduct. It focuses on building a good image by meeting the obligations and expectations of communities and society.

3. Method and data collection

This is a qualitative and quantitative research with the triangulated method of data collection used to collect data through in-depth interviews, observations, and questionnaires. The qualitative technique was chosen to investigate the government expectations of informal e-waste businesses. Therefore, smaller and more focused samples were needed more than large sample (Denzin et al., 2005). The research process in this study was divided into two steps with the first comprising of preliminary data collection through interviews with some Indonesian government officials (experts), namely 1) the Director of Area Contamination Recovery and E-waste Emergency Response of the Ministry of Environment and Forestry, 2) the Director-General of Waste, E-waste, Hazardous and Toxic Material of the Ministry of Environment and Forestry, 3) the Director of Electronic and Telematics Industry, 4) the Director of Small and Medium Industry of Metal, Machine, Electronics, and Conveyance, 5) the Assessment and Development Director of Trade Policies, 6) the Director of Environment in the Ministry of National Development Planning, 7) the Secretary to the Deputy Minister of Business Restructuring in the Ministry of Cooperation, Micro and Small Medium Enterprise, 8) the Head of the Environment and Hygiene Office, 9) the Head of Hygiene Management, 10) the Head Control of Environmental Impact of the Environment and Hygiene Office, and 11) the Head of Cooperation, Small Medium enterprise, and Commerce Office. The in-depth interviews followed the interview guidelines, and the summarized results are shown in Tables 1 and 2. However, due to limited time, this study focuses only on particular questions for each expert, with approximately 2 h spent on each expert.

The e-waste problem has not been solved, and it is worsening because the government regulations are not in line with the expectation of informal businesses. Therefore, it is necessary to confirm the performance measured in the set based on the government decrees, to the informal e-waste businesses. The Director of Area Contamination Recovery and E-waste Emergency Response of the Ministry of Environment and Forestry stated that a win–win solution is needed to realize a sound measurement for all parties to benefit from this measurement. The snowball sampling method was used to collect data from 186 respondents through questionnaire surveys with a quantitative technique from July 2018 to June 2019. This research was carried out on Java island in the Citayam-Bogor area, as suggested by the Ministry of Environment and Forestry. By observing informal e-waste businesses, a person who first started this business in 1971 was identified. From this information, it was obtained that the informal e-waste businesses are located in five provinces in Indonesia, namely West Java, Jakarta, East Java, Banten, and Riau Island.

The questionnaire was designed based on the SRL concepts developed by Maheswari et al., in 2018 and divided it into six-question sections that were linked to the balanced scorecard concept, namely 1) financial, 2) environmental, 3) stakeholders' values, 4) internal business process, 5) social and 6) innovation and growth (Shaik, 2014). Since most respondents from informal e-waste businesses are low-educated people, the researchers did not let them read and complete the closed-ended questionnaire by themselves. For the first output, the analyses consisted of two types: descriptive statistical analysis (mean, geometric median, and mode) and non-parametric (sign-test median) statistic. This research utilized the geometric mean due to its ability to calculate the average rate of changes and the compounding that occurs periodically with more weights to the small values and less to the large. Therefore, the geometric

Table 1. In-depth interview guideline (Maheswari et al., 2019).

Topics	Key points to be covered	Key question to be addressed
Motivation and business principles	Profit, planet, People, and Reputation	What motivation should e-waste business have?
Compliance of safety and equipment usage	Fulfillment of internal and external safety and health requirement	Is safety and health your main concern?
Environmental awareness and performance	Evidence of concern for the environment, social health, and community harmony	What is the evidence that this business concern also to people and planet?
Strategy in environmental management	Strategy in term of efforts in managing the environment	What is your business strategy?
Challenges	Problems formulation, why e-waste business is very difficult to control?	Challenges
Expectation	SRL realization	What are your expectations?
Willingness to cooperate	Finding the type of engagement to handle e-waste management	How big your willingness to engage in SRL implementation for handling e-waste problem?

Table 2. Summary of in-depth interview result.

Key questions to be addressed	Answers
1. What is the main motivation that must be owned in running e- waste business? (business principles)	Expert 1, 2: The respondents from The Ministry of Environment and Forestry emphasize that all types of e-waste business must obey to environmental regulation and make environmental preservation as their main goal Expert 5 to 10: All of respondents from government have the same opinion, namely every informal e-waste business must have four objectives, i.e. profit intention to fulfill their needs; environmental protection through reusing, recycling, and giving to others the electronic components; harmonious social environment by reducing rate of unemployment and increasing community standard of living; nation reputation with keeping our countries clean and avoiding to be a source of pollution. Expert 3, 4: Informal e-waste business must have a special agenda to reduce the use of natural resources and conduct collaboration with other business to decrease reverse logistics cost. Expert 11: The main goal of conducting e-waste business are getting profit and protecting the environment since the majority of people in developing countries such as in Indonesia are low educated. So, it will open a job opportunity.
2. Do you think that they pay attention to safety and health requirement for their employee and environment?	Expert 1, 2, 8, 9, 10 Concerning for the environment and surrounding health must be the first attention of all informal e-waste business so that their activities will satisfy not only for the business but also for other stakeholders especially for employee, community, and finally for the government. The business commitment in wearing standard equipment in processing e-waste material will be their key success. The high management initiative is needed to encourage the business in creative processing and designing of the return product, develop the scope of a business, and create a proper e-waste disposal system.
3. What is the evidence that this company concern with the planet and people?	Expert 1, 2, 8, 9, 10: The businesses have to maintain their technology compliance and streamlines technology in standard operational procedure when operating their activity. Expert 11: The informal e-waste businesses help in collecting e-waste from the community, recover some parts of components for repairing other broken electronic products to minimize residuals, give reasonable reimbursement cost for the owner, open job opportunity for uneducated people so their activity increases community welfare.
4. What is the business strategy that must be implemented?	Expert 1, 2, 3: Environmentally friendly resource and process must be the basis of informal e-waste businesses. Recovery assets can be done to streamline the resources Expert 4, 6: Business alliances must be implemented in developing e-waste business. The difficulties in finding the large quantities of raw materials can be overcome through sound cooperation. Expert 11: The business must give reasonable reimbursement cost to the community as its strategy to get the raw materials
5. What are the obstacles when running this business?	Expert 4: Informal e-waste businesses are distributed evenly in various remote areas in almost all developing countries which makes it difficult to monitor their activities. Therefore, they must instill environmental awareness in their mind. Expert 5 and 6: The informal e-waste businesses must prioritize benefit to all stakeholders. However, the balancing of benefit to them is not easy, moreover, there is no clear regulation from government. Besides that, the uncertainty of raw materials, high competition with high scale e-waste businesses in obtaining the raw material makes the informal businesses difficult to grow.
6. What are your expectations to informal e-waste business?	Expert 5, 7, 9, 10: The informal e-waste businesses must look for the creative process and design of return products, so that, the emphasis of RL activities is on recovery assets and not on dismantling and smelting process Expert 11: Eradicating RL activities is impossible. Therefore, the business owner must provide high-tech equipment and build a control mechanism to ensure that the employees work following the standard operational procedure.
7. How big their willingness to engage in SRL implementation for handling this problem	Expert 1–11: There must be a strong willingness either governments or informal e-waste businesses in conducting RL activities that in line with sustainability concern

mean is still able to give meaning to each datum despite its low value (Spizman and Weinstein, 2008).

4. Findings and discussions

4.1. Findings

4.1.1. Performance measures for informal e-waste business from government perspectives

RL is considered increasingly important in recent years, as shown by many electronic product manufacturers, with the application of the strategic tool to lift their performance and company reputation. According to Kaplan and Norton (1992), a balanced scorecard is a famous performance measurement widely used to assess businesses in four perspectives: financial, customer, internal business process, and learning and growth. However, Ho et al. (2012) stated that these four perspectives are not enough to measure informal RL businesses operating in developing countries. The performance measurement needs to refer to the Quattro bottom line concept to ensure that their RL activities do not sacrifice other interests such as the planet, people, and reputation (Maheswari et al., 2018). Therefore, the measurements used in this research were built by combining BSC and QBL concepts and based on government perspectives.

In terms of the financial performance in the SRL scorecard, this study underlined the five important measurements which are related to abilities as follows 1) to create profit from the sales of returned products, 2) to gain profit from repair services and upgrading, 3) to decrease material cost through recycling activities in order to provide raw materials for other new products, 4) to decrease total RL costs such as delivery and transportation and 5) to give a reasonable reimbursement cost to the community as a form of profit-sharing.

The second performance measurement for informal e-waste businesses is the impact of their activities on the environment. Almost all the experts in this research expected the informal e-waste businesses to be eradicated. Nevertheless, they also recognized the ability of the informal business to 1) manage e-waste. They help to extend the lifetime of electronic products through reselling, refurbishing, and upgrading. They also help in the collection process from the community for recycling to prevent e-waste from mixing with other household wastes. Garcia-Rodrigue et al. (2012) stated that the processing of used electronic products through RL activities tend to reduce the generation of e-waste in developing countries. However, lack of technology and capital, incapability of human resources, inadequate knowledge, and skill, and improper waste management in many developing countries, often trigger environmental violations. Therefore, abilities of informal business 2) to protect the environment and 3) to commit with the escalation of air, water, and soil quality are also important to be evaluated of informal RL businsess.

Stakeholders' values are the next measurement of performance in informal e-waste business. The research experts stated that businesses need to be beneficial to stakeholders with the ability to share profits with their community through reasonable reimbursement costs (Yoon and Jeong, 2016) protect the environment, create welfare, reduce unemployment, and maintain the reputation of their nation. Khor et al. (2015) stated that the implementation of RL activities needs to possess a significant green initiative. In other words, RL business should give benefit to 1) the government for example through paying tax, 2) community by giving an interesting incentive, and 3) investor through a profitable sharing. Furthermore, they need also to satisfy their 4) employees in terms of health protection and welfare. These parameters are also being suggested to measure informal e-waste business performance. However, benefitting for all the stakeholders is a big challenge for this business (Kokkinaki et al., 2002). Almost all e-waste businesses injure environmental and social interests with endless problems between the government and businesses. Therefore, the e-waste businesses demand that the government provides facilities, such as machines, to reduce air pollution from the burning and smelting process (Maheswari et al., 2018).

There are several requirements for e-waste businesses to perform adequately, namely 1) the use of an environmentally friendly process, 2) eco-friendly materials, 3) recovering assets 4) minimizing residual electronic product, 5) providing a proper waste disposal system, 6) committing to preserving the environment, and 7) supporting the owner to enable employees adhere to environmental regulations. This research proposed that these requirements are included in the internal business process measurement.

Previous studies (Maheswari et al., 2019; Budijati, 2016; Damanhuri and Padmi, 2012) have found that, although these e-waste businesses generally harm to the environment, they able 1) to increase social welfare, 2) reduce unemployment, 3) decrease the criminality, and 4) offer job opportunities for many low-educated people in almost all developing countries. Although firstly these experts doubted to use the social concept as one of the performance measurements, finally, they recognized that there are relationship harmonies between the informal businesses and communities, since this business often help communities for buying all used or broken electronic product that cannot be sold in a retail market.

Innovation and growth are the last measurements of informal e-waste businesses' performance. Informal e-waste businesses' performance needs to be able to innovate and grow in order to 1) recapture value from used electronic products, 2) develop the creative process and design of returned products, and 3) use high technology machines or equipment to avoid environmental pollution. These innovations and growth are achieved, assuming the business 5) has competent and initiative employees or management. The high competency of an employee is closely related to 6) strong initiative in locating an idea to convert e-waste into other types of valuable products. Unlike forward logistics, reverse logistics need a lean operating system to increase its efficiency, therefore, 7) streamlining the technology in standard operating procedure also increase efficiency. Therefore, this parameter is also be considered as one of the parameters for informal e-waste businesses.

4.1.2. Assimilation performance measures for sustainable reverse logistics

The next step is to assimilate the performance measures of SRLS based on government perspectives with informal e-waste business capabilities. These capabilities were formed from their motivations, strategies, and fulfillment of the requirements, as well as their activities and goals. Table 3 provided respondents profiles as a general description of informal e-waste business in Indonesia. Questionnaires were also distributed to the smelting sector because it is seen as a source of environmental problems. Although the education level of the majority of the business owners (respondents) was senior high school (37,1%), they tend to open up job opportunities for the uneducated people and employ more than 12 people. Some have a monthly cash flow of 250 million rupiahs, and the majority have operated their business for more than10 years.

From research observations, three operational patterns of informal e-waste businesses, especially for the e-waste smelting businesses, those are 1) operate on the edge of a river close to the sea; 2) operate on the edge of a forest; and 3) if they are situated in a densely populated city, they choose to carry out the smelting process in the middle of the funerals areas. Informal e-waste businesses are evenly distributed throughout Indonesia, particularly for the collecting and sorting processes. Although their numbers have decreased substantially, this activity remains the main source of livelihood in some areas. The West Java area comprises 32 large-scale recyclers in Tasikmalaya such as in Paniisan, Gunung Lipung, Dawagung, and Cilembang, which operate on the edge of a forest (the second pattern). According to the chairman of the smelting association in Tasikmalaya, the area initially had more than 70 recyclers. However, due to fierce business competition, government restrictions, and the difficulty of obtaining components such as PCB, handphone, and laptop, half of them decided to stop conducting RL business. Furthermore, most participants suffered lung cancer and permanent blindness due to the use of manual recycling processes. These participants stated that they were starting to feel the negative effect of RL activities on their health and in people around them.

Table 3. Profile of informal e-waste business in Indonesia for the questionnaire survey (N = 76).

Respondent profiles	N	(%)
Business types		
Dealer	23	12,4
Kiosk/intermediate	36	19,3
Exporter	18	9,7
Smelter	43	23,1
Retailer	39	20,9
Repair & service	27	14,6
Owner education level		
Elementary school	35	18,8
Junior high school	37	19,9
Senior high school	69	37,1
Diploma	19	10,2
Ever attended college	19	10,2
Undergraduate	7	3,8
Number of employees		
0	31	16,6
1–6	124	66,7
7–12	24	12,9
Years of operation in e-waste processing		
<5 years	21	11,3
6–10 years	109	58,6
11–15 years	38	20,4
16–20 years	11	5,9
>20 years	7	3,8
Cash flow per month in million		
<25	33	17,7
25,1–250	87	46,8
250,1–500	44	23,7
500,1–750	18	9,7
>750	4	2,1

A larger community of e-waste businesses was also found in Caringin-Bandung, with a sales turnover running into billions of rupiah. In addition, the business was also carried out in Kebon Kelapa, Ciparay, Panjunan, and Cicendo, located in Bandung. A total of 28 large and middle scale collectors and smelters of e-waste were found in Cirebon (Lemahtamba, Panguragan, Bunder, Tegal Gubuk, and Kaliwedi). In this village, almost every household runs this business illegally, and the sub-districts head at Panguragan recognized that this business increases the living standards of people. Other areas of West Java, namely Cikarang, Citayam-Bogor, Depok, and Cipayung Jaya, are places where informal e-waste businesses operate. Most of them collect, sort, and dismantle e-waste components before sending it to Tasikmalaya.

Some places in Banten Province, such as Tangerang, Neglasari, Tegal Angus, and Teluk Naga, the nearest area to Jakarta, the Indonesia capital, are the center of sorting and dismantling e-waste components. In the village of Tegal Angus, Teluk Naga – Banten Province, the entire community has chosen these activities to earn a living. Although the local government strictly prohibits this activity, they continue to operate clandestinely. Most informal e-waste businesses in this area, apply the first pattern, by operating on the edge of a river close to the sea. Senen-Poncol, Jatinegara, Pondok Labu, and Cipinang are some places in Jakarta that are also used as a central distribution point of e-waste. Because these places are in central Jakarta, they have to operate in the middle funeral area. Furthemore, Curah Malang, Sidokampir, Kendalsari, and Sebani are the center of e-waste businesses in Jombang in East Java. According to the Director General of Waste, Hazardous, and Toxic Waste Management, the Ministry of Environment and Forestry, there are 136 smelting locations with over 700 workers in East Java (greeners.co, 2018). Batam (Sagulung, Batu Aji, Tanjung Uncang), an area closest to Singapore and Malaysia is often a place for e-waste disposal. Figure 2 provides adequate details of the e-waste business and its component circulation using a distribution map.

For determining the performance measures for informal e-waste businesses, this research needs also to consider their capabilities, expectations, and opinions. This research used a combination of a semi-structured interview and a closed-ended questionnaire at the confirmation phase to obtain the best of SRLS parameters that provide the balance benefit to all stakeholders. Furthermore, the parameters were classified into six clusters in line with the sustainable reverse logistics scorecard, namely financial, environmental, stakeholders' value, internal business process, social, innovation, and growth. This was followed by a descriptive statistical analysis, which includes the mean, geometric mean, and mode, which was justified by the suggestion and expectations of our experts. We identified performance measurement as being beneficial for the SRLS when the mean and geometric mean is above 3, providing opportunities when it is between 1,5 and 3, and pose risk when the mean is bellow 1,5. The mode, which represents the most frequently chosen value, is used as another reference by experts. In this research, a mode value of 3 or 4 is beneficial, 2 provides opportunities, and 1 poses risk.

Following these processes, this research highlighted twenty measures that belong to the benefit, while ten measures provide

Figure 2. Dispersion of informal e-waste businesses throughout Indonesia.

opportunities as shown in Table 4. We determined that the measures with a mean and geometric mean above 3 and a mode value of 3 or 4 are beneficial. The symbol (√) was used for the sign-test median to denote the measure has a median above 2, which is also essential for performance indicators. Therefore, the factors are accepted for the performance measurement, assuming they can fulfill at least one criterion and are confirmed by the experts, so the last step is a confirmation step with the eleven experts.

Furthermore, two measures, namely technology compliance and employee competency in the innovation and growth dimension, both had a mean of 2,95. These measures were used because the research experts deemed it necessary for all e-waste businesses to have high-technology equipment and a skilled workforce. According to Sudarto et al. (2016), these two indicators are relevant to RL's capacity planning theory through the economies of scale concept to reduce inventory cost. Worker expertise and experience in RL activities are positively related to business performance (Khor et al., 2015). Therefore, this research states that twenty-two measures from the six dimensions need to be used to identify the informal e-waste business performance for developing countries and are proposed completely in Figure 3.

4.2. Discussion

Previous studies used a balanced scorecard concentrated for formal businesses such as manufacturers of electronic products, with each element in the BSC utilized to assess the firm performance (Agrawal et al., 2016a,b; Shaik, 2014). They also implemented the QBL concept because the environmental rules were established before the business existed. However, this research has two unique properties, namely formulating performance measures for informal business, and it is located in an electronic waste area. The BSC concept, which acts as performance measurement, is used to ensure the e-waste business process runs efficiently, pays attention to the right business processes, and prioritizes the learning and growth process while remaining profit oriented. In addition, since this business often pollutes the environment and disturbs the public health, the QBL concept also needs to be applied. Therefore, in this research, the performance of informal e-waste business is measured through six perspectives using a combination of BSC and QBL concept, namely financial, environmental, stakeholders' values, internal business process, social, and innovation and growth.

Table 4. Sustainable reverse logistics scorecard for informal e-waste business.

Cluster/Performance measures	Statistic Descriptive				Experts Confirmation
	Mean	Geometric mean	Mode	Sign-Test Median	
Financial					
1. Profit of returned product	**3,11**	**3,01**	3	√	√
2. Profit of repair service and upgrading features	2,89	2,82	3	√	√
3. Decreasing material cost	2,88	2,64	3	√	
4. Decreasing total reverse logistics cost	**3,14**	**3,05**	3	√	√
5. Reasonable reimbursement cost	**3,49**	**3,41**	4	√	√
Environmental					
6. Managing e-waste	**3,24**	**3,10**	4	√	√
7. Environmental protection	**3,18**	2,99	3	√	√
8. Escalation of air, water, and soil quality	2,21	2,04	3		
Stakeholders' values					
9. Benefit for government	2,86	2,70	3,5		√
10. Community satisfaction	**3,26**	**3,11**	3,7	√	√
11. Employee satisfaction	**3,58**	**3,46**	4	√	√
12. Investor satisfaction	**3,24**	**3,04**	4	√	√
Internal business process					
13. Eco-friendly materials	**3,45**	**3,30**	4	√	√
14. Environmentally friendly process	**3,31**	**3,22**	3,33	√	√
15. Recovery Assets	2,71	2,52	3		
16. Minimize residual	**3,43**	**3,36**	4	√	√
17. Proper waste disposal system	1,62	1,41	1		
18. Resource commitment	**3,29**	**3,15**	3,5	√	√
19. Owners support	**3,13**	**3,02**	3	√	√
Social					
20. Community welfare	**3,48**	**3,43**	4	√	√
21. Decreasing of unemployment	**3,30**	**3,16**	4	√	√
22. Harmonious relationship	**3,37**	**3,27**	4	√	√
23. Job opportunity	**3,64**	**3,56**	4	√	√
Innovation and growth					
24. Recapture value	**3,43**	**3,38**	4	√	√
25. Creative process & design of return product	**3,20**	**3,07**	3	√	√
26. Technology compliance	**2,95**	2,79	3		√
27. Business development	**3,03**	2,92	3,5		√
28. Streamlines technology in SOP	2,42	2,26	3		
29. Management initiative	2,25	2,12	2		
30. Employee competency	**2,95**	1,89	3		√

The bold numbers shows that the measure meet the criteria (accepted).

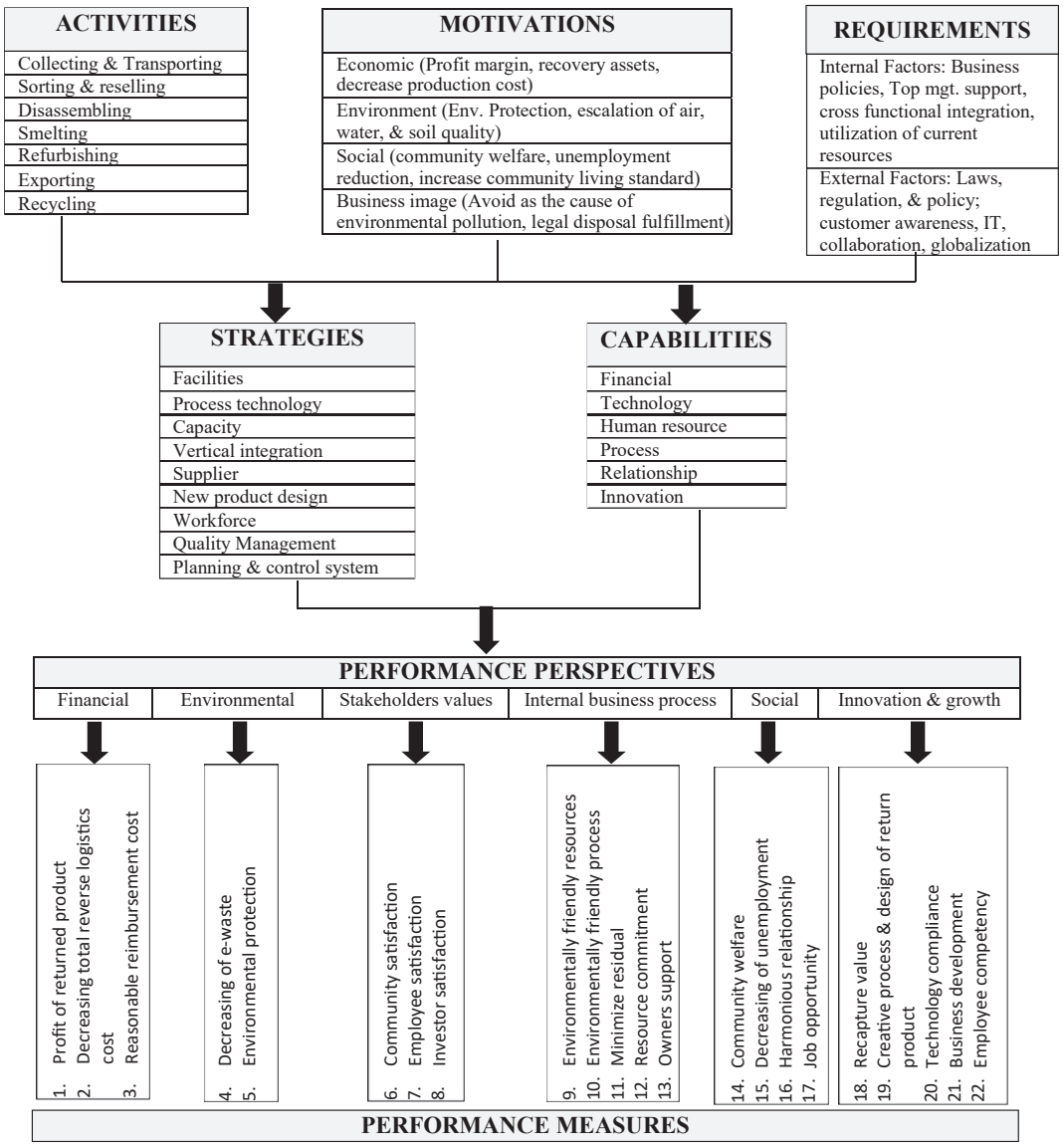

Figure 3. Performance measures for informal e-waste business in developing countries.

4.2.1. Financial

Financial performance parameters for informal RL businesses proposed by the government comprise five indicators. Firstly, the business needs to generate profit from returned products. Profit for RL business is the amount of money generated within a certain period after reduced by e-waste processing cost. This parameter needs to be emphasized due to the high risk of this business with a huge recovery costs. This business is permitted to operate as long as it is able to generate money more than operational costs. Therefore, through this parameter, the informal businesses are reminded of their responsibility to other parties such as the environment and social communities. According to Moneva and Ortas (2010), there is a significant relationship between financial performance and environmental performance. The polluter pay principle has been implemented to electronic manufacturers and other supply chain players to take back products discarded by their users (Jayaraman and Luo, 2007). However, the researcher argued that this principle can also be applied to informal e-waste business, for example buying a filter air technology for neutralizing toxic fumes that which has been applied to this business in Tangerang. Ezeah et al. (2013) argued that informal e-waste businesses had helped governments in collecting e-waste from households that usually it holds at home and spreads of radiation to themselves and the environment, therefore they should be supported like other businesses such as business in batik that often pollutes a river by washing it after a staining process. The provision of eco-recycling technology and facilities increases the informal e-waste business performance (Nnorom and Osibanjo, 2010; Akenji et al., 2011; Damanhuri and Padmi, 2012; Budijati, 2016). In addition, the provision of facilities and technologies infrastructures, giving them training, and supervising uninterruptedly is better than thinking to eradicate them since the huge amount of their number. Secondly, obtaining a profit from repair services and upgrading features is the main concern of e-waste businesses (RL activities) in developed countries (Prakash and Barua, 2016; Khor and Udin, 2012). This is because, from these activities, the lifetime of electronic products is extended. Recapture value and recovery assets can be realized as motivation in reverse logistics (Rogers and Tibben-Lembke, 1998). The flexibility of business in RL activity is significant in anticipating the uncertainty of the material and sustaining the business (Bai and Sarkis, 2013). However, this parameter was rejected by the informal business in Indonesia because they are more interested in recycling e-waste to extract gold, copper, and silver that give them more money. Thirdly, governments expected informal e-waste business to focus only on collecting, sorting, dismantling, separating, and repairing and servicing. The main reasons are the lack of eco-recycling technologies and facilities as well as the incapability of human resources to transfer knowledge

(Abdulrahman, 2012; Agrawal et al., 2016a,b). The government also emphasized material reduction and total reverse logistics cost using the cannibalism method and sharing transportation to deliver the sorted of e-waste to recycling facilities. However, this is also not their main focus as they aim to dismantle and recycle them to extract the gold and other valuable materials. In this case, the government's expectations were not in line with the desire for informal e-waste businesses. Fourthly, persuasive incentives are provided to encourage consumers to participate in RL. Almost all respondents agree to this parameter because used or broken electronics are used to get an e-waste component. Therefore, from the five parameters of financial measurements suggested by the government, only three are confirmed by the informal RL business.

4.2.2. Environmental

From the environmental perspective, the government determined three parameters to evaluate informal e-waste businesess. They need to provide a positive contribution in decreasing the amount of e-waste, protecting the environment from their activities, and escalating air, water, and soil quality. Although the research experts required all e-waste businesses to be more responsible for the environment, in fact, they are incapable of protecting the environment. However, they promise always to try to minimize pollution from their business process for the first two parameters. RL business decreasses the negative impact on the environment, increasing client service, while maximizing the value-added to returned residuals, returns (Cespon et al., 2009). The informal business also recognized the need to clean their surrounding environment from pollution by creating a traditional dismantling machine to avoid direct contact with e-waste components.

4.2.3. Stakeholders' value

All businesses are demanded to benefit other stakeholders (Agrawal et al., 2016a,b), so is informal business. As a business, it has also an obligation to pay tax, which in return serves communities and the business. However, they never make and publish annual reports such as an income statement, balance sheet, and cash flow. They were also unable to utilize management information systems (MISs), despite being recommended for production control, product delivery, and accounting processes (Fransisco et al., 2012; Garcia-Rodriguez et al., 2012). Therefore, the government is impossible to require an informal business to pay tax. Besides paying taxes, the business is also expected to provide job opportunities. It is part of satisfying the community through this business. For this indicator (satisfy communities), the informal business has successfully fulfilled it.

Furthermore, these businesses need to provide a fair income for their employees, a safe work environment, and labor prosperity (Ho et al., 2012). They also have the responsibility to satisfy their investors (Abdulrahman and Subramanian, 2012). The meaning of investors for informal e-waste businesses is a person who gives them the amount of money to buy e-waste components in large amounts and good prices (economies of scale). The funding is also used by an informal business to win an auction of e-waste. The last two parameters are recognized by them very difficult to reach, but it is still reasonable. Therefore, from the stakeholder's value perspective, the informal e-waste business only confirmed three parameters.

4.2.4. Internal business process

There are many parameters in the internal business process perspective, namely, eco-friendly materials, environmentally friendly processes, recovery assets, minimize residual, proper waste management disposal system, resource commitment, and owner support. Based on experts' confirmation, only two parameters cannot be reached, namely assets recovery and proper waste disposal system, because informal businesses are incapable of undertaking them. Furthermore, these two parameters do not match with their business motivation, strategy, and capability. It is also difficult to use eco-friendly materials due to the mandatory use of chemicals in the gold refining process. They recognized often dispose of the residual material in the ground or ditch. To reduce the soil or water pollution, they use a bucket to collect the residual materials. They stated, it can be sold to a bigger recycling business with high recycling technology. A proper waste disposal system from their recycling activities is not their attention. In developed countries such as Switzerland and Sweden, electronic waste is transported by specific waste vehicles because it consists of hazardous and toxic material (Demajorovic et al., 2016). Appropriate waste management strategies, including the prevention of unsustainable use of resources such as chemical materials, need to be the main focus of e-waste business (Otles and Kartal, 2018; Lin et al., 2014).

4.2.5. Social

From the social perspective, the government suggested using four parameters to evaluate the performance of informal e-waste businesses, namely the business need to create community welfare, decrease unemployment, develop a harmonize relationship between a business and public, and create large jobs opportunities. There is no debate from the informal business. All of the parameters are accepted and have been run by all of them. The government finds it impossible to handle the amount of e-waste and arrange the recycling process (Wrigth et al., 2011). Therefore, it is better to collaborate with other parties such as this informal business. To avoid environmental pollution, the government as a facilitator needs to provide the facilities and technology infrastructure (Yudoko, 2012). Atasu and Wossenhove (2012) also stated that the government also needs to organize a monopolistic of e-waste collection for easy monitoring of their next activities such as dismantling or recycling. A collection center prevents unharmonized between the business and the public. Government intervention is also needed in recycling or RL activities to enforce the rules (Wright et al., 2011).

4.2.6. Innovation and growth

From the innovation and growth perpective, there are seven parameters to assess informal e-waste business performance. However, only five are confirmed by informal e-waste business, namely recapturing values, creative process and design of return products, technology compliance, business development, and employee's competency. Streamlining technology in standard operational procedures (SOP) and management initiatives is not focused on informal e-waste business. While, recapture value is a simple parameter for them since it is their main activity. According to Wright et al. (2011), recapture value is the main activity in reverse logistics with the creative process and design of return products carried out by some informal businesses. Furthermore, some informal businesses created a destroyer machine for the grinding process to avoid direct contact with e-waste products. Besides preventing direct contact with e-waste, by using this machine, the results of grinding e-waste components are smoother and make it easier to filter the gold. Creating an air filter machine has been out by one of our respondents at Tangerang. He created this machine after getting out of prison as his environmental violation for fourteen days. These two pieces of evidence showed the effort of e-waste businesses in technology compliance and development. Employee competency is the last parameter that was confirmed by the informal business. Although it seems impossible for them, they believe the government has a wide range to develop their competency. The government can collaborate with manufacturers and formal e-waste businesses to increase their ability to recycle in an environmentally friendly way. Next, it also provides facilities and technologies that meet eco-recycling qualifications and carry out uninterrupted supervision until such things become a habit.

5. Conclusion

Formulation of performance measurement for informal e-waste business is very needed due to the extreme growth of environmental violations caused by RL activities. Informal businesses only rely on traditional methods in e-waste processing. As a business even though it is

informal, its performance needs to be evaluated. The existing performance indicators are not appropriate to be applied in developing countries due to the varing situations and cultures. For example, no clear regulation, low awareness of communities, poverty, unemployment, etc. Besides, the indicators were formulated for measuring formal business performance, therefore, to keep the balancing performance of this informal business, the researcher believes the balanced scorecard needs to be combined with the Quattro bottom line approaches. The BSC approach is used to evaluate the business based on its ability to generate profit, to satisfy communities, employees, and investors (stakeholders' values), to use eco-friendly recycling, and to develop their business. Meanwhile, the QBL concept enable this business ito be assessed based on environmental and social parameters. The combination of the two approaches is called sustainable reverse logistics scorecards (SRLS).

Initially, the SRLS had 30 important measurements, however, in the second step of this research, only 22 parameters were used as a measurement of informal e-waste business performance. This is because they followed the expectations of the experts and the motivation, strategy, capability, and motivations of informal e-waste businesses. The three highest score of these performance measures is the ability to create job opportunities (social), employee satisfaction (stakeholders' value), and a reasonable reimbursement cost (financial). These businesses need to be able to reduce unemployment and satisfy the employees in the context of their health and welfare. To ensure the raw material from the community, these businesses need to be able to give a reasonable reimbursement cost for their products. E-waste businesses must consider incentive criteria for collecting returnable (Das and Chowdhury, 2011). This research predicts either government or informal e-waste businesses in Indonesia and maybe in other developing countries that have the same characteristics, will be interested in this SRL and will use them to evaluate the e-waste business. We hope it will be an accurate performance measure and help the government to certify this business.

6. Theoretical and managerial implications

The findings of this research offer a strong concept of performance measurement for informal e-waste business. Therefore, a new paradigm emerged for environmental and public purposes of informal and formal enterprises. This research contributed to the performance theory and reverse logistics theories for the formal business, which can now be applied for informal e-waste business. The balanced scorecard concepts have more complete measurements and include the environmental and social issues in their perspective. This new concept certainly has practical implications due to the inability of the government to provide an adequate number of officers to handle electronic waste directly. A total of twenty-two parameters were used to assess or evaluate the performance of informal e-waste business. Furthermore, the assessment result is used by the government to determine business permit granting, eco-recycler selection, reward and punishment implementation, eco-recycling partner selection, and environmental incentive allocation.

7. Limitation and future research direction

This study encountered difficulties obtaining data from all areas in Indonesia and limited suggestions from previous studies. However, the main limitation is contacting the e-waste business owner, with the response rate lower than desired. They were afraid to meet others because they thought foreigners are government officials trying to arrest them for environmental violations. Besides, most of them were poorly educated, thereby making it difficult for them to fill out the questionnaire. This made this research to cover only five provinces of Indonesia. Therefore, further studies need to distribute a closed-ended questionnaire using these twenty-two parameters to assess the performance of informal e-waste businesses in thirty-four provinces in Indonesia.

Declarations

Author contribution statement

Hesti Maheswari: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Gatot Yudoko: Conceived and designed the experiments; Performed the experiments.

Akbar Adhiutama: Analyzed and interpreted the data.

Haruki Agustina: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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