

The Law of E-Waste: Closing the Loop for Green Digital Technologies and Economic Resilience- A Malaysian Perspective

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Abstract: The exponential growth of digital technologies globally has led to a parallel surge in electronic waste (e-waste), posing significant environmental and health risks while also representing a potential resource for valuable materials. Malaysia, as a rapidly digitalising nation, faces mounting challenges in managing its e-waste stream effectively. This paper examines the current legal and regulatory landscape governing e-waste in Malaysia, focusing on its adequacy in promoting a circular economy model – closing the loop – for green digital technologies and fostering economic resilience. Through a comparative analysis with established frameworks in the European Union (Waste Electrical and Electronic Equipment - WEEE Directive) and Japan (Law for Promotion of Effective Utilization of Resources), this paper identifies critical gaps in Malaysia's approach, particularly concerning Extended Producer Responsibility (EPR), formal collection systems, and integration of the informal sector. It argues that adopting comprehensive, specific e-waste legislation incorporating mandatory EPR, clear collection and recycling targets, and mechanisms to formalise informal collection is crucial. Such reforms are vital not only for mitigating environmental harm but also for unlocking the economic potential of urban mining and supporting Malaysia's transition towards a sustainable and resilient digital economy.

Keywords: *E-waste, Environmental Law, Circular Economy, Extended Producer Responsibility (EPR), Comparative Law.*

1. Introduction and Background

The relentless pace of technological innovation, coupled with increasing consumer appetite and ever-shorter product lifecycles, has unleashed a global electronic waste (e-waste) tsunami (Akhtar, 2024). The United Nations' Global E-waste Monitor 2024 paints a stark picture: the world generated a record 62 million metric tonnes of e-waste in 2022, a figure rising five times faster than documented recycling efforts. This deluge of discarded electrical and electronic equipment (EEE) represents not only a monumental environmental challenge but also a squandering of valuable resources.

Malaysia, a nation at the forefront of the global Electrical and Electronics (E&E) industry and a rapidly digitalising economy, finds itself at the epicentre of this digital paradox (Akhtar, 2024). The very sector that fuels its economic growth and technological advancement is simultaneously the source of one of its fastest-growing and most hazardous solid waste streams. This is not a simple problem of waste disposal but a structural consequence of an economic model where the environmental costs of consumption have not been fully integrated into the product lifecycle. The legal and regulatory frameworks have struggled to keep pace with this economic and technological acceleration, creating a critical vulnerability.

The central thesis of this analysis is that Malaysia's current legal framework for e-waste is fundamentally bifurcated. It provides robust, cradle-to-grave regulation for industrial e-waste but leaves a critical legislative vacuum for the enormous and growing stream of household-generated e-waste (Ilankoon, 2023). This "household hiatus" creates a cascade of negative consequences, including severe environmental degradation, significant public health risks, the loss of billions of ringgit in recoverable resources, and the proliferation of a dangerous informal recycling sector. This article argues that closing this regulatory loop through the enactment of a comprehensive, mandatory Extended Producer Responsibility (EPR) framework is not merely an environmental necessity. It is a strategic imperative for achieving the nation's ambitions for economic resilience, resource security and a sustainable circular economy, as articulated in national policies such as the

Twelfth Malaysia Plan and the Circular Economy Blueprint for Solid Waste.

2. Literature Review

To comprehend the legal challenge, one must first grasp the sheer scale of the e-waste problem in Malaysia. The available data, though sometimes varied across sources, consistently points to a massive and escalating issue.

E-Waste Generation Volumes

Estimates of annual e-waste generation in Malaysia highlight the magnitude of the flow. Multiple sources cite a figure of approximately 365,000 tonnes generated annually, a weight exceeding the iconic Petronas Twin Towers (Akhtar, 2024). The Global E-waste Monitor 2020 provided a similar figure, estimating that Malaysia generated 364 kilotons (kt) of e-waste in 2019, which translates to an average of 11.1 kg per capita. Historical data reveal a clear upward trend. Between 2005 and 2023, Malaysia produced a cumulative total of nearly 2.62 million metric tonnes of e-waste (Palansamy, 2025b). A significant spike occurred in 2020, with a record 904,008.90 metric tonnes generated, a surge largely attributed to increased purchases of electronic devices during the nationwide Movement Control Order (MCO). Projections indicate this growth will continue unabated, with forecasts predicting Malaysia will generate 24.5 million units of e-waste by 2025 (Akhtar, 2024).

The Management Gap: Collection and Recycling Rates

Despite the colossal volume of e-waste generated, formal collection and recycling systems capture only a small fraction. In 2023, Malaysia's national e-waste recovery rate stood at a modest 21.1%. Out of 65,280.14 metric tonnes officially collected, only 13,759.98 metric tonnes were recovered as products or raw materials (Palansamy, 2025b). While this figure is slightly above the 2020 global average of 17.4%, it lags considerably behind regional economic peers such as Singapore (59%), South Korea (49%), and Taiwan (60%) (Akhtar, 2024).

The management gap is most pronounced for household e-waste, where the recycling rate is estimated to not exceed 25%. Some reports suggest that as few as 5% of consumers dispose of their e-waste through proper channels, either by recycling it or returning it to the manufacturer (Palansamy, 2025a). This implies that hundreds of thousands of tonnes of e-waste from households are unaccounted for annually, likely ending up in municipal landfills, being hoarded in homes, or, most problematically, being diverted into the informal sector (Akhtar, 2024). This statistical chasm between generation and collection represents a "dark flow" of unmanaged waste, which is the primary source of environmental contamination and the lifeblood of the hazardous informal recycling economy. It is a direct measure of the current regulatory system's failure to capture and manage the bulk of the nation's e-waste.

Composition and Key Sources

The scope of e-waste officially targeted by the Department of Environment (DOE) for management is currently limited to six specific items: mobile phones, computers, televisions, air-conditioners, refrigerators, and washing machines. Mobile phones and personal computers are the most commonly discarded items. Data indicates a sharp increase in e-waste from specific categories over the last decade. For instance, e-waste from television sets, personal computers, and rechargeable batteries nearly doubled from 463,866 metric tonnes in 2011 to 832,692 metric tonnes in 2020. Similarly, waste from air-conditioners and washing machines rose from 172,281 metric tonnes in 2010 to 211,348 metric tonnes in 2020.

Table 1: Comparative E-Waste Statistics for Malaysia (Selected Years)

YEAR	TOTAL GENERATION (METRIC TONNES - DOE/LOCAL SOURCES)	TOTAL GENERATION PER CAPITA (METRIC TONNES - GLOBAL MONITOR)	GENERATION (KG)	TOTAL COLLECTED FORMAL (METRIC TONNES)	RECOVERY RATE (%)
2019	~365,000 (annual estimate)	364,000	11.1	N/A	N/A
2020	904,008.90	N/A	N/A	N/A	30.67 (overall recycling)
2021	N/A	N/A	N/A	2,459 (household)	<25 (household)

YEAR	TOTAL GENERATION (METRIC TONNES - DOE/LOCAL SOURCES)	TOTAL GENERATION PER CAPITA (METRIC TONNES - GLOBAL MONITOR)	GENERATION (KG)	TOTAL COLLECTED FORMAL (METRIC TONNES)	RECOVERY RATE (%)
2023	65,280.14 (reported generation)	N/A	N/A	only) 65,280.14	estimate) 21.1
2025	24.5 million units (projection)	N/A	N/A	N/A	N/A

Note: Data discrepancies exist due to different methodologies (e.g., weight vs. units, industrial vs. household, reported vs. estimated generation). "N/A" indicates data not available in the reviewed sources for that specific metric and year.

3. Research Methodology

This article is prepared based on doctrinal study and analysis. Web resources, laws, and policies implemented by the Malaysian government are carefully analysed to serve as an input for future research to be conducted on e-waste management in Malaysia.

4. Results

Malaysia's legal approach to e-waste management is a tale of two systems. While industrial e-waste is governed by a strict and comprehensive regulatory regime, household e-waste exists in a legal grey area, creating a fundamental imbalance that undermines the nation's environmental and economic goals.

The Legal Foundation: Environmental Quality Act 1974 (EQA 1974)

The Environmental Quality Act 1974 (Act 127) serves as the foundational environmental law in Malaysia, providing the overarching legal authority for pollution control and waste management (Environmental Quality Act 1974). While not specific to e-waste, its broad provisions empower the Minister to regulate activities that could harm the environment. Key sections such as Section 24 (prohibiting soil pollution), Section 29 (prohibiting waste discharge into Malaysian waters), and particularly Section 34B (prohibiting the improper placement or deposit of scheduled wastes) establish the legal bedrock upon which more specific regulations are built.

The Industrial Mandate: Environmental Quality (Scheduled Wastes) Regulations 2005

The cornerstone of Malaysia's current e-waste control is the Environmental Quality (Scheduled Wastes) Regulations 2005, enacted under the EQA 1974 (Awang, 2010). These regulations are robust and prescriptive, establishing a cradle-to-grave management system for hazardous wastes generated by industries. E-waste is explicitly classified under this regime with the code SW110 (Ilankoon, 2023).

The definition of SW110 is comprehensive, covering "waste from electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes... or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl".

The Regulations impose stringent obligations on industrial waste generators, including:

Proper Storage: Wastes must be stored in compatible, durable, and clearly labelled containers that are kept closed to prevent spillage. On-site storage is limited to a maximum of 180 days or a quantity not exceeding 20 metric tonnes.

Mandatory Tracking: All movements of scheduled waste must be documented and reported through the Electronic Scheduled Waste Information System (eSWIS), ensuring a clear chain of custody (Palansamy, 2025a).

Licensed Disposal: SW110 waste can only be transported by licensed contractors and delivered to DOE-licensed recovery facilities for treatment and disposal.

The Household Hiatus: A Critical Regulatory Void

The primary weakness of the Malaysian system lies in the fact that the stringent requirements of the 2005 Regulations are designed for industrial entities and are practically unenforceable on millions of individual

households (Ilankoon, 2023). This creates a critical regulatory void. While household e-waste technically falls under the SW110 definition, its management is left on a largely voluntary basis, relying on public awareness campaigns and drop-off initiatives (Palansamy, 2025a).

The consequences of this "household hiatus" are severe. With low public awareness and participation, vast quantities of household e-waste are improperly disposed of—either co-mingled with municipal solid waste destined for landfills or sold to informal collectors (Akhtar, 2024). This not only represents a failure of waste management but also creates the conditions for a hazardous shadow economy to thrive.

The De Facto Solution: Socio-Legal Impact of the Informal Sector

The regulatory gap for household e-waste has given rise to a large and active informal sector that has become the de facto collection system for a significant portion of the country's e-waste (Ilankoon, 2023).

Socio-Economic Role: This sector provides a source of livelihood for many individuals who operate as collectors, often using modified bicycles or small trucks to gather discarded electronics from homes and businesses. They are driven by a direct economic incentive, as households can often sell their old appliances for a small sum of cash.

Environmental and Health Catastrophe: The methods employed by this sector are primitive, unregulated, and extremely dangerous. To extract valuable materials like copper, gold, and silver, informal operators often resort to open burning of circuit boards and cables or using hazardous chemicals like acid for leaching (Ali & Talmizi, 2024). These practices release a cocktail of toxic substances—including lead, mercury, cadmium, dioxins, and furans—directly into the air, soil, and water systems. This poses severe and direct health risks, such as respiratory illnesses, neurological damage, and cancer, to the workers (who often lack any protective equipment) and the surrounding communities (Mawardi et al., 2025).

Legal Status: These operations are illegal, operating "under the noses of the authorities". This shadow economy is also frequently linked to the illegal importation of e-waste from developed countries, further exacerbating Malaysia's environmental burden.

The bifurcated legal framework creates a perverse economic incentive that actively undermines formal, safe recycling. The informal sector can afford to pay households for e-waste precisely because it externalizes all environmental, health, and safety costs onto the public. Formal, licensed recyclers, who must bear the high operational costs of complying with the 2005 Regulations (e.g., pollution control, worker safety, proper disposal of hazardous residues), cannot compete on price (Sofian Azizi et al., 2023). This price disparity creates a powerful economic current that pulls the vast majority of household e-waste away from the regulated system and into the most dangerous and polluting channels. The law, through its omission, has inadvertently nurtured the very problem it should be designed to solve.

Discussion

Existing Measures: Malaysia vs Advanced Jurisdictions

The challenge of e-waste management is not occurring in a policy vacuum. It is intrinsically linked to Malaysia's broader national ambitions to transition towards a green, resilient, and circular economy. A series of high-level government plans and roadmaps signal a clear political will to move beyond the traditional "take-make-dispose" linear model.

National Policy Framework

Several key national strategies underscore the government's commitment to circularity and sustainable waste management:

Twelfth Malaysia Plan (12MP) (2021-2025): This five-year development plan sets an ambitious target of achieving a 40% national recycling rate by 2025. Crucially, it explicitly prioritizes the adoption of the Extended Producer Responsibility (EPR) approach as a key policy tool to achieve this goal (Akhtar, 2024).

Circular Economy Blueprint for Solid Waste (2025-2035): Launched by the Ministry of Housing and Local Government, this blueprint provides a more detailed roadmap. Its strategic pillars include establishing EPR legislation, introducing zero-waste-to-landfill certification for manufacturers, developing integrated waste

management facilities like waste-eco parks, and using data systems to track the waste value chain. Other Supporting Roadmaps: The principles of circularity and EPR are echoed in other strategic documents, including the New Industrial Master Plan 2030 (NIMP 2030), the Green Technology Master Plan, and the Malaysia Plastics Sustainability Roadmap (2021-2030), which also advocates for an EPR scheme.

This consistent, cross-ministerial consensus on the need for a circular economy and EPR demonstrates a high-level strategic direction. However, a significant "policy-implementation gap" exists. While these roadmaps articulate the "what" and "why," the specific, legally binding regulations required to operationalize these ambitions for household e-waste—the largest unmanaged stream—remain pending. The nation has a destination but lacks the legal vehicle to get there.

Economic Resilience through Urban Mining

A central pillar of the circular economy for e-waste is the concept of "urban mining"—the process of recovering valuable materials from discarded products (Espinoza et al., 2020). E-waste is not just waste; it is a rich, above-ground reservoir of resources. The total value of raw materials contained in global e-waste was estimated at a staggering \$57 billion in 2019.

For Malaysia, this represents a significant and largely untapped economic opportunity. Recoverable materials from its e-waste stream include precious metals like gold, silver, and palladium, as well as base metals like copper and aluminium. Developing a robust urban mining industry would not only generate substantial revenue and create high-skilled jobs but also enhance national economic resilience by reducing dependency on volatile global supply chains for virgin raw materials (Mawardi et al., 2025).

Green Digital Technologies and the E-Waste Nexus

The transition to green technologies presents both a challenge and an opportunity. The rapid adoption of Electric Vehicles (EVs), for instance, is creating a new and complex e-waste stream in the form of end-of-life batteries. Malaysia has set an ambitious goal of having 1.5 million EVs on its roads by 2040. However, the country currently lacks the technical capacity for large-scale EV battery disposal and recycling. These batteries are rich in critical minerals like lithium, cobalt, and nickel, but are also highly hazardous if mismanaged.

A functioning circular economy for e-waste is therefore a prerequisite for the sustainable growth of green technologies. This requires leveraging Malaysia's strong E&E manufacturing base to pioneer and adopt advanced recycling technologies, such as AI-driven sorting systems and hydrometallurgical processes for battery material recovery, thereby transforming a future liability into a strategic asset.

Table 2: Key Malaysian Policies and Roadmaps Influencing E-Waste Management (2018-2035)

POLICY/ROADMAP TITLE	TIMEFRAME	KEY OBJECTIVES	SPECIFIC RELEVANCE TO E-WASTE/EPR	RESPONSIBLE MINISTRY/AGENCY
Twelfth Malaysia Plan (12MP)	2021-2025	Advance green growth, enhance sustainability, and achieve a 40% recycling rate.	Prioritises the adoption of the EPR approach to support the circular economy.	Ministry of Economy
Circular Economy Blueprint for Solid Waste	2025-2035	Transition to a circular economy for solid waste and reduce landfill dependency.	Explicitly includes establishing legislation for EPR and zero-waste-to-landfill certification.	Ministry of Housing and Local Government (KPKT)
New Industrial Master Plan 2030 (NIMP 2030)	2023-2030	Drive industrial development, focusing on high-tech and sustainable sectors.	Promotes circular economy principles to enhance sustainability and resource efficiency in manufacturing.	Ministry of Investment, Trade and Industry (MITI)

POLICY/ROADMAP TITLE	TIMEFRAME	KEY OBJECTIVES	SPECIFIC RELEVANCE TO E-WASTE/EPR	RESPONSIBLE MINISTRY/AGENCY
Malaysia Plastics Sustainability Roadmap	2021-2030	Achieve plastic circularity, reduce plastic pollution.	Outlines a framework for an EPR scheme for packaging, including the establishment of a Producer Responsibility Organisation (PRO).	Ministry of Natural Resources and Environmental Sustainability (NRES)
Green Technology Master Plan	2017-2030	Mainstream green technology into national development.	Proposes the development of EPR policies to facilitate growth in resource recovery.	Ministry of Natural Resources and Environmental Sustainability (NRES)

Extended Producer Responsibility (EPR): The Linchpin for a Coherent System

To bridge the gap between national ambition and on-the-ground reality, a single policy instrument stands out as the linchpin: Extended Producer Responsibility (EPR). This approach is consistently identified in Malaysia's own strategic documents as the key to unlocking a circular economy for waste.

Core Principles of EPR

EPR is an environmental policy approach that extends a producer's responsibility—whether financial, physical, or both—to the post-consumer stage of a product's life cycle. It is founded on the "polluter pays" principle, shifting the economic burden of waste management from municipalities (and by extension, taxpayers) to the producers and consumers of the products that become waste. This creates a powerful incentive for producers to design products that are more durable, easier to repair, and less hazardous, as these design choices directly impact their end-of-life management costs (Directive 2012/19/EU, 2012).

Malaysia's EPR Journey

Malaysia is not starting from scratch. The legal foundation for EPR already exists in principle within national legislation. Section 102 of the Solid Waste and Public Cleansing Management Act 2007 (Act 672) grants the Minister the authority to introduce take-back and deposit-refund systems, while the broad powers under the EQA 1974 also provide a basis for such schemes.

To date, however, the application of EPR in Malaysia has been limited to voluntary, industry-led initiatives, such as the Malaysian Recycling Alliance (MAREA), which is primarily focused on post-consumer packaging waste. The government has clearly signalled its intent to move beyond this. The national policy trajectory indicates a planned transition from the current voluntary phase (2023-2025) to a mandatory EPR scheme beginning in 2026, with packaging and electronics identified as the priority sectors.

Key Components and Challenges of a Malaysian EPR System

Implementing a successful mandatory EPR system for e-waste will require several critical components:

Producer Responsibility Organisation (PRO): An independent, non-profit, industry-funded PRO will be essential to manage the system. Its roles would include collecting fees from producers, coordinating nationwide collection and recycling logistics, managing data, and ensuring compliance on behalf of its members.

Financing Model: The system would be financed through an eco-modulated fee paid by producers for each EEE unit placed on the market. This fee would vary based on the product's recyclability and hazardous content, incentivizing better design. This central fund would then be used to pay for the entire chain of collection, transport, and environmentally sound recycling.

Collection Infrastructure: The EPR fund would finance the establishment of a convenient and comprehensive collection network. This would formalize and expand existing channels, such as retailer take-back schemes, and support new ones, like door-to-door collection services, to effectively divert e-waste from landfills and the informal sector (Mat Sari, 2021).

Transparency and Data Management: A robust, transparent reporting system is non-negotiable. It must track material flows from the point of sale to final recycling, verify collection and recycling rates, and prevent fraud. This would likely involve a significant upgrade and integration of existing platforms like eSWIS and the MyEwaste app (Palansamy, 2025a).

A crucial function of this system is solving the "negative value" problem. Certain e-waste items, like old refrigerators containing ozone-depleting CFCs or CRT televisions with leaded glass, cost more to treat safely than the value of the materials recovered (Yusof, 2025). The informal sector simply cherry-picks valuable parts and illegally dumps these hazardous, costly-to-treat components (Masrom, 2019). A properly designed EPR financing mechanism addresses this by using the fees collected from all products, including high-volume and profitable items like smartphones, to create a central fund. This fund then cross-subsidizes the collection and proper treatment of "negative value" items, making it economically viable for formal recyclers to handle them. This mechanism is the only way to ensure all e-waste is managed responsibly, not just the profitable parts.

International Benchmarking: Lessons from European and Japanese Legal Models

As Malaysia charts its course, it can draw valuable lessons from established e-waste management frameworks in other jurisdictions. The European Union and Japan, in particular, offer two distinct yet successful models for comparison.

The European Union Model: Comprehensive and Prescriptive

The EU's approach is characterized by a comprehensive, legally binding framework that addresses the e-waste problem from both upstream and downstream.

Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU): This directive forms the cornerstone of downstream management. Its key features include legally binding, ambitious collection targets (e.g., a rate of 65% of the average weight of EEE placed on the market), a broad "open scope" that covers virtually all EEE, mandatory producer registration in each member state, and the establishment of producer-financed take-back systems. This ensures producers are directly responsible for funding the collection and recycling of their products at end-of-life.

Restriction of Hazardous Substances (RoHS) Directive (2011/65/EU): This directive provides the upstream control. It restricts the use of specific hazardous substances (such as lead, mercury, cadmium, and certain flame retardants) in the manufacturing of new EEE. By designing hazards out of the product from the beginning, the RoHS Directive simplifies and reduces the cost and environmental risk of end-of-life treatment.

The primary lesson from the EU model is the effectiveness of a holistic, top-down legal architecture that combines stringent downstream collection and financing obligations with proactive upstream substance restrictions.

The Japanese Model: Shared Responsibility and Specificity

Japan's model is notable for its clear allocation of roles and its targeted, product-specific approach.

Law for the Recycling of Specified Kinds of Home Appliances (HARL): This law establishes a unique "shared responsibility" model for four major appliance categories: televisions, refrigerators, washing machines, and air conditioners. The roles are explicitly defined:

- Consumers pay a collection and recycling fee at the time of disposal;
- retailers are obligated to collect the old appliance when selling a new one; and
- Manufacturers are obligated to accept and recycle the collected units to meet high, legally mandated recycling rates.

A physical manifest (coupon) system ensures traceability from consumer to recycler.

Law for the Promotion of Effective Utilization of Resources (LPUR): This is a broader law that promotes the 3Rs (Reduce, Reuse, Recycle) across many industries. For e-waste, it encourages voluntary, manufacturer-led collection and recycling schemes for products not covered by HARL, most notably personal computers.

The Japanese model offers Malaysia lessons in the power of simplicity and clearly defined roles. Its consumer-pays-at-disposal financing model presents a viable alternative to the producer-pays-at-production model common in the EU, while its focus on specific, high-volume products demonstrates the potential of a targeted approach.

Table 3: Comparative Analysis of E-Waste Management Frameworks: Malaysia, EU, and Japan

FEATURE	MALAYSIA (CURRENT/PROPOSED)	EUROPEAN UNION (WEEE/ROHS)	JAPAN (HARL/LPUR)
Legal Basis	EQA 1974; Scheduled Wastes Regs 2005; Proposed household regulations.	Legally binding Directives (WEEE & RoHS) transposed into national law.	Legally binding Acts (HARL, LPUR).
Scope	Strict for industrial (SW110); Voluntary/limited for 6 household items.	"Open scope" covering all EEE categories.	Specific (HARL for 4 appliances); Broader encouragement (LPUR for PCs, etc.).
Financing Model	Industry-funded (industrial); Voluntary/none (household); Proposed producer-funded EPR.	Producer-funded (fees paid when placing product on market).	Consumer-funded (fees paid at time of disposal).
Producer Obligations	Strict for industrial generators; Voluntary for household products; Mandatory EPR proposed.	Finance collection/recycling; Meet targets; Register in each country.	Recycle collected units to meet legal rates (HARL); Voluntary collection (LPUR).
Retailer Obligations	Voluntary take-back by some.	Must take back WEEE on a 1:1 basis, and 0:1 for very small WEEE.	Must collect old appliances on a 1:1 basis and transfer to the manufacturer (HARL).
Consumer Obligations	Dispose of e-waste at designated points (voluntary).	Segregate e-waste from municipal waste.	Pay collection and recycling fee at disposal (HARL).
Collection Targets	None for household e-waste; 40% overall recycling goal (12MP).	Mandatory, high-level targets (e.g., 65% of EEE placed on market).	No specific collection target, but high recycling rate mandates imply high collection.
Upstream Controls	None.	Mandatory substance restrictions (RoHS Directive).	Encouraged via LPUR (design for the environment).

5. Managerial Implications and Recommendations

Synthesizing the analysis of Malaysia's domestic challenges, national ambitions, and international best practices, a clear path forward emerges. The following integrated legal and policy recommendations are proposed to close the regulatory loop, formalize e-waste management, and align Malaysia with its circular economy goals.

Legislative Reform: Creating a Unified Framework

The current bifurcation of the legal framework is the root cause of systemic failure. Relying on the 2005 Regulations for households is untenable, and the voluntary system has proven ineffective, as evidenced by chronically low collection rates and the limited public uptake of initiatives like the MyEwaste app (Akhtar, 2024).

Recommendation: Enact new, specific legislation to govern household e-waste. This could take the form of a standalone "Waste Electrical and Electronic Equipment Management Act" or, more pragmatically, a new set of comprehensive regulations under the EQA 1974, titled "Environmental Quality (Waste Electrical and Electronic Equipment) Regulations." This new instrument must be mandatory and should be designed to supersede the voluntary approach for household e-waste, while leaving the effective industrial framework under the 2005 Regulations in place for B2B waste streams.

EPR Implementation Roadmap: A Practical Pathway

A mandatory EPR scheme is the necessary operational engine for the new legal framework. A phased approach will allow industry, government, and consumers to adapt.

Recommendation: Legislate a mandatory, phased-in EPR scheme.

Phase 1 (Years 1-2): The initial phase should focus on the six e-waste categories currently defined by the DOE. The legal mandate for a single, non-profit Producer Responsibility Organisation (PRO) should be established. All producers and importers of these six product types must register with the PRO and begin paying eco-modulated fees into a central, ring-fenced fund.

Phase 2 (Years 3-5): The scope of the EPR scheme should be progressively expanded to align more closely with the EU's comprehensive "open scope" model. This would gradually bring other categories of small appliances, IT equipment, toys, and tools into the system. This phase should also explicitly incorporate challenging future waste streams, most notably EV batteries, ensuring a proactive rather than reactive approach.

Formalising the Informal: From Threat to Asset

The informal sector's extensive collection network is a valuable, albeit currently hazardous, asset. Eradication is impractical; integration is strategic.

Recommendation: Develop a national program to register, train, and license informal collectors, formally integrating them as the crucial "first mile" of the EPR collection system. This program should provide training on the safe handling of e-waste, provision of basic Personal Protective Equipment (PPE), and access to designated aggregation points. The EPR fund could then provide a stable, per-kilogram payment to these licensed collectors for all e-waste delivered to authorized recyclers. This formalizes their role, provides a safer and more stable livelihood, and decisively cuts off the supply of materials to illegal, polluting backyard operations (Ilankoon, 2023).

Strengthening Enforcement and Upstream Controls

A successful EPR system depends on robust enforcement and a long-term vision that extends to product design.

Recommendation 1 (Enforcement): Enhance digital tracking and transparency. The new regulations should mandate the use of a unified digital platform—an evolution of eSWIS and MyEwaste—for all stakeholders. Producers would report sales data, retailers would report take-backs, licensed collectors would log collections, and recyclers would report processing outputs. To ensure integrity and prevent fraud, the use of technologies like blockchain should be explored to create an immutable ledger tracking e-waste from cradle to grave (Xavier et al., 2021).

Recommendation 2 (Upstream Controls): Introduce a "RoHS-Lite" regulation. While a full ban on substances may be complex to implement initially, Malaysia should enact regulations that mandate design for recyclability. This would require producers to meet certain standards for ease of disassembly and material separation. Furthermore, producers should be required to declare the hazardous substance content of their products, a principle borrowed from Japan's LPUR. This information is critical for recyclers to manage materials safely and efficiently, reducing costs and environmental risks downstream. It is far more effective to design out a hazard than to manage it as toxic waste decades later.

By adopting these integrated recommendations, Malaysia can move beyond its current fragmented approach. It can forge a coherent legal and operational framework that not only mitigates the environmental and health risks of e-waste but also unlocks its economic potential, firmly placing the nation on a path towards a resilient and sustainable circular economy.

Conclusion

Malaysia stands at a critical juncture in managing its electronic waste. The current legal framework, while providing a foundation through scheduled waste regulations, is insufficient to address the scale and complexity of the e-waste challenge posed by rapid digitalization, particularly concerning household e-waste. Relying on fragmented regulations and voluntary initiatives hinders the transition towards a circular economy, leading to environmental pollution, health risks, and the loss of valuable secondary resources.

Learning from the comprehensive, EPR-based systems implemented in the EU and Japan, and Malaysia has a clear pathway forward. Enacting dedicated e-waste legislation that mandates EPR, sets clear collection and recycling targets, integrates the informal sector safely, and promotes green design is essential. Such reforms

are not merely an environmental necessity but a strategic imperative for fostering innovation in green digital technologies, creating economic opportunities through urban mining and recycling industries, and ultimately building a more resilient and sustainable national economy. Closing the loop on e-waste is fundamental to ensuring that Malaysia's digital future is both prosperous and environmentally sound. Further research should focus on the socio-economic impacts of formalizing the informal sector and the specific design of an optimal EPR financing mechanism for the Malaysian context.

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