

Master Thesis in  
Sustainable Development  
*Earth System Governance track*

## Exploration and Assessment of the Governance and Management of the Electrical and Electronic Waste Sector in Italy.



(Sidki, 2020)

*Master:* Sustainable Development

*Track:* Earth System Governance

*Course number:* GEO4-2321

*Number of credits:* 30 ECTS

*Wordcount:* 28.086

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## Abstract

Electrical and electronic waste (e-waste) is one of the fastest-growing waste streams that is currently generated. Solid waste is a threatening issue, but e-waste is particularly toxic and urgent. It contains chemicals and materials that if not correctly disposed of are toxic for human health and extremely polluting for the environment.

This research aimed at comprehending the governance and organizational structure and the stakeholders' dynamics in a system adopting the EPR approach. To increase the general comprehension of EPR implementation and e-waste governance, the thesis focused on the governance and management of e-waste and the EPR system, with a case study in Italy.

The governance and the organization of e-waste management were firstly studied through a policy analysis. Linked to this the performances of e-waste collection have been analysed between 2005 and 2020, to assess if the policy intentions were achieved in the performances. In parallel, a stakeholder analysis was performed. The result of this first phase showed that Italy built a complex bureaucratic system to fulfil EPR responsibilities, that are divided among various actors. The political sector appears quite lacking compared to the business sector that is efficient and technologically advances. The EPR implementation positively influenced the collection rate, efficiency, and recycling rates. However, the performances did not meet the European target and different areas need to be improved. To identify these areas, the strengths and weaknesses of the Italian system were assessed through a framework with 4 categories and 21 indicators. The framework was based on the study of the strength and weaknesses of the EPR systems and the success factors and implementations barriers for efficient e-waste management. Considering that Italy is vulnerable to criminal activities, a set of indicators to test the vulnerability of the system to criminality were added to the assessment framework. The analysis showed the main weaknesses relates to a legislation and regulation system, weak control and inspection mechanisms, a strong presence of the informal sector and free riders. Lastly, the ERP system implemented in Italy, as in many other countries, does not contribute significantly to the achievement of the eco-design goal.

## Table of content

List of abbreviations .....	6
<b>1. Introduction .....</b>	<b>7</b>
1.1 Electronic and Electric Waste .....	7
1.2 Social and scientific relevance .....	8
1.3 Research Aim and Research Questions .....	8
<b>2. Theoretical Background .....</b>	<b>10</b>
2.1 Environmental Governance .....	10
2.2 Extended Producer Responsibility (EPR) historical roots .....	11
2.3 E-waste governance in the European Union .....	12
2.4 Empirical Background .....	14
2.5 Theoretical framework .....	15
2.5.1 Strength and weaknesses of the Extended Producer Responsibility .....	15
2.5.2 Success conditions and implementations barriers in e-waste governance .....	16
2.5.3 Vulnerability to illegal and harmful procedures .....	17
2.6 Conceptual and Analytical Framework .....	18
<b>3. Methodology .....</b>	<b>22</b>
3.1 Research Framework .....	22
3.2 Methodology overview for each research phase .....	22
3.3 Policy & Performance Analysis .....	23
3.4 Stakeholder Analysis .....	24
3.5 Strength and Weaknesses Assessment & Points of Improvements .....	26
<b>4. Results .....</b>	<b>31</b>
4.1 Italian e-waste system .....	31
4.1.1 Policy Analysis .....	31
4.1.2 EPR responsibilities allocation and Stakeholder analysis .....	41
4.1.3 Performances .....	47
4.2 Assessment Italian e-waste management and governance system .....	49
4.2.1 Assessment of the first category: EPR System .....	49
4.2.2 Assessment of the second category: Policy and Regulation System .....	51
4.2.3 Assessment of the third category: Stakeholders .....	53
4.2.4 Assessment of the fourth category: Infrastructure .....	54
<b>5. Discussion .....</b>	<b>56</b>
5.1 Governance of e-waste management in Italy .....	56
5.2 Assessment of the Italian system .....	57
5.3 Possible Improvements of the Italian System .....	59

5.4 Theoretical Reflection.....	60
<b>6. Limitation and Recommendation for Future Research .....</b>	<b>62</b>
<b>7. Conclusion .....</b>	<b>64</b>
Appendixes .....	66
References.....	66

## List of Figures

<b>Figure 1:</b> Conceptual framework.....	19
<b>Figure 2:</b> Research framework .....	22
<b>Figure 3:</b> Hierarchy of Italian legislative system.....	31
<b>Figure 4:</b> Evolution of the actors and targets and policies regarding e-waste in Italy.....	32
<b>Figure 5:</b> Stakeholders' interactions and EPR responsibilities along the life cycle of EEE.....	44
<b>Figure 6:</b> Performance collection of e-waste in Italy expressed in kg pro capita between the years 2005 and 2015.....	47
<b>Figure 7:</b> Performance collection of e-waste in Italy expressed in kg pro capita between the years 2016 and 2020.....	48

## List of Tables

<b>Table 1:</b> Main Dimensions and Features in the Modes of Environmental Governance Framework (Driessen et al., 2012, p. 148) .....	11
<b>Table 2:</b> Main strengths and weaknesses of the EPR system. Retrieved from Vermeulen & Campbell-Johnston (2021) .....	15
<b>Table 3:</b> Successful factors for successful e-waste management. Retrieved from Borner & Hegger (2018).....	16
<b>Table 4:</b> Main Barriers in e-waste governance. Retrieved from Kumar & Dixit (2018).....	17
<b>Table 5:</b> Challenges for e-waste management. Adapted from Bisschop (2014).....	18
<b>Table 6:</b> Analytical framework for the Assessment of the Italian system.....	20
<b>Table 7:</b> Overview of the research methodologies.....	23
<b>Table 8:</b> List of stakeholders interviewed, the category of actor they belong to, the type of interview and the date.....	24
<b>Table 9:</b> Top 5 provinces in Italy in 2020 according to their performances of collection pro capita (data from CdCRAEE) .....	25
<b>Table 10:</b> Bottom 5 provinces in Italy in 2020 according to their performances of collection pro capita (data from CdCRAEE).....	25
<b>Table 11:</b> Graphic representation of the Provinces and Regions considered for the research and their location on the Italian Map. ....	25
<b>Table 12:</b> Analytical framework for the second phase of the research. Adapted and revised from Bisschop (2014); Borner & Hegger (2018); Corsini et al., (2017); Driessen et al., (2012) Kumar & Dixit (2018); Vermeulen & Campbell-Johnston (2021); Watkins et al., (2017).....	28
<b>Table 13:</b> Differences in reported e-waste collection data between ISPRA and CdCRAEE.....	40
<b>Table 14:</b> Organizational, economic, and informative responsibilities in Italy divided by stakeholders.....	42
<b>Table 15:</b> Dataset from ISPRA and CdCRAEE regarding Italian collection performances in the timespan 2005-2020. Retrieved from ISPRA and CdCRAEE.....	47
<b>Table 16:</b> Analytical Framework first category: EPR System. ....	49
<b>Table 17:</b> Percentage of recycled e-waste divided by group (ERION, 2021; ECODOM, 2020) .....	50
<b>Table 18:</b> Analytical Framework second category: Policy and regulation system.....	51
<b>Table 19:</b> Analytical Framework third category: Stakeholders.....	53
<b>Table 20:</b> Analytical Framework fourth category: Infrastructure.....	54
<b>Table 21:</b> Summary of perceived issues identified through the analysis.....	55

## List of abbreviations

**ANCI** Associazioni nazionale comuni italiani (National association of the Italian municipalities, in Italian)

**ARPA** Agenzie regionali per la protezione dell'ambiente (Regional agencies in protection of the environment, in Italian)

**CdCRAEE** Centro di Coordinamento Rifiuti Apparecchiature Elettriche e Elettroniche (centre for e-waste in Italian)

**EEE** Electrical and electronic equipment

**E-waste** Electrical and electronic waste (abbreviation adopted in the thesis)

**EPR** Extended Producer responsibility

**EU** European Union

**ISPRA** Istituto Superiore Per la Ricerca Ambientale (National Institute for the research and in the protection of the environment, in Italian)

**ISTAT** Istituto Nazionale di Statistica (National Institute for Statistics, in Italian)

**OECD** Organization for Economic Cooperation and Development

**PRO** Producer Responsibility Organization

**RAEE** Rifiuti e Apparecchiature Elettriche e Elettroniche (e-waste in Italian)

**RoHS** Restriction of the use of certain hazardous substances

**WEEE** Waste Electrical and Electronic Equipment

**SISTRI** Sistema di controllo della tracciabilità dei rifiuti (System for the control and traceability of waste, in Italian)

## 1. Introduction

### 1.1 *Electronic and Electric Waste.*

Solid waste is one of the most threatening issues that the current generations and the environment is facing. Globally, 2.01 billion tonnes of municipal solid waste are generated every year and it is expected to reach 3.40 billion tonnes annually by 2050 (Statista). It is a direct consequence of the linear economy model, based on the “take-make-consume-throw” production and consumption model (European Parliament, 2021a). If not properly managed, waste causes many environmental and health problems. It can contaminate soil and water, can cause marine and air pollution and odour and littering problems (INTOSAI WGEA, 2016). In addition, improper waste management can severely affect people’s living conditions: contaminated soil and water and polluted air are threatening to human health and the methane gases produced by waste are also contributing to climate change (European Environmental Agency, 2014; Singh, 2019).

Among all, electronic and electrical waste (e-waste) is one of the fastest-growing and most dangerous wastes currently generated (Zeng et al., 2015). E-waste is the waste caused by the disposal of electrical and electronic equipment (EEE), defined by the European Union (EU) as: “dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1 500 volts for direct current” (Directive 2012/19/EU, 2012, p.6). E-waste is labelled as hazardous waste because it contains some components (chemicals, metals, etc) that if incorrectly disposed can be extremely toxic for human health and harmful to the environment (Bisschop, 2014). In 2019, 53.6 million metric tonnes of e-waste were produced globally, totalling 7.3 kg per inhabitant (Statista). In Europe, 12 metric tonnes corresponding to 16.2 kg per inhabitant were generated in 2019, of which only 5.1 metric tonnes were collected and properly recycled (Forti et al., 2020). This issue becomes even more problematic when considering that most of the dismantling is delocalized in countries of the Global South where the end-of-life practices are not adequate to protect people and the environment (Bisschop, 2012).

In the EU, various policies and directives have been developed since the early 2000s regarding e-waste management. In 2003, the RoHS (Restriction of the use of certain hazardous substances) and in 2002, the WEEE (Waste electrical and electric equipment) Directive were made specifically to control the hazardousness of e-waste and consequently the need for correct disposal. In addition, the WEEE directive introduced a new principle, the Extended Producer Responsibility (EPR) that shifts the responsibility of the end-of-life treatments from the consumer to the producer (Sachs, 2006). The EPR is implemented through organizational, economic, and informative instruments to achieve higher collection rates, increase recycling and promoting eco-design (Lindhqvist, 2000).

Even though the EPR principle is voluntarily adopted to deal with some type of waste, it is mandatory for e-waste management in the European Union (European Commission, 2019). However, some freedom has been left to the Member States to implement EPR for e-waste with their specific organizational structure. Considering this, the starting point of this research was the willingness to increase the understanding of the governance and management of e-waste and the implementation of EPR. To do so, conducting a case study, in Italy, was considered the most suitable choice to have a deep understanding of the issue in its context (Yin, 2009).

Italy is the biggest producer of e-waste in Southern Europe, with 1063 kilotons of e-waste generated in 2019 (17,5 kg per capita) of which only 369 kilotons are recycled (34,7% compared to an average of 43% in the EU) (Forti et al., 2020). Like many other countries, Italy has taken a specific approach to deal with e-waste but most of the studies has focused on the economic impact of EPR or the technical performances (see Section 2.3). The governance, the policy implemented, and the actors involved were partially and not recently investigated. Little attention has also been given to an overview of the EPR implementation and whether the system adopted contributed to the achievement of the EPR goals and better e-waste governance and

management. This would also partially contribute to the general discourse on the influence of governance on the efficiency and effectiveness of EPR policies that, according to Hickle (2014), is still under-researched.

### *1.2 Social and scientific relevance*

The exponential growth of waste has threatening burdens for both society and the environment and managing correctly waste is essential. In 2016, 1.6 billion tonnes of carbon dioxide equivalent greenhouse gas emissions (CO<sub>2</sub> -equivalent) were linked to solid waste disposal, counting for 5% of all emissions. This number is expected to become 2.6 billion tonnes in 2050. (Kaza et al., 2018). Additionally to the health threat, the improper disposal of waste is an incredible loss of resources, materials, and energy (Eurostat, 2019). The e-waste contains common and precious metals, but also chemical elements that are considered critical raw materials because of their scarcity and high demand from the industrial sector (Marra et al., 2019). However, only a low percentage of metals are recycled (Marra et al., 2019) even though many base metals can be recovered to over 90% while precious metals can be recovered to an extent of 97-98% (Huisman, 2003 as cited in Khetriwal et al., 2009).

Both the EU and the United Nations have outlined specific goals regarding e-waste. The most recent European directive on e-waste established ambitious goals in various categories, especially for the collection rate, which is set to 65% of EEE placed on the market or 85% of e-waste generated by the Member states (Directive 2012/19/EU, 2012). In addition, different Sustainable Development Goals mentions e-waste and have concrete goals towards better and safer management. For example, indicator 12.4.2 focuses on the treatment of waste, generation of hazardous waste and its management and indicator 11.6.1 that analyses solid waste and its management. (Forti et al., 2020)

The issues related to e-waste and the knowledge gap identified exemplify the reasons why research on the governance and the management of e-waste are still needed. A case study in Italy was considered a good starting point to fill, at least partially, the knowledge gap. The comprehension of governance structure, stakeholders' dynamics, and the EPR system could contribute to the amelioration of the Italian system and increase the general comprehension of EPR implementation and e-waste governance.

### *1.3 Research Aim and Research Questions*

This research aimed to increase the organizational understand of EPR implementation in the context of e-waste in Italy. Considering the knowledge gap, the thesis focuses on first exploring the governance and of the stakeholders involved, and second, assessing the points of strength and weaknesses to provide some recommendations for improvements. Therefore, the thesis aimed at replying to the following research questions:

*RQs: How is the governance for electronic and electrical waste management currently organized in Italy?  
And what are the possible options for improvement?*

The following sub-question guided the research.

*Sub RQ1: What is the current legislative corpus regarding e-waste in Italy?*

The first sub-question supported the understanding of which laws and decrees are in place and how the Italian legislative system incorporated the e-waste and EPR related EU directives. Based on this, this first phase aimed at understanding if the policies implemented resulted in improved performances in terms of EPR goals. This analysis supported also the research for the stakeholders' analysis.

*Sub RQ2: Which are the stakeholders involved and what are their roles, responsibilities, and interconnection between them?*

The second sub-question focused on the stakeholders involved, from the private and public sectors, exploring the possible involvement of criminality in e-waste management. The goal of this phase was to have a clear

understanding of which stakeholders are involved, their interaction and how the different responsibilities are allocated.

*Sub RQ3: What are the points of strength and weaknesses of the current system?*

After the explorative part of this thesis, the third sub-question aimed at assessing the current Italian system, identifying the main strengths and weaknesses.

*Sub RQ4: How can the system be improved?*

Lastly, the fourth sub-questions provided some recommendations for improvements based on the assessment and the stakeholders' inputs.

The thesis is structured as follow. Chapter 2 presents the theoretical background, comprehensive of the theoretical concepts, the empirical context, and the conceptual and analytical framework. Chapter 3 presents and explain the methodology adopted for each phase of the research. Chapter 4 is dedicated to the results and Chapter 5 discuss the results. Lastly Chapter 6 outline the limitation of this research and recommendation for future research and Chapter 7 contains the conclusions. Appendixes can be found after the References chapter.

## 2. Theoretical Background

In the following chapter, the theoretical concepts used for this research are presented and explained. Starting with environmental governance (see Section 2.1), the concept of governance and environmental governance are briefly explained, as well as the Modes of Governance Framework by Driessen et al. (2012). After, an explanation of the EPR (see Section 2.2) is provided and a brief overview of the main directives presents the e-waste governance in Europe is presented (see Section 2.3). Next, the empirical background (see Section 2.4) frames the research context and outlines the knowledge gap. Lastly, the theoretical framework (see Section 2.5) explains the theories and concepts adopted by this research, which are elaborated in the conceptual and analytical framework (see Section 2.6).

### 2.1 Environmental Governance

Governance is a complex concept that has often been misunderstood and associated only with government, that it is “the authority or function of governing” (Fasenfest, 2020, p.771). The Commission on Global Governance (1995) defines governance as the process in which individual and institutions overcome their different interests or needs and cooperate to manage their common affair. Considering the broad application of governance, for this research the concept has been narrowed to focus on environmental governance, defined as “ the set of regulatory processes, mechanisms and organizations through which political actors influence environmental action and outcome” (Lemos & Agrawal, 2006, p.298). Governance, by definition, maximizes citizens wellbeing, not exclusively via government intervention, but through the collaboration in different system as civil society, private sectors, not-for-profit entities (Keping, 2017; Lemos & Agrawal, 2006).

In the environmental field, the concept of governance is fundamental, as deeply involved in the transformation towards sustainability (Patterson et al., 2017) Especially in this context, Governance embraces a dynamic and interactive nature. The monopoly of the public sector has been abandoned for a more interactive process based on collaboration between different actors from the state, the markets, and the civil society (Driessen et al., 2012). To analyse the different modes of environmental governance, Driessen et al., (2012) developed a framework starting from the interaction between the state, the markets, and the civil society. The different combination of these three actors determines five different types of governance. When the state is recognized as a prominent role, governance can be *centralized* or *decentralized*. Alternatively, the triad state-market-society is defined as *public-private* governance when market and society collaborate more between them, or *interactive* when all actors collaborate equally. Lastly, when market and civil society are more dominant, the governance type is labelled as *self-governance*. (Driessen et al., 2012)

To analyse the governance structures, the institutional relations and the policy content concepts are also fundamental. Through an extensive literature review, Driessen et al., (2012) identified 11 features that can be grouped into three main dimensions: actor, institutional, and policy content (*Table 1*).

**Table 1:** Main Dimensions and Features in the Modes of Environmental Governance Framework (Driessen et al., 2012, p. 148)

Main Dimensions	Features
Actor features	Key public actors that initiate the action
	Position of other stakeholders
	Predominant policy level in which actors operates
	Formal and/or informal basis of power of the actors
Institutional features	Model of Representation
	Formal and/or informal rules of exchange and interaction
	Mechanism of social interaction
Features concerning policy content	Type of goals pursued
	Policy instruments predominantly used for policy implementation
	Type of knowledge used in all policy phases
	Policies integration

These features were combined with the five modes of governance to create an applicable framework to recognize, understand, and compare different modes and the possible shifts. Each governance mode differs depending on the 11 features: for example, the initiating actors in the centralised governance are the central governmental agencies, while in the interactive one, multiple actors from the government, the private sector and the civil society are the initiating actors (Driessen et al., 2012)

Thus, to comprehend and explain the changes in e-waste management, ‘governance’ is an appropriate perspective that can explain and illustrate the differences in stakeholders’ involvement, policy content and institutional relations (Borner & Hegger, 2018). In this discourse, the framework of Driessen et al., 2012 is particularly relevant because it allows a meaningful analysis of the shift in environmental governance. Hence, applying this framework in this research also allows a critical assessment of the current situation, opening the debate for possible improvement. (Driessen et al., 2012).

### 2.2 Extended Producer Responsibility (EPR) historical roots

The EPR is a policy strategy introduced by Thomas Lindhqvist in 1990 in a report to the Swedish Ministry of the Environment. EPR is formally defined as “an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling, and final disposal of the product” (Lindhqvist, 2000 p.9).

Initially introduced in different countries such as Germany, Sweden, and Denmark, the EPR was based on the “polluter pays principle” which was supposed to prevent waste while encouraging eco-design and proper disposal of waste (Vermeulen et al., 2021). The concept was later adopted in the 1990s by the European Union in waste management legislation as a tool for recovery and recycling specific streams. Later, the EPR became mandatory for the end-of-life disposal of vehicles, batteries, accumulators, tyres, and e-waste (Campbell-Johnston et al., 2020). In addition to these streams, some countries also apply the EPR system to used oils, textiles, medicines, furniture, etc. (Monier et al., 2014)

The EPR is implemented through organizational, economic, and informative instruments and has the goal of contributing to three primary environmental objectives: a proper organization that leads to a high collection rate, increasing recycling and promoting the adoption of the principle of design for the environment along the entire life cycle of the product (Lindhqvist, 2000). There are numerous policy instruments through which the EPR can be implemented, and the OECD (2005) has grouped under 4 main categories:

1. *Product take-back requirements* that allocate the end-of-life management responsibility to producers or retailers.
2. *Economic and market-based instruments* that can assume the form of deposit-refund policies, advanced disposal fees, material taxes or upstream combination of tax and subsidies.

3. *Regulations and performance standards* that can be mandatory (as a minimum recycled content) or voluntarily adopted by industries in developing their products
4. *Information-based instruments* as awareness and educational campaigns or informative product labels.

In the European application, the EPR is especially focused on product take-back systems, allocated to business actors that are responsible for the organizational, financial and informational duties (Vermeulen et al., 2021). These can be fulfilled voluntarily or collectively through a Producer Responsibility Organization (PRO), an organization of companies that take the organizational responsibility of EPR from its member, ensuring the correct management and disposal of waste (Khatriwal et al., 2009). The PROs organize the collection and the treatment of waste in collaboration with the national governments, which are responsible for establishing the legal framework and the recycling targets (Vermeulen et al., 2021). EPR is considered a pivotal instrument in considering the environmental externalities in the entire products life and a major policy tool in support of the European Waste hierarchy implementation. In addition, coupled with other economic and legislative tools, EPR is also a strong instrument for encouraging behavioural changes of all actors involved, from producers to retailers and consumers, from the government to municipalities. (Monier et al., 2014)

Under the EPR system, various governance models and structures have been implemented and various responsibilities have been allocated between public and private actors (Hickle, 2014). Many authors have labelled the EPR as a hybrid system, a mixed governance structure between private and public sectors with different sets of responsibilities between producers, retailers, Producers Responsibilities Organizations (PROs), and the different government authorities involved in waste management (Hickle, 2014; Borner & Hegger, 2018). The OECD outlines 4 different EPR models based on the allocation of responsibilities (OECD, 2016 as cited in Vermeulen & Campbell-Johnston, 2021):

1. One single PRO with commercial and/or municipal collection and processing services
2. Multiple PROs with the clearinghouse and commercial and/or municipal collection and processing services
3. Governance structure for tradable credits system
4. Government-run EPR system

Through the comprehension of the type of governance structure and the responsibilities allocation, it is possible to understand the policy intents, as a mirror of the political situation in which EPR has been developed (Hickle, 2014). Therefore, the governance lens allows deriving meaningful recommendations for improving e-waste governance and EPR implementation (Borner & Hegger, 2018), especially considering that the influence of governance on the efficiency and effectiveness of EPR policies is still under-investigated (Hickle, 2014). In addition, the knowledge around EPR could increase with the study of formal and informal actors that benefits from the system and the policies and infrastructures put in place (Evans & Vermeulen, 2021).

### *2.3 E-waste governance in the European Union*

Considering the rapid and constant growth of e-waste, the proper governance and safe management of e-waste are essential. The European Union has been a front-runner in developing policies and directives for dealing with e-waste in the safest, cleanest and most circular approach possible (Khatriwal et al., 2009). In this section, a brief overview of the European Directives implemented in the last 20 years is presented to outline the current management and policies implemented.

In the early 2000s, three directives were published for the management of e-waste. Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment had the scope of protecting human health and the environment from the dangerous disposal of e-waste. Article 4

stated that from 1<sup>st</sup> July 2006, new electrical and electronic equipment will not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls or polybrominated diphenyl ethers. Directive 2002/96/EC on waste electrical and electronic equipment took a more holistic approach to e-waste, prioritizing the prevention, reuse, recycling, recovery and reducing to the disposal. Nevertheless, the directive also strived for a safer and improved management of e-waste, involving all stakeholders along the entire supply chain. The directive adopted the EPR as the guiding principle, recommending the Member States to (1) encourage a design of equipment that would facilitate the dismantling, recovery, reuse and recycle; (2) increase the separate collection of e-waste setting up a system with distributors that allow consumers to bring back their e-waste free of charge when buying a new product; (3) assure that producers, individually or collectively, set up systems to treat e-waste in the most advanced techniques for treatments, recovery and recycling. This Directive put a minimum collection rate target of 4 kg on average of household e-waste collected per inhabitant per year, to be achieved from 31<sup>st</sup>, December 2006. Lastly, Directive 2002/96/EC covers the EEE divided into 10 categories:

1. Large household appliances
2. Small household appliances
3. IT and telecommunication equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools (except for large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (except for all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers.

European Directive 2006/12/EC and Directive 2008/98/EC established the framework and the key concepts for handling waste in the European Union. The concepts of waste and waste management, collection, re-use, recycle, recovery and disposal were defined, as well as increasing the measures for waste prevention along the entire life cycle of products. The waste hierarchy and the polluter-pays principles are the guidelines adopted for handling waste in a safe way for both people and the environment. In Directive 2008/98/EC the EPR principle is strengthened again, defining the requirements for Member States that are responsible for implementing the legislative and non-legislative measures to enforce EPR. The costs of waste management must be covered by the original producer, defined as “any natural or legal person who professionally develops, manufactures, processes, treats, sells or imports products” (Article 8). Lastly, a minimum target for preparing waste for reuse and recycle is set at 50% of the waste weight.

Directive 2012/19/EU updated Directive 2002/96/EC and Directive 2008/98/EC and strengthened the above-mentioned concepts of waste management in protection of human health and the environment, waste hierarchy, and EPR. In particular, Directive 2012/19/EU intended to contribute to sustainable production and consumption prioritizing of prevention of e-waste through eco-design requirements for products. These requirements are part of the EPR strategy and are finalized to facilitate repair, reuse, dismantling, upgrading, disassembly, recovery and recycling of EEE. In addition, the EU set new ambitious collection and recovery targets. From 2016, Member State should achieve a minimum collection rate of 45% calculated on the total weight of e-waste collected, expressed as a percentage of the average weight of EEE placed in the market in the preceding years. The percentages need to increase between 2016 and 2019, achieving a collection rate of 85% of e-waste generated, equivalent to a collection rate of 65% of the average weight of EEE put on the market in the 3 preceding years. Specific recovery targets are set for each category of e-waste and are listed in Appendix 2. Lastly, this directive recognizes the fundamental importance of informing users and consumers of the proper disposal of e-waste and therefore, the Member States should actively educate their citizens. Some articles from Directive 2012/19/EU have been amended with Directive 2018/894 that (1) details the

procedure for Member States to report data concerning e-waste targets to the EU and (2) encourages Member State to use economic instruments and other tools to incentivize the application of the waste hierarchy.

#### 2.4 Empirical Background

The following section presents a synthetic literature review, functional to understand the current body of knowledge of the Italian EPR system and e-waste management. This establishes the starting point of the research and allows a better framing of the knowledge gap that this thesis aimed to (at least partially) fill. To frame the empirical background, 8 articles were considered fundamental, selected in a 16 years' timespan literature since the first introduction of the EPR system in Italy for e-waste in 2005 with Legislative Decree 151 (Favot et al., 2018). *Appendix 1* presents a more in-depth analysis of the most relevant articles for this research.

In Italy, the EPR duties of producers are fulfilled by 17 collective schemes (in 2015) that are coordinated by a national clearinghouse<sup>1</sup> (Favot, 2015). The physical responsibility is fulfilled by the collective systems that collecting e-waste for the producers (Favot, 2015), and municipalities set up the collection points (Cahill et al., 2010). The economic responsibilities are shared among distributors, municipalities, and producers (Cahill et al., 2010) and the producers pay the collective scheme to cover the costs of treatments and logistics (Favot, 2015). The informative responsibilities are on the clearinghouse that shares knowledge and research with all the collective systems in Italy (Favot, 2015).

Concerning the technical performances, between 2009 and 2014 the target of 4 kg per inhabitant of collected e-waste was nearly achieved (Favot et al., 2016) and various factors influenced the collection. The territorial differences deeply influence the performances that are positive in the North of Italy and generally negative in the South, also affected by the lack of an established collection system (Isernia et al., 2018; Favot & Grassetti 2017). Gender is another factor that affects the collection results, whether to a higher concentration of female population corresponds a higher collection rate (Favot & Grassetti, 2017). Regarding the economic performances, between 2009 and 2014 the production costs decreased by more than 35% (Favot et al., 2016). Fees paid by producers in terms of sales revenues decreased, showing a ratio of 0,50% in 2009 and 0,38% in 2014 but it could increase again with the new collection rate targets established by the European Union (collection of 85% of e-waste generated) (Favot et al., 2018). Nevertheless, after the introduction of the WEE Directive, the prices of products increased on an average of 2,19% among the 6 categories of EEE (Favot & Marini, 2013). The only information regarding institutions and governance of e-waste and EPR in Italy comes from Favot (2014) that performed a literature review on EPR for e-waste applying the New Institutional Economics framework. The article showed that the institutions play a fundamental role in dealing with e-waste externalities and the EPR implementation contributes to changing property rights, moving the responsibilities onto the producer (Favot, 2014).

Recent studies have shown that Italy is the biggest producer of e-waste in Southern Europe. In 2019, 1063 kt of e-waste has been produced of which only the 34,7% (369 kt) are known to be collected and recycled, a lower collection rate compared to an average of 43% in Europe (Forti et al., 2020). In Italy, 35% of e-waste generated do not arrive at authorised or legal treatment plants, corresponding to 42% of all EEE put on the market (Baldé et al., 2020). One of the most significant problems lies in the control and reporting system, where different sources present different data and information about collection and recycling (Forti et al., 2020). A similar weakness was also identified by Favot et al., (2016) that identified a lack of transparency and data, especially on costs, as one of the main limitations of research on the Italian EPR system. A weak control system also allows the development of unauthorized collectors systems, that unofficially manages e-waste, negatively affecting the whole system (Baldé et al., 2020).

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<sup>1</sup> "A third-party central agency or corporation acting as a regulator for a competitive market" (Monier et al., 2014, p. 6)

## 2.5 Theoretical framework

Having reviewed the past 16 years of literature regarding Italy, it is clear that the focus was primarily on the economic side of e-waste management and performances. Little attention has been given to organizational understanding and the interactions between all the actors involved. Also missing is an updated overview of the system, and how the policies currently put in place are contributing to the achievement of the targets set by the European Union. Therefore, this thesis studied, first, the specific configuration of the EPR organizational, economic, and informative instruments that characterize e-waste governance and management put in place in Italy. Second, the research evaluated the capacity of the specific Italian EPR and e-waste governance policies configuration to be effective measures for achieving the policy intentions and assessing the strengths and weaknesses of the system. To do so, some fundamental concepts are adopted and customized to later be explored and assessed in the Italian context. These theoretical concepts are presented in Section 2.5.1, 2.5.2, 2.5.3 and then elaborated in Section 2.4.

### 2.5.1 Strength and weaknesses of the Extended Producer Responsibility

EPR is considered a pivotal instrument for waste management, which encourages the prevention, reuse, and recycling of materials, as well as incentivising the involvement of all actors (Monier et al., 2014). However, during the last almost 20 years of implementation of EPR for e-waste, various researchers have highlighted its advantages and its limitation. *Table 2* provides a detailed summary made by Vermeulen & Campbell-Johnston (2021) of the strength and weaknesses, divided by its three main focuses of EPR schemes: organizing recycling, efficiency, stimulating eco-design.

**Table 2:** Main strengths and weaknesses of the EPR system. Retrieved from Vermeulen & Campbell-Johnston (2021)

	Strengths	Weaknesses
Organising recycling	EPR schemes do divert waste streams from landfilling or incineration to forms of material recycling, which leads to environmental benefits <sup>3, 4, 7, 8</sup> National / EU targets are met in frontrunning countries <sup>8</sup> Using industry's managerial capacity to organise recycling markets <sup>2, 7</sup>	Targets are not met everywhere Responsibility for recycling beyond the targeted collection rates not taken (non-separated waste, littering, orphans) <sup>5</sup> Recycling process choices need to be based on better assessments <sup>4, 5, 8</sup> EPR promotes material recycling over re-use and other R-options <sup>1, 8</sup> Targets and standards are not harmonized and weakly enforced <sup>3</sup> Exports of waste to low-income countries prevail <sup>3, 5</sup>
Efficiency	Low operation costs (2% to 0,1% of product price), but data incomplete <sup>2, 8</sup> (Favot, Veit and Massarutto, 2018) Higher volume of materials collected in collective EPRs enable more efficient recycling technology <sup>2</sup> In practice both competing and single PROs exist in different countries, views on which is most efficient are contested <sup>3</sup>	Voluntary PROs face freeriding <sup>4, 6</sup> The level of costs of recycling allocated to producers differs strongly between countries <sup>2</sup> Data collection and sharing is weak, due to cost avoidance <sup>1, 4, 5</sup> In case recycling is profitable, recycling processors compete with collective systems, cherry-picking the easy gains <sup>3, 4</sup>
Stimulating eco-design		Low impact on eco-design <sup>3, 4, 8</sup> Weak incentives on eco-design, fee systems ignore eco-design efforts <sup>1, 2, 3, 5, 8</sup> The lack of harmonized legislation hinders impacts on product design <sup>3</sup>

1 = (Lifset, Atasu and Tojo, 2013); 2 = (Massarutto, 2014); 3 = (Kunz, Mayers and Van Wassenhove, 2018); 4 = (Atasu, 2019), 5 = (Kalimo et al., 2015), 6 = (Hermann, Gailhofer and Schomerus, 2020), 7 = (Shan and Yang, 2020); 8 = (Campbell-Johnston et al., 2021)

Other factors that influence the application of the EPR schemes are strong coordination between EPR and e-waste policies (Corsini et al., 2017); clear responsibilities' division among all stakeholders along the product chain (Corsini et al., 2017; Monier et al., 2014); clear and transparent legal and economic framework

(Campbell-Johnston et al., 2021; Monier et al., 2014); fair competition and a structured surveillance system when applying the EPR schemes (Monier et al., 2014).

These factors are especially crucial in Italy, where an updated overview of the EPR scheme applied for e-waste is missing. It is still unclear which are the responsibilities of the various actors, the complete economic framework and especially the legal framework in place. In addition, a strong management and control system is lacking, leaving freedom to wrongful and unauthorized management. (Baldé et al., 2020; Favot et al., 2016; Forti et al., 2020:). Therefore, the various aspects of the EPR scheme presented in this section were used as a guideline for conducting the initial exploratory research and were later assessed in the Italian system (see Section 2.4).

### 2.5.2 Success conditions and implementations barriers in e-waste governance

To identify the strength and weaknesses of the e-waste governance in Italy, the articles of Borner & Hegger (2018) and Kumar & Dixit (2018) are used to build the analytical framework (see Section 2.4). These articles have been chosen for two main reasons: (1) they both build on an extensive literature review of respectively success conditions and main barriers for successful e-waste management and (2) were published in 2018 and therefore can be labelled as quite recent and representative of the existing knowledge base.

Borner & Hegger (2018) identified the governance characteristics that, if present, can improve the success of e-waste governance and management in systems that implemented the EPR principle. *Table 3* presents the four success conditions and relative indicators as provided by Borner & Hegger (2018)

**Table 3:** Successful factors for successful e-waste management. Retrieved from Borner & Hegger (2018)

Success conditions	Indicators
Inclusions of all stakeholders of WEEE reverse logistics	Consolidation of all relevant actors in an (exchange) forum
Overall strategic collaboration among actors or e-waste reverse logistics	Positive and trustful relationship, aligned waste management strategy
Adequate rule system for the WEEE reverse logistics	Clear allocation of responsibilities and regulations Rule system is adjusted to changes in its environment
Knowledge sharing and appropriate performance measurement for overall WEEE reverse logistics	Willingness to share knowledge and availability of knowledge exchange platforms Appropriate performance measurement and information system

Through literature review and experts' inputs, Kumar & Dixit (2018) were able to identify seven main barriers that prevent successful e-waste management: (1) Policy and Regulatory (2) Infrastructural, (3) Knowledge, (4) Socio-economic, (5) Socio-cultural, (6) Technological, and (7) Financial. Considering the focus of this research on governance structure, only barriers number one, two four and six are instrumental. Barriers three and five are omitted because the consumer habits and knowledge set are out of the scope of this research, as well as barrier seven that has been already explored in previous research. *Table 4* presents in detail the barriers and sub-barriers.

**Table 4:** Main Barriers in e-waste governance. Retrieved from Kumar & Dixit (2018)

Main Barrier Criteria	Sub Barriers Criteria
(1) Policy and Regulatory Barriers	(1.1) Delay in EPR approaches (1.2) Delay in WEEE Law enforcement (1.3) Lack of systematic monitoring and auditing (1.4) Un-defined role of stakeholders (1.5) Lack of RoHS practices (1.6) Lack of policies and regulations addressing environmentally sound WEEE recycling (1.7) Violation of Basel Ban Amendment
(2) Infrastructural Barriers	(2.1) Lack of infrastructure facility (storage, transportation, treatment and disposal technology) (2.2) Limited planning and forecasting of WEEE generation (2.3) Lack of coordination or collaboration between partner
(4) Socio-economic Barriers	(4.1) Competition between formal and informal sector (4.2) Insufficient subsidy and tax system for formal sector (4.3) Deficient e-market deposit refund system initiatives (4.4) Poor safety concern during informal recycling (4.5) Lack of willingness to pay (4.6) Inadequate harmonized system code (4.7) Low recycling penetration and supply of domestic WEEE
(6) Technological Barriers	(6.1) Lack of green recycling practices for handling WEEE issues (6.2) Limited skilled workforce (6.3) Outdated technologies and processes of recycling (6.4) Lack of established standards and certification for WEEE recycling firms (6.5) Lack of biological treatment of WEEE (6.6) Inadequate R&D assistance related to metal recovery (6.7) Lack of flexibility to change over to new practices from the current system

### 2.5.3 Vulnerability to illegal and harmful procedures

Another important aspect to consider when studying Italy and its waste management is the presence of criminality, especially the organized criminality as Mafia, 'Ndrangheta, Camorra and similar. One of the main fields in which organized criminality operates is the waste sector (D'Amato & Zoli, 2010). It has been proven that the presence of the Mafia restricts the capacity of the government of imposing taxes to boost the correct disposal of waste (D'Amato & Zorzi, 2010) but little has been documented regarding the relationship between waste, sustainability, and organized criminality involvement.

A good starting point is the D'Amato et al., (2011) research, which analysed how waste management costs and the presence of crime affect the legal and illegal disposal of waste and recyclable levels. Through an economic model, the authors show that separate collection, recycling, and legal disposal are significantly lower when organized crime is present. Moreover, a stronger presence of organized criminality is directly linked to fewer waste infrastructures and incineration plants and dumping, or illegal disposal is vastly adopted. (D'Amato et al., 2011) Even fewer documents were produced specifically regarding the link between e-waste and organized criminality. In 2018, a Parliamentary Committee of Inquiry on illegal activities connected to the cycle of waste and environmental offences related to them has produced a report regarding the illegal management of waste in Italy or from Italy to other countries. These crimes can be committed not only by organized criminality but also by small economic operators or private actors, underlying how these phenomena are common and distributed in different layers of society. These illegal practices not only contribute to transnational environmental dumping but also affects the national economic sphere that is deprived of valuable materials otherwise intended for recycling. Among others, the document produced by the Parliamentary Committee has presented a relevant case regarding e-waste. The so-called "Freon Operations" (*Operazione Freon* in Italian) in 2013 has discovered an illegal trade of e-waste that was taken from the collection centres and exported to some African countries (as Nigeria or Ivory Coast). The illegal scheme was put in place to favour a parallel disposal system that advantaged all actors in the disposal chain (producers, retailers, installers, distributors, etc) that were not willing to pay for the legal transportations and disposal costs of e-waste. (Braga et al., 2018)

Thus, it is established that Italy is affected by organized criminality and its interest in waste and e-waste. Therefore, to complete the e-waste governance discourse, another lens to identify if and the extent of criminality involvement has been adopted with the article by Bisschop (2014). The author analysed the trade of e-waste from Belgium to Ghana through documents analysis, interviews, and field visits, deriving some general observations and insights. By focusing on the role of state, corporate and civil society, Bisschop (2014) presents an overview of challenges for e-waste management that makes it vulnerable to illegal and harmful procedures. Next to this, the author provided some recommendations or comments on how to avoid some challenges or how to improve the situation. *Table 5* presents the main challenges, the sub-challenges and the recommendations or comments more in detail.

**Table 5:** Challenges for e-waste management. Adapted from Bisschop (2014)

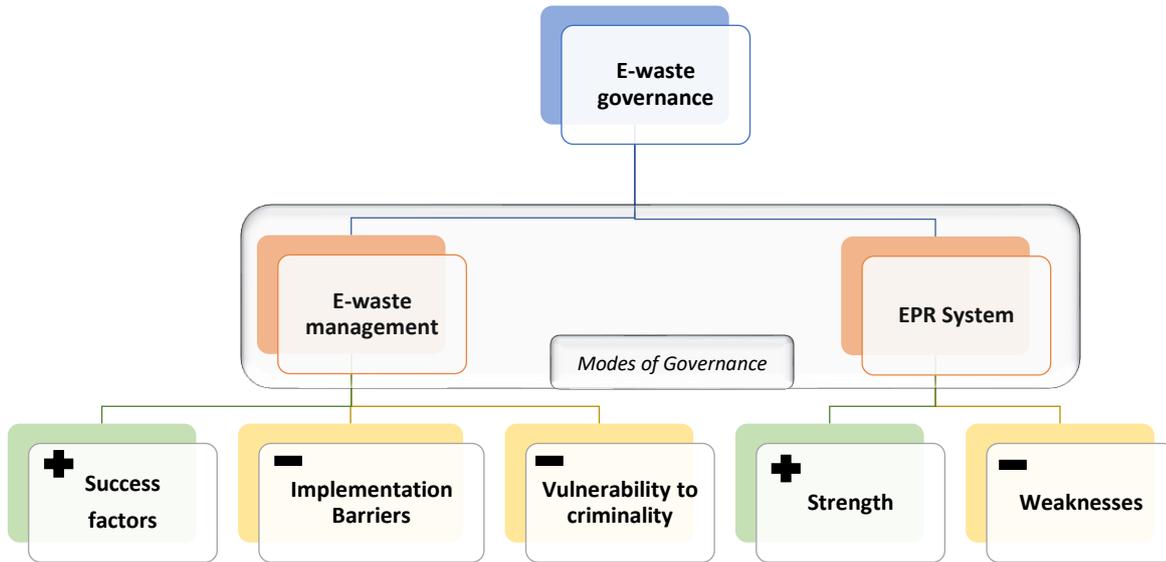
Main Challenges	Sub-Challenges	Recommendations or Comments
Waste as a product and a sector	Price fixing, racketeering and illegal market It is cheaper to dispose of waste with illegal firms or with legal companies that dispose of it incorrectly Companies that process e-waste legally and safely are few and expensive	High standards facilities Strict legislation on waste management and exports Certification schemes Encourage the willingness and support the ability to commit to environmental legislation Comply to EPR
Legal definitions and policymaking	Waste crimes: administrative violations (missing or incomplete documentation) or criminal violations (against laws and bans) Policy frameworks are often interpretable that expose them to criminal practices or wrong implementation. Legislative corpus is not always practical	Ratification of all directives and laws Rely on environmental inspectorates Makes regulations easily applicable and comprehensible
Implementation	Lack of capacity for performing inspections Environmental issues are not primary focus of customs Different implementations of policy among EU member states	Establish an EU environmental agency with inspectorate authority Increase harmonization in laws and fines for nonconformity Increase knowledge and awareness with specific training
Involving local governance actors and interactions between governance actors	Governance of e-waste is government-oriented and lacks cooperation among different sectors Different goals or intentions among stakeholders Illegal transport and disposal of waste is linked to the "organized crime"	Strengthen the role of local-level governance Strengthen cooperation among different actors Increase information exchange Integration of non-government actors as civil society, NGOs, or business Networked and interactive national and international governance Transparency and clear definition of tasks Tracking of illegal waste flows as a tool to increase quantities of raw materials

### 2.6 Conceptual and Analytical Framework

This research was divided into two phases: the first exploratory stage was performed to understand the Italian e-waste situation (replying to sub-questions 1 and 2), while the second part focused on the assessment of the strengths and weaknesses (replying to sub-question 3) and proving some recommendation to improve the Italian system (replying to sub-question 4).

The explorative phase of the research was guided by the Modes of Governance framework (Driessen et al., 2012), focusing on understanding the actor and the policy content dimensions in the Italian System. The Institutional features have been consciously neglected as they are not the main focus of this research. Alongside this framework, the understanding of the fundamental features of EPR also guided the research. The organizational, economic, and informative instruments of the Italian implementation of EPR have been studied, as well as Italian performances for the EPR primary goals, namely high collection rate, increased recycling and stimulation of eco-design (Lindhqvist, 2000).

For the second part of the research, the assessment of the e-waste management and the EPR system in Italy, it was necessary to elaborate on the theories presented in Section 2 to produce an analytical framework. The interactions between the different concepts are presented in *Figure 1*.



**Figure 1:** Conceptual framework

According to the authors, these theoretical concepts (success factors, implementation barriers, vulnerability to criminality of the e-waste management and points of strengths and weaknesses of the EPR System), if present, influence positively (represented with a green box in *Figure 1*) and negatively (represented with a yellow box in *Figure 1*) the overall system. Therefore, these independent variables need to be assessed to understand how they affect the e-waste governance and, eventually, identify the weaknesses of the system. In addition, the modes of governance framework (represented with a transparent box in the background in *Figure 1*) consents to guide the explorative analysis for both the EPR system and e-waste management.

Considering that some concepts presented in the theoretical background are similar among authors, the analytical framework was produced elaborating on these theories in a framework with 4 categories and 21 indicators. *Table 6* presents the categories and indicators.

**Table 6:** Analytical framework for the Assessment of the Italian system

Categories	Indicators
<b>(1) EPR System</b>	(1.1) Proper and on-time implementation of EPR for e-waste
	(1.2) Improve Efficiency
	(1.3) Improve Recycling
	(1.4) Improve Eco-design
<b>(2) Policy and Regulation System</b>	(2.1) Proper implementation and observation of E-waste-related directives
	(2.2) Adequate rule system for e-waste proper treatment
	(2.3) Subsidy or tax system
	(2.4) Presence of planning and forecasting strategies
	(2.5) Monitor and auditing system
	(2.6) Reporting system
<b>(3) Stakeholders</b>	(3.1) Defined role of stakeholders
	(3.2) Inclusion of all stakeholders
	(3.3) Clear allocation of responsibilities for stakeholders
	(3.4) Coordination between stakeholders
	(3.5) Collaboration between stakeholders
	(3.6) Knowledge and expertise exchange system
	(3.7) Competition between formal and informal sector
<b>(4) Infrastructure</b>	(4.1) Skilled workforce
	(4.2) Infrastructures' facilities
	(4.3) Proper and updated technologies for recycling

The first category aims to assess the implementation of the EPR system in Italy and whether it contributes to improving the recycling rate, the efficiency, and the eco-design of EEE products. In addition, Kumar and Dixit (2018) and Bisschop (2014) recognize as an improper and late implementation of the EPR could negatively affect the system. Thus, this aspect is also explored.

The second category focuses on the policy and regulation system. As for the EPR, Kuman and Dixit (2018) and Bisschop (2014) affirms that all e-waste related directive are negatively affected by the improper and late implementation. Secondly, according to Bisschop (2014), an adequate rule system and the presence of planning and forecasting strategies are effective tools to decrease the vulnerability to illegal or harmful practices. In addition, monitor, auditing, and report systems are supporting tools for the proper implementation of regulations and schemes and increase the comprehension and applicability of regulations and laws. These instruments prevent or (at least) decrease the infiltration of criminality or wrongful practices in e-waste management. (Bisschop, 2014; Borner & Hegger, 2018; Monier, 2014). Lastly, Kumar and Dixit (2018) identified the lack of or insufficient subsidy or tax system as one of the socio-economic barriers that affect the e-waste system.

The third category analyses the various aspects of the stakeholders involved. Two main aspects can jeopardize the e-waste governance, namely an unclear definition of role for stakeholders (Kumar & Dixit, 2018; Corsini et al., 2017) and strong competition between formal and informal sectors (Kumar & Dixit, 2018; Bisschop, 2014). On the other hand, the clear allocation of responsibilities among stakeholders, that are coordinated, and collaborative are factors that contribute to the successful implementation of the governance (Borner & Hegger, 2019; Bisschop, 2014; Corsini et al., 2017; Monier et al., 2014). Other important aspects that improve e-waste management are the inclusion of all stakeholders involved in the whole life cycle of EEE products and the presence of a knowledge and expertise exchange system (Borner & Hegger, 2019; Bisschop, 2014)

The last category focuses on the infrastructure. Kumar & Dixit (2018) and Bisschop (2014) identify technology as one of the main barriers to successful e-waste governance. In particular, a limited skilled workforce, and outdated technologies and infrastructures for recycling deeply affect the capacity of a system to treat e-

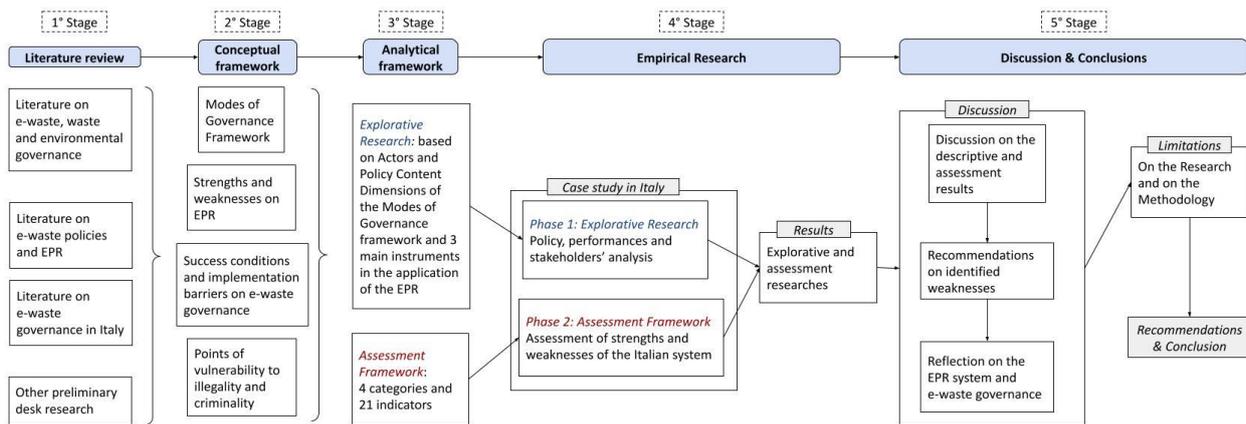
waste most correctly and safely possible (Kumar and Dixit, 2018). In addition, Bisschop (2014) recommends high standards for e-waste treatment facilities, coupled with certification schemes and training for the workforce to improve the treatment of e-waste.

A similar framework was also elaborated by BiPRO GmbH in collaboration with Deloitte for a report commissioned by the European Commission. The WEEE compliance promotion exercise Final Report (Kling et al., 2018) reviewed the 2012 EU WEEE Directive implementation and the e-waste management at the European Union level with the scope of assessing the current capacity of achieving the targets and providing support and guidance. The authors developed a framework with 6 criteria (Implementation of the EPR principle, WEEE prevention, WEEE collection, WEEE treatment, WEEE recovery and recycling/preparation for reuse, Inspection and monitoring system) and 22 sub-criteria. For each sub-criteria, the authors provided an explanation section in which they present a set of specific requirements that if fulfilled could score 1, 2 or 4 points, if not fulfilled would score 0. Considering that this report was not available at the time of the development of the framework, the criteria and sub-criteria were not adopted for this research. Nevertheless, the scoring system is an effective system to assess the fulfilment of the indicators elaborate for this research and thus, a simpler version of this system has been adopted for the assessment phase of this research (see Section 3.5).

### 3. Methodology

#### 3.1 Research Framework

This research aimed to increase the organizational understanding of e-waste governance in Italy by assessing the governance structure, the policy implementation and the actors involved. Considering the goal of this research, a case study research design is the most suitable choice because allows an in-depth, qualitative analysis of a phenomenon in its context (Yin, 2009). Therefore, the thesis will follow the research framework presented in *Figure 2*.



**Figure 2:** Research framework

#### 3.2 Methodology overview for each research phase

The preliminary step of this research was a literature review that has been carried out searching on Scopus or Google Scholar. The keywords used were “Italy”, “electronic and electric waste”, “management” and “governance” or synonyms and/or abbreviations as “e-waste” or “WEEE”. The articles considered fundamental to frame the knowledge gap were 8, selected in a 16 years’ timespan literature review to consider every publication after the introduction of the EPR system in Italy for e-waste in 2005 with Legislative Decree 151 (Favot et al., 2018).

After the identification of the knowledge gap through the literature review, the empirical research was divided into two phases. The first exploratory phase aimed to understand and describe the Italian system in place, the legislative corpus and the stakeholders involved (see Section 3.3 and 3.4). The second phase proceeded in assessing the system through the operationalization of the analytical framework (*Table 12*) and subsequently provided some recommendations for improving the weaknesses identified (see Section 3.5). *Table 8* presents an overview of the methodology, divided by phases, the type of analysis, the required data, and the sources. The research was not a linear process, and the different phases were conducted in parallel. An interactive approach between literature reviews, desk research and interviews was considered the most suitable choice, considering the qualitative nature of this research.

**Table 7:** Overview of the research methodologies

Stage in the Research Framework	Phase of the Research	Research Methods	Type of Data	Source
Stage 1	Identification Knowledge gap and preliminary research	Literature Review and Desk research	Scientific articles, official reports and documents regarding e-waste in Italy	Scopus; Google Scholar.
Stage 4, Phase 1	Analysis of the current legislative corpus and performance in a 15-year timespan	Policy and Performance Analysis	Decreets, official documents, secondary data, and official statistical materials Performances, monitoring, and evaluation reports	Italian Parliament websites (Chamber website and Senate website); Official gazette of the Italian Republic; Statista, Eurostat, ISTAT; ISPRA website; RAEE <sup>3</sup> and CdCRAEE <sup>4</sup> ; Scientific articles.
	Analysis of stakeholders involved, their roles, responsibilities, and interconnections	Stakeholder Analysis	Actors' interviews from Government PROs and clearinghouse Business sector Waste management facilities Academic experts	
Stage 4, Phase 2	Analysis of the points of strength and weaknesses	Assessment of indicators present in the analytical framework in <i>Table 12</i>	Decreets, official documents, secondary data, and official statistical materials Performances, monitoring, and evaluation reports Stakeholders Interviews	Scientific articles; Interviews coding; Documents and reports received from stakeholders; Previously consulted sources in Stage 1 and Stage 4 Phase 1.
	Recommendation for improvements	Identification spheres of improvement and provide recommendations	Outcome previous analysis Literature Input from stakeholders' interviews	

### 3.3 Policy & Performance Analysis

The starting point of this research was a policy and performance analysis. According to the European Law, the policies adopted by the European Union needs to be incorporated and implemented at European Member State level, according to the time and the modes specified in the European directives. Therefore, to evaluate the implementation at the Italian level of the different directives regarding e-waste, it has been verified if the legislative corpus contains these laws and decrees. Firstly, it has been checked if all European directives were implemented in the Italian law system, within the required (or expected) time. To be fully operative, the European directives are implemented in the Italian legislation system through Legislative or Ministerial Decrees (*Decreti Attuativi* or *Decreti Legge* or *Decreti Ministeriali* in Italian). Thus, the presence of these decrees has been verified. Secondly, it has been investigated which conditions and specifications are required from the Italian law, if they correspond to the European one and if they are sufficiently clear to properly implement e-waste management and EPR. The translation has not been judged, but it has been analysed the clarity of the laws and the choice of certain terminology that has an impact on the reception of the directives.

In parallel, the performances were analysed. Firstly, through the reports published by the CdCRAEE (the Italian clearinghouse for e-waste), all data regarding the collection of e-waste were collected since 2005 (the oldest report available). Secondly, the data were analysed to understand if the introduction of the different decrees has impacted the collection rate and the recycling rates. The performance analysis was also functional to the choice of some Italian regions and provinces to study. Preliminary research showed that provinces are responsible for planning and organizing the collection of e-waste in Italy. Therefore, the study of at least 1 province of the top performers and 1 province of the bottom performers would have supported

<sup>3</sup> RAEE stands for *Rifiuti e Apparecchiature Elettriche e Elettroniche*, e-waste in Italian

<sup>4</sup> CdCRAEE stands for *Centro di Coordinamento Rifiuti Apparecchiature Elettriche e Elettroniche*, centre for e-waste in Italian

the understanding of strengths and weaknesses of the Italian System and clarified whether the differences between the North and South of Italy are still in place.

### 3.4 Stakeholder Analysis

A stakeholder analysis was performed to understand the organization of e-waste management in Italy and which actors are involved in the management of its e-waste.

To identify the stakeholders, a preliminary list of actors was produced through desk research, based on the policy analysis, or identified via a Google search with “e-waste management in Italy” and similar as keywords, both in English and in Italian (“*gestione rifiuti elettrici e elettronici*” or “*gestione RAEE*” in Italian). Other stakeholders were identified through snowballing or chain sampling, which permits to “accesses informants through contact information that is provided by other informants” (Noy, 2008, p.330). To do so, during the interviews with the stakeholders, it was asked if there are other actors involved and how it would have been possible to contact them. This strategy has been carried out until all actors (or at least, main actors or group of actors) involved in e-waste management were reached. *Table 8* presents an overview of the stakeholder contacted, the category of actor they belong to, their role, the type of interview and the date. The interview code is added to reference synthetically the information of the interviews in the Results and Discussion sections.

**Table 8:** List of stakeholders interviewed, the category of actor they belong to, the type of interview and the date.

<i>Stakeholder</i>	<i>Category</i>	<i>Role</i>	<i>Type of Interview</i>	<i>Date</i>	<i>Interview Code</i>
Fabrizio Longoni	Clearinghouse	General Directive	Online interview	22/04/2021	CL1
Luca Campadello and Filippo Stringa	ERION	Project Innovation Manager and Project Innovation Specialist	Online interview	12/05/2021, 19/07/2021	BS1
Anonymous responder	ECOEM	Employees	Email exchange	7/05/2021	BS2
Dr Marinella Favot	Academia	Academic Researcher	Email exchange	11/05/2021	AC1
Simone Birtig and Elena Caprotti	Friuli Venezia Giulia Region	Responsible for the environment section	Online interview	29/04/2021	GOV1
Giovanni Scannicchio and the waste and environmental section of Puglia region.	Puglia Region	Responsible for the environment section	Email exchange	8/06/2021	GOV2
Francesca Marchetti	Latina Province	Responsible for the environment section	Online interview	23/04/2021	GOV3
Antonio Tumminelli	Caltanissetta Province	Responsible for the environment section	Online interview	29/04/2021	GOV4
Francesco Damiano	Manfredonia Municipality	Responsible for waste management	Email exchange	9/06/2021	GOV5

The stakeholders contacted were from the national government, in particular from the Ministry for the Ecological Transition, from regions and provinces, from the academic and research institutes, from the PROs and the clearinghouse, from the business sectors, and the waste management facilities. The regions and provinces contacted were chosen based on the pro capita performance of provinces in 2020. This approach was adopted since regions have a formal organizational role, but provinces and municipalities have the management and operational responsibilities. Therefore, provinces were contacted to increase the overall comprehension of e-waste governance, which are the points of strengths, or the problems encountered in managing e-waste at the provincial level. Considering that municipalities in Italy are extremely variegated in size, characteristics, and management, the most suitable choice was contacting the provinces. The reason behind contacting 10 different provinces was to increase the chances of interviewing at least 1 top performer and 1 bottom performer. *Tables 9* and *10* present the top and bottom performers and relative data.

**Table 9:** Top 5 provinces in Italy in 2020 according to their performances of collection pro capita (CdCRAEE, 2021b)

Top 5 Provinces in Italy in 2020			
Province	Collection (kg)	Inhabitants	Pro capita (kg/inh)
Matera	2808499	200012	14,04
Prato	3416967	248292	13,76
Sassari	6080974	482006	12,62
Gorizia	1683145	140650	11,97
Latina	6428907	552090	11,64

**Table 10:** Bottom 5 provinces in Italy in 2020 according to their performances of collection pro capita (CdCRAEE, 2021b)

Bottom 5 Provinces in Italy in 2020			
Province	Collection (kg)	Inhabitants	Pro capita (kg/inh)
Caltanissetta	391310	272458	1,44
Crotone	335870	171666	1,96
Pescara	650442	315725	2,06
Taranto	1249532	582814	2,14
Foggia	1399400	628221	2,23

In 2020, Matera, Prato, Sassari, Gorizia, and Latina were the top 5 performers, while Caltanissetta, Crotone, Pescara, Taranto, and Foggia were the bottom 5 performers. To have a broader overview of the e-waste governance and management, also the regions in which the provinces are located were contacted. The regions are Basilicata, Tuscany, Sardinia, Friuli-Venezia Giulia, and Lazio (for the top 5), and Sicily, Calabria, Abruzzo, and Puglia (for the bottom 5). *Table 11* shows graphically these regions and the provinces. The provinces are in order of performance, from the most performant to the least performant.

**Table 11:** Graphic representation of the Provinces and Regions considered for the research and their location on the Italian Map.

Representation on the Italian Map	Provinces	Regions
	1. Matera	Basilicata
	2. Prato	Tuscany
	3. Sassari	Sardinia
	4. Gorizia	Friuli Venezia Giulia
	5. Latina	Lazio
	6. Caltanissetta	Sicilia
	7. Crotone	Calabria
	8. Pescara	Abruzzo
	9. Taranto	Puglia
	10. Foggia	Puglia

For various reasons, not all targeted stakeholders replied or were available for an interview. In particular, it was not possible to reach anyone from the Italian government, the ISPRA research institute, the waste companies, the retailers and the producers. While trying to contact some representative of Foggia province, I discovered that the administration was and still is under investigation for mafia affiliation and therefore impossible to reach. In alternative, I was able to contact the responsible for waste management at the municipality of Manfredonia (in the province of Foggia) to have a partial understanding of how e-waste is managed in Puglia and more specifically in Foggia.

During the meetings, semi-structured interviews were carried out. This type of interview is a combination of predefined questions and less structured open questions (Wilson, 2014). This method was chosen to match the explorative nature of the first part of this research as well as to provide more freedom in interviewees answers. The questions, based on the analytical framework, were customized for each type of actor involved, choosing different questions based on the actors' role, responsibilities and based on new findings during the research. *Appendix 2* contains an example of the coding and a link to a drive folder with the interview guides for each interviewee, the transcription and the report of the coding.

All interviews were conducted in Italian, not only for convenience but also to grasp every nuance in the answers. The interviews were subject to participants willingness and feasibility thus some interviews were substituted with email interaction, or the study of documents, reports or information received from the stakeholders via email. The online interviews lasted from 20 to 60 minutes, and they were recorded (previous verbal agreement from the interviewees), transcribed, and coded via the software NVivo. The analysis of the interviews was based on the deductive method for analysing qualitative data through coding (Cho & Lee, 2014). The starting point was the analytical framework, where the 4 categories (EPR System, Policy and regulation system, Stakeholders, and Infrastructures) were the preconceived codes and the analysis proceed with a deductive approach, looking for specific information under those categories. In addition, considering that the interviews followed a semi-structured system, some information that did not strictly belong to any categories were coded under 2 other categories, "strengths" and "weaknesses".

The first result of this analysis was a stakeholder map, showing the actors involved and the interaction between them, replying to the second sub-question. Secondly, the interview directly contributed to the comprehension of the Italian system, the identification of the issues, and they provided solutions or thoughts for ameliorations.

### *3.5 Strength and Weaknesses Assessment & Points of Improvements*

The second phase of this research has focused on assessing the points of strengths and weaknesses of the Italian e-waste governance and management. The indicators in the analytical framework have been operationalized (*Table 12*) and used as a checklist of aspects to assess. The outcome of this framework assessment replied to sub-question 3 but also identified the points of improvement, replying to sub-question 4.

The scoring system in *Table 12* is based on the WEEE compliance system Final Report (Kling et al., 2018). For this research, the scoring system is adopted as a benchmark to assess Italy performances on the 21 indicators in *Table 12*. A score of 2 corresponds to best practice, a score of 1 is given when there are points of improvement, while the score of 0 is for wrong or weak implementation that can affect the e-waste governance system. To help the visualization, a colour coding has been applied: the colour code (green for 2, yellow for 1, and red for 0) helped the identification of the indicators that need to be implemented (red cell) or improved (yellow cell). An ideal system would have all indicators coded in green, so the assessment shows in red or yellow which indicators needs improvement. The data were taken from the analysis of documents and reports found through desk research, and the information provided by the interviewees.

After this phase, some recommendations for the points to improve were provided. In this research, Italy has been the main focus, and the improvements were customised on the findings, but in the Discussion chapter (see Section 5), some considerations about the EPR system and the e-waste governance on a more general level are proposed. The improvements for Italy were based on literature reviews and input provided from the stakeholders interviewed or the documents and reports sent.

**Table 12:** Analytical framework for the second phase of the research. Adapted and revised from Bisschop (2014); Borner & Hegger (2018); Corsini et al., (2017); Driessen et al., (2012) Kumar & Dixit (2018); Vermeulen & Campbell-Johnston (2021); Watkins et al., (2017).

Categories	Indicators	Operationalization	Scoring System
<b>(1) EPR System</b>	(1.1) Proper and on-time implementation of EPR for e-waste	(1.1.1) Ratification of the EPR system in the Italian Law system before the deadline according to the European Decree. In case a specific implementation is not explicitly mentioned, adopt the implementation time required by general communitarian law.	Ratification of EPR System on time: <b>2</b> / Delay in ratification: <b>1</b> / EPR System has not been adopted: <b>0</b>
		(1.1.2) Presence of actuation decrees (required by the Italian law to put in force a law)	YES: <b>2</b> / NO: <b>0</b>
		(1.1.3) Existence of a take-back obligation (Monier et al., 2014)	YES: <b>2</b> / NO: <b>0</b>
		(1.1.4) % of territorial coverage (Monier et al., 2014)	The territory is almost entirely covered: <b>2</b> / The territory is partially covered: <b>1</b> / The territory is little or not covered: <b>0</b>
	(1.2) Improve Efficiency	(1.2.1) Improved collection rates since the introduction of the EPR scheme	YES: <b>2</b> / NO: <b>0</b>
		(1.2.2) Low operations costs	YES: <b>2</b> / NO: <b>0</b>
		(1.2.3) Presence of a Producers Responsibility Organization or a single national PROs	YES: <b>2</b> / NO: <b>0</b>
		(1.2.4) Increased data availability and collection	YES: <b>2</b> / NO: <b>0</b>
		(1.2.5) Percentage of Free riders (Monier et al., 2014)	The percentage of Free riders deeply affects the system: <b>0</b> / The percentage of free riders is neglectable: <b>1</b> / There are no free riders recorded: <b>2</b>
	(1.3) Improve Recycling	(1.3.1) Improved recycling rates since the introduction of the EPR scheme	YES: <b>2</b> / NO: <b>0</b>
		(1.3.2) National or EU targets are met	YES: <b>2</b> / NO: <b>0</b>
		(1.3.3) Developments of markets for reusing secondary raw materials (Watkins et al., 2017)	YES: <b>2</b> / NO: <b>0</b>
	(1.4) Improve Eco-design	(1.4.1) Improved product design since the introduction of the EPR scheme	YES: <b>2</b> / NO: <b>0</b>
		(1.4.2) Presence of eco-design incentives	YES: <b>2</b> / NO: <b>0</b>
	<b>(2) Policy and Regulation System</b>	(2.1) Proper implementation and observation of E-waste-related directives	(2.1.1) Presence of RoHS law in Italy (Directive 2002/95/EC)
(2.1.2) Presence of recorded violation of Basel Ban amendment			YES: <b>0</b> / NO: <b>2</b>
(2.2) Adequate rule system for e-waste proper treatment		(2.2.1) The regulation system is clearly applicable and comprehensible (Bisschop, 2014)	YES: <b>2</b> / NO: <b>0</b>
		(2.2.2) "The more-involved actors consider the allocation of responsibilities and the regulations to be clearly stipulated" (Borner & Hegger, 2018, p.275)	YES: <b>2</b> / NO: <b>0</b>
		(2.2.3) "The rules system has been adjusted to accommodate flaws" (Borner & Hegger, 2018, p.276)	YES: <b>2</b> / NO: <b>0</b>

	(2.3) Subsidy or tax system	(2.3.1) Presence of a subsidy or tax system that encourage the willingness and support the ability to commit to environmental legislation (Bisschop, 2014)	YES: <b>2</b> / NO: <b>0</b>
	(2.4) Presence of planning and forecasting strategies	(2.4.1) Presence of a national plan to reduce e-waste, adopted and implemented to all layers of governance	A plan is present and is widely adopted: <b>2</b> / There is a plan, but the implementation is not everywhere: <b>1</b> / There is no plan neither an implementation: <b>0</b>
	(2.5) Monitor and auditing system	(2.5.1) Presence of a system to trace and track waste flows. If the IT capacity is not available, the condition is fulfilled if actors are willing to share knowledge and data and if an exchange platform is available (Kissling et al., 2013 as cited in Borner & Hegger, 2018)	Presence of a technologically advance trace-and-track system supported by stakeholders knowledge and data sharing: <b>2</b> / Presence of a trace-and-track system based on stakeholders knowledge and data sharing: <b>1</b> / A trace-and-track system is not present: <b>0</b>
		(2.5.2) Capacity of performing inspections (Bisschop, 2014)	The responsible control body performs regular inspections and sanctions are efficient: <b>2</b> / The responsible control body performs irregular inspections, and the sanctioning system is not efficient: <b>1</b> / The responsible control body does not perform any control and sanctions are not implemented: <b>0</b>
	(2.6) Reporting system	(2.6.1) Presence of a detailed system of reporting	YES: <b>2</b> / NO: <b>0</b>
		(2.6.2) The actors involved consider the reporting system clear and transparent	YES: <b>2</b> / NO: <b>0</b>
<b>(3)</b> <b>Stakeholders</b>	(3.1) Defined role of stakeholders	(3.1.1) The stakeholders consider their role clear to themselves and to other actors involved	YES: <b>2</b> / NO: <b>0</b>
	(3.2) Inclusion of all stakeholders	(3.1.2) Stakeholders from every level (government, business, waste processors, collectors, producers) are included and the governance is interactive	All/most stakeholders are included, and the governance is interactive: <b>2</b> / All/most stakeholders are included but the governance is not interactive: <b>1</b> / Not all stakeholders are included, and the governance is not interactive: <b>0</b>
	(3.3) Clear allocation of responsibilities for stakeholders	(3.3.1) The stakeholders consider their responsibility clear to themselves and to other actors involved	YES: <b>2</b> / NO: <b>0</b>
	(3.4) Coordination between stakeholders	(3.4.1) Stakeholders coordinate their strategies and actions autonomously or through a third entity	YES: <b>2</b> / NO: <b>0</b>

	(3.5) Collaboration between stakeholders	(3.5.1) Presence of a forum for transparent and structured stakeholder consultations	YES: 2 / NO: 0
		(3.5.2) Stakeholders strategically collaborate among all layers of governance and between private and public sector	YES: 2 / NO: 0
	(3.6) Knowledge and expertise exchange system	(3.6.1) "Ability to gain insights into one another's knowledge of processes and approaches through learning and knowledge-sharing programmes across e-waste networks" (Wittstruck & Teuteberg, 2012, p.148 as cited in Borner & Hegger, 2018)	YES: 2 / NO: 0
	(3.7) Competition between formal and informal sector	(3.7.1) Presence of a competitive informal sector (Bisschop, 2014)	YES: 0 / NO: 2
<b>(4)</b> <b>Infrastructure</b>	(4.1) Skilled workforce	(4.1.1) Workforce is skilled and updated to newer systems of disposal thanks to specific training or courses provided by the private actors they work for	YES: 2 / NO: 0
		(4.1.2) Lack of willingness/flexibility to change over to new practices from the current system	YES: 0 / NO: 2
	(4.2) Infrastructures' facilities	(4.2.1) Presence of storage facilities, transportation companies, treatment plants, and disposal technology	YES: 2 / NO: 0
		(4.2.2) Presence of high standards that e-waste facilities have to comply to	YES: 2 / NO: 0
		(4.2.3) Presence of certification schemes for waste companies and transportation companies	YES: 2 / NO: 0
	(4.3) Proper and updated technologies for recycling	(4.3.1) Presence of advanced technologies in the treatment plants	YES: 2 / NO: 0

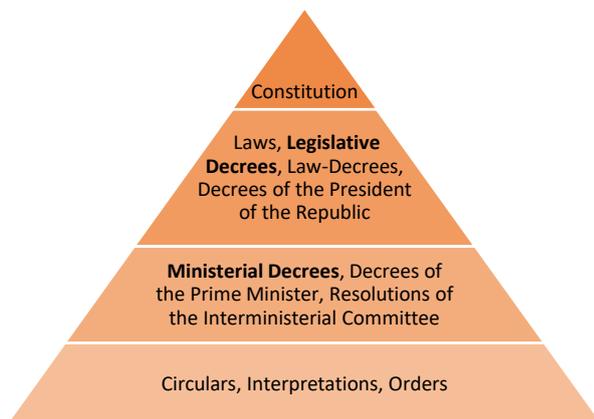
## 4. Results

This chapter presents the results divided into 2 sections. Sub-section 4.1 firstly presents the policy analysis, the performance analysis, and the current organization of the e-waste management in Italy. Sub-section 4.2 focuses on the assessment of the strengths and weaknesses of the Italian system.

### 4.1 Italian e-waste system

#### 4.1.1 Policy Analysis

This section presents all the legislative and ministerial decrees regarding e-waste in Italy since the first implementation of EPR for e-waste, in 2005. A legislative decree is a measure that has the same legislative power as a law, but it is emanated by the Government instead of the Parliament, as would happen for official laws. A legislative decree is published by the Government on peculiar themes or subjects that cannot be examined by the Parliament because their complexity could obstruct the Parliament agenda. Therefore, the Parliament authorizes the Government with a “delegation law” to produce a law (the legislative decree) within the limits and the scope stated in the delegation law. A ministerial decree is an act of the Government that has the same capacity of producing legal norms as a law, but it cannot be a law as is not voted by the Parliament. This type of decree needs to be present to the Court of Auditors to be registered and be fully effective. To have a clearer overview of the different Italian normative acts, *Figure 3* presents the hierarchy, from the most fundamental laws in the Italian system contained in the Constitutions to the least powerful, the Circular, Interpretation and Orders. Legislative Decrees and Ministerial Decrees are highlighted to show their position in the hierarchy.



**Figure 3:** Hierarchy of Italian legislative system

In the following paragraphs, the most important aspects of the decrees regarding e-waste are presented. They are compared to the European decree that they refer to, and analysed according to implementation time, coherence with the European text and clarity of information and requirements provided. For completeness, every decree that mentioned e-waste or EEE is presented but the decrees n° 151/2005, n° 152/2006, and n° 49/2014 are considered fundamental, thus analysed in depth. These decrees are analysed not only to understand the targets and goals set but also to compare the policies intentions with the actual performances achieved.

The decrees are in chronological order to present the evolution of the different policies and decrees during the 15 years' time span in which the EPR has been introduced in Italy. *Figure 4* presents a summary of the most important findings regarding the actors involved and the targets and policies put in place by the Italian legislators. The body of the decrees has been translated from Italian but since I am not a competent translator, this section may contain some errors or incorrect translation. Therefore, the link for each decree has been put in *Appendix 3*.

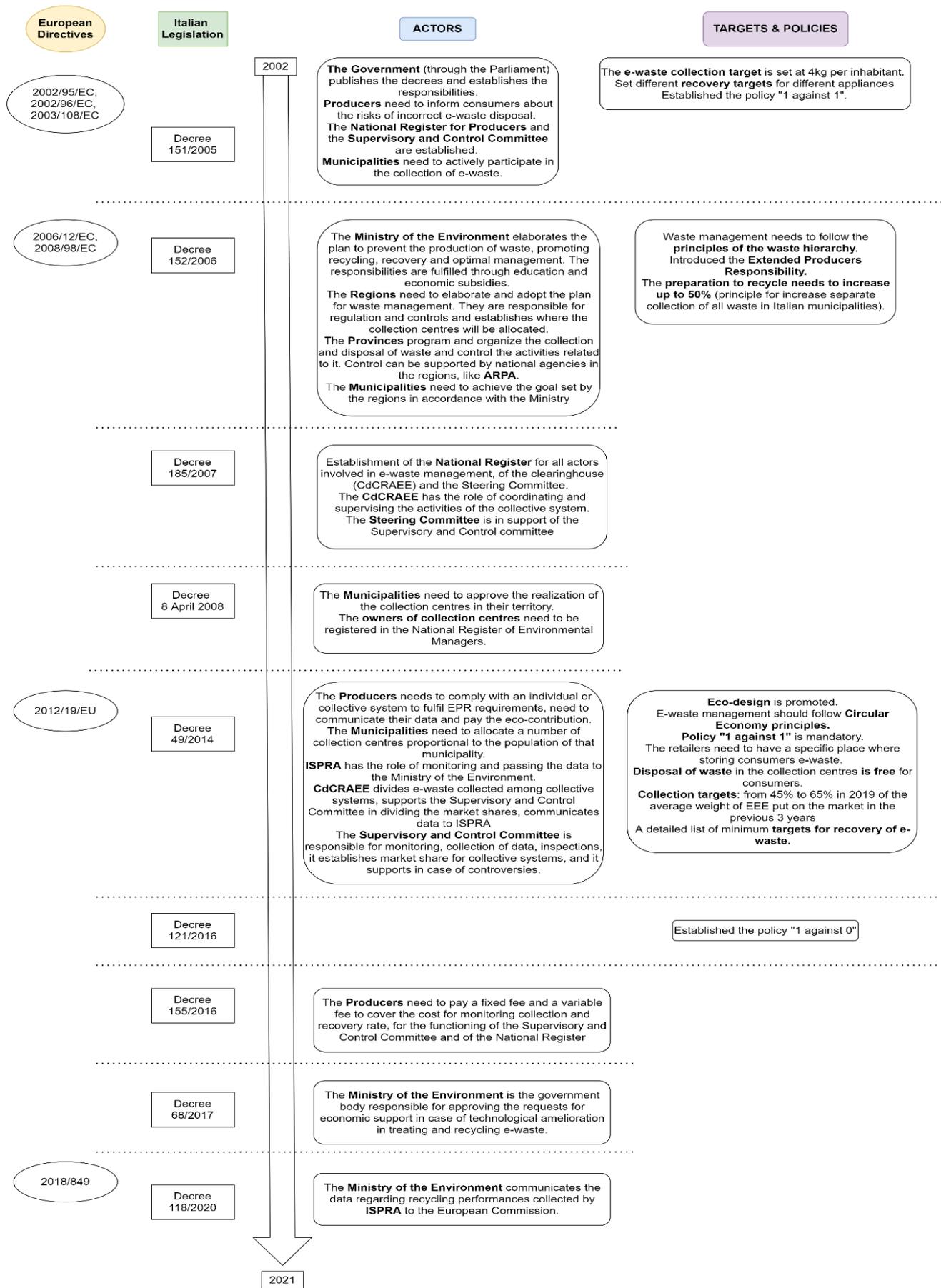


Figure 4: Evolution of the actors and targets and policies regarding e-waste in Italy

### **Legislative Decree 25 July 2005 n°151**

This decree, in actuation of the European Directives 2002/95/EC, 2002/96/EC, and 2003/108/EC, established measures to prevent e-waste, to promote recycling, reuse and reduce, to ameliorate the intervention of stakeholders involved in e-waste supply chain and to reduce the use of hazardous substances in electronic and electrical equipment. In particular, the decree establishes regulations for the following themes:

- Art. 2 presents the categories of e-waste. The division follows exactly the European one, categorizing 10 different types of e-waste: large household appliances; small household appliances; IT and telecommunication equipment; consumer equipment; lighting equipment; electrical and electronic tools; toys, leisure and sports equipment; medical devices; monitoring and control instruments; automatic dispensers.
- Art. 4 focuses on product design to promote reuse, recycling, and reparability. A general environmental advantage and protection principle needs to be applied when designing products.
- Art. 5 prohibits the use of hazardous substances as plum, mercury, cadmium, etc in EEE products.
- Art. 6 established a management system specifically for municipalities and producers and retailers to promote the separate collection of e-waste from the residual waste. The target is set to a minimum of 4 kg of collected e-waste per inhabitant. To do so, municipalities guarantee the accessibility and adequacy of collection systems specifically for e-waste (*Centri di Raccolta* in Italian); producers and retailers assure the “1 against 1” rules (*1 contro 1* in Italian, an example of take-back policy), meaning that for every new electrical or electronic product bought, the consumer can give back the old one without paying any fee.
- Art. 8 focuses on regulations and requirements for treatments’ plants, that needs to use the most technologically advanced treatments and a safe working environment. These plants can be established through normal and simplified procedures (in accordance with the province or the municipality, respectively) and need to comply with the requirements of quality and conformity.
- Art. 9 specifically address the recovery of e-waste. Producers need to establish a collective or individual system to collect e-waste and needs to achieve:
  - a. For big household appliances and vending machines, 80% recovery and 75% reuse and recycling
  - b. For IT and consumer equipment, 75% recovery and 65% reuse and recycling
  - c. For small household appliances, lighting equipment, electronic and electrical tools, and control and monitoring equipment, 70% recovery and 50% reuse and recycling
  - d. For all fluorescent light sources, 80% reuse and recycling
- Art. 13 establishes that the producer needs to provide, in the instruction for use of the products, information regarding the disposal of e-waste as do not dispose of in the general waste and the various disposal possibilities, the environmental and social impact of the incorrect disposal, and the sanctions in case of incorrect disposal.
- Art. 14 institutes the National Register for the actors involved in the e-waste management, in which all stakeholders need to be registered.
- Art. 15 instituted the Supervisory and Control committee on e-waste management, appointed to collect data, calculate the market share for each producer (to calculate the financial fee for e-waste management), and programme and perform inspections and controls. The committee needs to be implemented with Ministerial decree within 6 months from the adoption of this decree (January 2006).

The European Directives 2002/95/EC, 2002/96/EC and 2003/108/EC are fully transported in the Italian legislative system with the legislative decree 151/2005. Even though completeness and clarity were achieved, the legislative decree was published after the time limit put by the European Commission on the 13<sup>th</sup> of August 2004. The targets set in article 9 are precisely transported from Article 7 of the European Directive 2002/96/EC, but there are no data available to control the achievement of those goals. Another point of

criticism regards the eco-design requirement. Although the decree is the first to mention eco-design (Art. 4) as a goal, there are no concrete measures or requirements mentioned, nor strategy to achieve it. Lastly, specific goals are set for collection, recovery, and reuse but a concrete strategy and coordination plan is missing.

#### **Legislative Decree 14 April 2006 n°152**

This decree on the Environmental Regulations (*Norme in Materia Ambientale* in Italian) contains dispositions and general principles regarding environmental management and protection. In particular, the decree presents the procedures to assess environmental impact, the regulations in protection of soil, air, and water from pollution, against desertification and CO2 emissions, for better management of water sources, for waste management and rules on compensation for environmental damage. This decree is the transposition of the European Directive 2006/12/EC that has been lately updated in the European Directive 2008/98/EC. Considering that the European Directive 2008/98/CE set the deadline for the implementation to the 12<sup>th</sup> of December 2010, the directive has been transported on time with the Legislative Decree 152 in 2006. Regarding waste management, the decree establishes:

- Art. 178 specifies that waste management needs to follow the principles of precaution, prevention, sustainability, proportionality, and responsibility and cooperation among stakeholders involved in every stage of the supply chain.
- Art. 178-bis presents the Extended Producer Responsibility as a tool to support the prevention of waste and the efficient use of resources. A producer is intended as any person that professionally develops, manufactures, transforms, sells, or imports products. With this decree producers are made financially responsible for waste management and have to advertise the information related to recyclability, reusability and environmental impact of their products. In addition, they have to improve the design of products to extend their life, decrease or eliminate waste during their production and after use, and guarantee safe disposal.
- Art. 179 presents the hierarchy of waste management, starting with prevention, then preparation for reuse, recycling, recovery, and lastly disposal. The general principle to follow is the best environmental option when treating waste. To do that, the public administrations need to promote the development of clean and advanced technologies for waste management and need to encourage the eco-design of products and the use of recycled materials.
- Art. 180 focuses on prevention. To promote prevention and reduction of waste, the Ministry of the environment adopts a national plan for prevention and elaborate indicators that will be integrated into regional plans (explained in art. 199). Each year, the Ministry of the environment will present to the Chamber in the Italian Parliament with a report on progress, targets achieved, and critical points.
- Art. 180-bis focuses on reuse and preparation to reuse. The public administrations at all levels promote reuse and preparation to reuse with economic and logistical tools (as supporting the construction of accredited repair and reuse centres), with the adoption of specific criteria in the procurements' procedures.
- Art. 181 focuses on recycling and recovery of waste. Following the Ministry, the regions establish the criteria that municipalities need to comply with to realize the separate collection at least for paper, metals, plastic, glass and when possible, for wood. Within 2020, the target for preparation of household waste to recycling will be increased at least up to 50%.
- Art. 182 focuses on the disposal of waste. The disposal needs to be done in safe conditions only for the residual waste for which recovery is not possible any longer. The weight and volume of waste that will be disposed of needs to be reduced as much as possible and it is forbidden to dispose of hazardous waste in a region that did not produce it.
- Art. 183 contains the definitions of waste, specific waste, producers, etc. This article place e-waste under the categories of urban waste, in particular, "unsorted household and separated collection" (art. 183 letter b-ter).

- Art. 188 establishes that the responsibility for waste management is on the producers along the entire life cycle, that will manage their disposal and treatment themselves or through a third party, as waste companies, consortia or simile.
- Art. 188-bis specifies that waste traceability needs to be guaranteed from production till the disposal, following the obligation imposed by the Ministry of the environment through the control for traceability system (*SISTRI, Sistema di controllo della tracciabilità dei rifiuti* in Italian).
- Art. 195 specifies the responsibilities of the Italian State. The National government has the planning and coordination functions to prevent the production of waste. The government has also the responsibility of promoting the recycling, recovery, and optimal management of waste fluxes. This responsibility can be fulfilled through education programs or economic subsidies that are promoted by the government.
- Art. 196 and 199 specify the responsibilities of the regions. The regional administrations need to elaborate and adopt the regional plans for waste management in accordance with the provinces and the municipalities. The regions are responsible for regulating and performing controls, especially to improve the separate collection of waste. Lastly, regions elaborate the criteria to identify the areas in which locating disposal and treatments plants.
- Art. 197 specifies the responsibilities of the provinces. In general, provinces have the role of programming and organizing the collection and disposal of waste and controlling all activities related to waste management. Control and reporting can be supported by specialized regional agencies for the environmental protection (*ARPA, Agenzie regionali per la protezione dell'ambiente* in Italian).
- Art. 198 specifies the responsibilities of the Municipalities that implement the waste management plans. They are responsible for the logistics and the controls, and they have to report to both provinces and regions.
- Art. 227 is the only article that explicitly mentions electronic and electrical waste, confirming that the decree does not apply any new regulation. Thus, Legislative Decree 2005 n°151 remains the referral decree for specific e-waste management and regulations.

**Ministerial Decree 25 September 2007 n°185**

This decree instituted the National Register for the actors involved in the e-waste management, the clearinghouse (*CdCRAEE*) and the Steering Committee on e-waste management. The decree was lately amended by the legislative decree 49 in 2014. The decree specified the structure and the functions of the National Register that also needs to communicate the data related to EEE. The producers must subscribe to the register after adhering to one or more collective systems (as ERION, ECOEM, Cobat, Ridomus, etc) in accordance with the type(s) of e-waste produced. The Steering Committee had the role of supporting the Supervisory and Control Committee, specifically regarding the monitoring, the logistics and the economic and communication activities.

This decree introduced for the first time the clearinghouse as the centre for coordination of all activities related to e-waste management, its responsibilities, and the organizational structure. The clearinghouse *CdCRAEE (Centro di coordinamento Rifiuti di Apparecchiature Elettriche e Elettroniche* in Italian, corresponding to “coordination centre of e-waste”) is a consortium created by all collective systems (as required by art. 9, Decree 185/2007) that treat household e-waste. These collective systems must adhere to the *CdCRAEE* (within 30 days from their constitution), on the contrary, collective systems that treat professional e-waste are free to decide whether to join the *CdCRAEE* or not. The decree presents the organization and the functions of the clearinghouse. The *CdCRAEE* has the responsibility of:

- Optimize the activities of the collective systems
- Define the general conditions for the waste collection in collaboration with the ANCI (national association of Italian municipalities)

- Establish agreements with the association of workers involved in the disposal of e-waste, to assure the correct treatment of this waste
- Assure the necessary collaboration among all stakeholders, especially between collective systems dealing with the same kind of e-waste
- Assure the monitoring of e-waste fluxes, divided by category, and communicate the data to the Supervisory and Control Committee
- Develop a prevention program for each kind of e-waste

Considering that decree 151/2005 already required the creation of the National Register, finding the same requirement in this ministerial decree 2 years later proves that the National Register was not implemented before and/or needed some adjustments to be fully in force. Nevertheless, decree 151/2005 did not set a specific deadline for the implementation, allowing some extent of freedom in the implementation. Regarding the CdCRAEE, the decree presents the structure of the new organ. On the other hand, the responsibilities stated assume a general and vague tone of recommendations, more than practical and concrete strategies.

***Ministerial Decree 8 April 2008, amendment of article 183, paragraph1, letter cc of Decree 152/2006***

The decree defines the structure and organization for the municipal and inter-municipal collections centres in municipalities. These collections centres are intended to receive the already divided urban waste to facilitate the achievement of higher collection targets. The realization of the collection centres is approved by the Municipalities and the owner of these centres needs to be registered of the National Register of Environmental Managers. The decree provided a detailed list of technical, management, and structural requirements for the collection centres. The decree has been modified by the ministerial decree 13 May 2009.

***Ministerial Decree 8 March 2010, n°65***

The decree presents the simplified modes for e-waste management for retailers, installers, and professionals of service centres. The decree aimed to simplify the e-waste management to make effective the take-back policy “1 against 1”, and to incentivise and facilitate the correct disposal for this waste. The decree has been integrated into the Legislative decree 49/2014.

***Ministerial Decree 14 March 2014, n°49***

The decree is the actuation decree for the European directive 2012/19/EU on e-waste. It mentions specific requirements for the following aspects:

- Art. 5 promotes eco-design, stimulating the cooperation between all the actors (producers and waste operators) and promoting the recycled, repaired, or reused market for EEE.
- Art. 6 and 7 states that the criteria for e-waste management should follow the circular economy principles (in particular, reuse, preparation for reuse, and recovery) and the actors' involved needs to comply with this strategy.
- Art. 8, 9 and 10 establishes the duties of producers. They are obliged to comply with individual or collective systems to fulfil their take-back responsibilities and meeting the targets. In addition, the producers need to communicate their data (collection, treatments, recovery, and disposal) to the Ministry of Environment to be able to calculate the amount they are required to pay annually (so-called eco-contribution).
- Art. 11 establishes the consumer can bring their old EEE when buying a new one to a retailer, who are obliged to inform the consumers. The retailers, in addition, need to store the e-waste in a closed and sheltered (from water and wind) space and later the retailers had to bring the collected e-waste to the collection centres.
- Art. 12 and 13 specifies requirements regarding the separated collection of e-waste. Household e-waste collection is supported and promoted by the municipalities that must place the collection centres in a number proportionate to the population and in accessible places. The disposal of waste

in the collection centres is free of charge for consumers (private citizens) while businesses need to coordinate with the collection centres for the collection and related costs.

- Art. 14 put specific targets for the collection of e-waste. The monitoring is assigned to the ISPRA and the data are passed to the Ministry of the Environment (also specified in Art. 31)
  - a. Till December 2015, the collection target is set at 4kg/inhabitant per year
  - b. From January 1<sup>st</sup>, 2016, a minimum target of 45% needs to be achieved, calculated on the total weight of e-waste collected in a certain year and expressed as a percentage of the average weight of EEE put on the market in the previous 3 years. Between 2016 and December 31<sup>st</sup>, 2018, the target needs to pass from 45% to 65%.
  - c. From January 1<sup>st</sup>, 2019, the target is set at 65% of the average weight of EEE put on the market in the previous 3 years or a minimum collection of 85% of the weight of e-waste produced on the national territory.
- Art. 15 and 16 underlines that coordination and collaboration among all stakeholders need to be a priority for efficient e-waste collection and management. The decree mentions general requirements and strategies, as “the collection needs to be one rationally and homogeneously on all territory” or “individuation of appropriate collection centres” without specifying how they intend these requirements to be fulfilled.
- Art. 17, 18, and 19 focus on e-waste treatment and treatment plants. All phases of e-waste treatment (from the transport from the collection points to the treatment plants) needs to be performed in the safest conditions possible for the workers. Especially for e-waste containing hazardous materials and liquids, the transport and treatment need to fulfil the highest safety measures in the Italian law system. The articles refer to other specific articles, rules, and decrees in the Italian legislation regarding health measures that need to be followed, leaving little space for incorrect interpretations.
- Article 18 specifically requires the adaptation to the new regulation for all treatment plants and to update the authorizations via a request to the municipalities or provinces or regions.
- Art. 20 specifies that business and treatments plants that manage e-waste disposal needs to be authorized by municipal or provincial or regional authorities (according to the legislative decree 152/2006) to prevent wrongful or inadequate treatment.
- Art. 23 and 24 specify that the costs of household and businesses e-waste management are producers’ responsibility. These costs can be covered individually or collectively (through the collective systems that share costs and market share based on the weight of EEE produced in the previous year).
- Art. 26 establishes that the producers need to provide, in the instruction for use of the products, information regarding the disposal of e-waste as: do not dispose of in the general waste and the various disposal possibilities; the environmental and social impact of the incorrect disposal; and the sanctions in case of incorrect disposal. This article was already present in the legislative decree 2005/151 but it has been made more precise and comprehensive of EEE that don’t contain the instruction for use. In this case, the information is provided directly from the retailers.
- Art. 27 established that the producers need to provide information to enable or facilitate the maintenance, the upgrading or the reparation, and the preparation for reuse or recycling to the competent bodies (treatment plants, retailers, or reparation stores).
- Art. 32 mentions that all governance layers need to cooperate through administrative collaboration and information sharing. The article mentions that information sharing can be done electronically but it does not provide any concrete tool or platform in support.
- Art. 33 and 34 focus on the activities and responsibilities of the clearinghouse CdCRAEE. In addition to what was stated in decree 185/2007, these articles establish that the CdCRAEE:

- a. Guarantees a homogeneously and fair division of e-waste to be collected from the collection centres among collective systems, according to the principles of fair competition and non-discriminations.
  - b. Supports the Supervisory and Control Committee in dividing the market shares of collective systems. The market shares of each system are calculated based on the self-declaration that the collective system made of their market shares. These shares are the sum of the producer market shares for the year, the equivalent of the number of products they will be able to put on the market and based on that, the e-waste shares are calculated. This is necessary to calculate the eco-contribution that each producer needs to pay to fulfil the EPR requirements.
  - c. Assures a timely reply to collect e-waste from collection centres
  - d. Collects and monitors the data on collection and treatment of e-waste and shares the information with ISPRA
- Art. 35 reinforce the role and responsibilities of the Supervisory and Control Committee, established in 2005. The committee has the role of monitors, data collection, inspections, establishing the market shares for the collective systems, and support in case of issues or controversy. The committee reports directly to the Ministry of the Environment and its secretary is guaranteed by the ISPRA. This double control is a positive indicator for transparency and truthful reporting.
  - Art. 36 institutes a new Steering Committee for e-waste management with the role of supporting the action of the Supervisory and Control Committee and the clearinghouse.
  - Art. 37 focuses on inspection and monitoring, but it does not mention specifically who are the competent bodies in charge of the controls.
  - Art. 38 contains a precise and extensive set of sanctions that regulate the violation for all stakeholders (retailers, producers, treatment plants and workers), the non-inscription to the National Register, the non-communication for data and information.
  - The 5<sup>th</sup> Appendix of Decree 49/2014 provides a detailed list of minimum targets for the recovery of e-waste divided per category. The targets are transposed from the EU Directive integrally and can be found in *Appendix 3*.

All articles of the European directive 2012/19/EU were transposed in the Italian legislative system with this decree. The Italian articles are clearly presented, comprehensive and logically structured, and refers to all stakeholders (policymakers, producers, retailers, control bodies, monitor and reporting bodies, clearinghouse and consumers). The targets set in article 14 are precisely transported from Article 7 of the European Directive 2012/19/EU. The various management or treatment options are presented and in line with the objective of the European plan for a circular future. Nevertheless, the ministerial decree has been published and March 14<sup>th</sup>, 2014, while the deadline in the European Directive was for February 14<sup>th</sup>, 2014. Another aspect to consider is the ambiguity of certain terminology, which could have given a greater extent of freedom in the interpretation when applying the regulations (for example, art. 15, 16, 27 or 32).

#### ***Decree 31 May 2016, n°121***

The decree regulates the modes for collecting small e-waste. Retailers must take back household small e-waste without charging any fee with the policy “1 against 0” (*1 contro 0* in Italian, another type of take-back policy): this policy allows consumers to bring their e-waste for free without having to buy a new item. The collection points need to be located nearby or inside the retailer shop.

It was not possible to determine the reasons why Decrees from 2016 are called “decrees”, not specifying whether they are legislative or ministerial.

### ***Decree 10 June 2016, n°140***

The decree presents criteria and modes to encourage eco-design for EEE, in fulfilment of decree 49/2014 and directive 2012/19/EU. In addition to decree 49/2014, this decree requires:

- Art. 3 lists activities to promote the production of eco-compatibles EEE: use of recycled or biodegradable materials, reduction of quantity and diversity of materials, an increase of recyclability of EEE and its components, limitation of hazardous components, and optimization of product disassemble. Producers that are proven to have implemented those improvements can request a reduction of the eco-contribution fee. There are no data available to confirm whether this strategy has been put in place, the extent of the reductions available or the link between the presence of eco-contribution reduction fees and improved eco-design. In addition, there is no specific mention to which kind of EEE producers these reductions would apply to (national or international, operating on the Italian territory or importing products from other Countries, importers, or exporters) but considering that Decree 140/2016 refers to Decree 49/2014, it might be applied the same definition of producers and distributors<sup>6</sup>.
- Art. 4 reaffirms the need for cooperation between producers and waste treatments facilities professionals. This will promote adequate recovery and recycling. The article mentions that the clearinghouse will support this collaboration with a database that needs to be updated by the stakeholders.
- Art. 5 states that producers need to improve the durability and reliability of products, facilitate the maintenance and reparation as well as the technological development and the modular design of products. In support of this, producers need to organize training courses for waste treatments workers.
- Art. 6 reaffirms the monitoring as a responsibility of ISPRA in collaboration with the clearinghouse database.

The decree provides in the attachments a concrete evaluation grid to assess the life cycle, the end of life, the reparability, the disassembling level and the ISO certification of the products. Based on the results of the evaluation, the eco-contribution can be correctly calculated and paid by the producers. This grid represents a useful tool to standardize the assessment of the products, also allowing a simpler monitoring system for the control bodies. Nevertheless, the grid and the willingness of improving the eco-design could be improved. The decree does not mention any precise goals or target for use of recycled or biodegradable materials, as setting a precise % of materials that needs to be biodegradable or recycled. Concerning reparability and disassembly, the grid has an extremely simple scoring point system, where “being reparable or disassemble” scores 1 while the opposite scores 2. The degree of reparability or disassembly is not assessed, nor is the feasibility of doing these operations on the products.

### ***Decree 17 June 2016, n°155***

The decree established the fee that EEE producers must pay to cover the cost for monitoring collection and recovery rate, for the functioning of the Supervisory and Control and the Steering committees, and for keeping the National Register. The fee consists of a fixed fee (10 euros per year paid by each producer) and a variable fee, calculated as the difference between the costs above mentioned (monitoring of rates, functioning of two committees and keeping the National Register) and the fixed fee. The variable fee is then divided between producers according to their market share (therefore how much EEE they put in the market). The decree provides specific instructions on how to fulfil these obligations and provides the calculation for the variable fees. In doing so, the decree results are comprehensible and easily applicable for both the producers and the clearinghouses that support the implementation of these financial aspects.

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<sup>6</sup> See Article 4 Ministerial Decree 49/2014

### **Decree 25 July 2016, n°188**

The decree promotes the development of new technologies for treating and recycling e-waste. In particular, the decree mentions economic support to ameliorate treatment plants, to develop new technologies for recycling and recovery of higher quantities of e-waste, decrease the energy demand during the treatments and limit the risk for workers' health. The Ministry of the Environment is the government body responsible for approving the requests for economic support.

### **Decree 9 March 2017, n° 68**

The decree regards the regulation and the procedures for the provision of financial guarantees. The guarantees are lent for household e-waste to the Ministry of the Environment by the EEE producers (in case of individual fulfilment of obligations) or by the collective system (in case the producers are in a PROs). The guarantee is valid for a year or until the producer withdraw from the National Register. The decree provides two formulas to calculate the financial guarantee in case the producer fulfil its obligations individually or collectively.

### **Decree 3 September 2020, n°118**

The decree is in actuation of the European directive 2018/849 that modifies the directive 2012/19/EU on e-waste. The decree modifies the legislative decree 49/2014 and 188/2008 on the understanding that the adjustments will not result in additional costs on the public finances. The decree 118/2020 declares, in particular, that (1) the Ministry of the Environment must communicate annually to the European Commission (from January 1<sup>st</sup>, 2021) the recycling performances and the quality and efficiency controls, collected and performed by the ISPRA; (2) e-waste management costs for photovoltaic are covered by the producers for both household and professional photovoltaic waste.

The European directive 2018/849 was transposed correctly and completely with the decree 118/2020 and the articles are clearly presented. Nevertheless, the deadline set by the European Union was the 5<sup>th</sup>, July 2020 and it has been missed, since this decree has been published on the 3<sup>rd</sup> of September 2020. In the decree, the first requirements concerning the report to the European Commission is an additional tool to support Member State in achieving higher targets for e-waste collection and management, and a control tool to increase proper and legal disposal of e-waste. The main critical point is that ISPRA is the only authorized public body responsible for providing the data for the required report. Confronting the e-waste data that ISPRA published in the last report in 2019 and the one that the CdCRAEE published in the same year, there are quite significant differences, as can be seen in *Table 13*.

**Table 13:** Differences in reported e-waste collection data between ISPRA and CdCRAEE.

<b>E-waste categories</b>	<b>ISPRA Dataset (Quantities in tons)</b>	<b>CdCRAEE Dataset (Quantities in tons)</b>	<b>Tons from CdCRAEE Dataset compared to ISPRA Dataset (difference in percentage)</b>
<i>R1 - Temperature exchange equipment with fluids</i>	73.211	93.432	+27,62%
<i>R2 - large appliances</i>	82.237	115.109	+39,97%
<i>R3 - TVs and monitors</i>	58.495	59.853	+2.32%
<i>R4 - IT and consumer electronics, lightning equipment, PV panels, and more</i>	63.849	72.609	+13,27%
<i>R5 - light sources</i>	1.894	2.066	+9,08%
<b>Total</b>	<b>279.685</b>	<b>343.069</b>	<b>+22,66%</b>

ISPRA justifies the difference between the two data for two reasons: firstly, e-waste could have been wrongful labelled (as bulky waste, iron, metal or so) in the municipal collection centres and therefore, not collected and reported as e-waste. The second reason allocates the responsibility to different ways of collecting e-waste (legal or illegal) that do not involve the municipality and, consequently, do not result in

the official data. These explanations are supported also by the CdCRAEE that, in addition, affirms that the clearinghouse data are more precise because based directly on the e-waste collected and treated by the collective systems, that know exactly how much EEE is put on the market and how much e-waste is collected. These data are also suitable to be communicated to the European Commissions, but for unknown reasons, the CdCRAEE data are not taken into account for the official report (CL1).

Decree 118/2020 is the last policy published regarding e-waste. In the Recovery Plan 2021 that the National government is currently elaborating, the concepts of circular economy, ecological transition, and sustainable development play a pivotal role, in line with the European Green deal. 60 billion euros are allocated to achieve (1) circular economy and circular agriculture, (2) energetic transition and sustainable mobility, (3) energy efficiency and upgrading of buildings, and (4) protection of land and water resources. Regarding waste management, the plan aims to improve the capacity for efficient and sustainable management in collaboration with the local authorities and the amelioration of the infrastructures. (Bonucci, 2021)

#### *4.1.2 EPR responsibilities allocation and Stakeholder analysis*

Italy developed a complex bureaucratic system to fulfil the EPR requirements and to implement the European directives. In this sub-section, a summary and a reflection of the policy analysis are presented. The most relevant findings of the policy analysis are divided according to the organizational, economic and informative responsibilities that characterize the implementation of EPR (Lidhquist, 2000). These findings, summarized in *Table 14*, are integrated with the information from the stakeholders' analysis.

According to the Italian Legislative corpus, e-waste duties are divided among the government (Ministry of the Environment, regions, provinces and municipalities), governmental organs (National register for stakeholders involved in e-waste management, Supervisory and Control committee on e-waste management, ISPRA), market actors (producers, retailers and collective systems) and the clearinghouse (CdCRAEE) that is a consortium of collective systems that operates under the supervision of the Ministry for the Ecological Transition.

The legislators used two different linguistic styles to address the responsibilities among actors. A more general and recommendatory language is used to address the government and governmental organs, that are recommended to "guarantee accessibility", "establish rules or management systems", "elaborate plans", "adopt measures", "support the control and reporting system". Few responsibilities are portrayed as necessary, as for the municipalities that need to place the collection centres in their territory. Also for the governmental organs as ISPRA or the Supervisory Committee, the decrees label them as "responsible" for the data collection or the control, without any mandatory requirements. On the contrary, a more mandatory and precise language is used for the market's actors. Especially producers, retailers and collective systems "must", "have to" or "are obliged" to manage e-waste or register to collective systems or pay the eco-contributions and other economic fees for the maintaining of different governmental organs. A mixed-language is reserved to the CdCRAEE, which has both recommendatory and mandatory requirements to fulfil in collaboration with the Ministry for the Ecological transitions.

**Table 14:** Organizational, economic, and informative responsibilities in Italy divided by stakeholders.

Actor\Responsibility	Organizational	Economic	Informative
<b>Municipality</b>	Management role (logistic of collection) and reporting (art. 198, decree 156/2006). Realization of collection centres (decree 8 April 2008), in number proportionate to the population and in accessible places (art. 12 e 13, decree 49/2014).	Indirect responsibility: through the waste tax paid by citizens, municipalities pay a company to collect waste (all waste) and to transport it to the collection centres (BS1).	
<b>Provinces</b>	Programming, organizational and control role. Control role can be supported by regional agencies (ARPAs) (art 197, decree 156/2006).		
<b>Regions</b>	Establish criteria to realize the separate collection (art 181, decree 152/2006). Elaborate and adopt the plans, control, and regulation role especially for improving separate collection and decide the location of disposal and treatment plants (art 196 and 199, decree 156/2006).		Responsible for educational and informative campaigns for increasing separate collection (GOV1).
<b>Ministry of the Ecological Transition/ National Government</b>	Adoption of national plan and elaboration of indicators on progress targets achieved and criticalities (art 180, decree 152/2006). Planning and coordination to prevent waste production, promoting recycling, recovery and optimal management (art 195 decree 156/2006). Set targets of collection aligned with EU targets (art 14, decree 49/2014).	Promotion of economic subsidies for recycling, recovery, and the optimal management of waste fluxes. (art 195, decree 152/2006). Institution of eco-contribution fees subsidies for eco-design implementation (art 3 decree 140/2016). Approves the economic support requests (decree 188/2016).	Promotion of education programs to increase awareness on waste management (art 195, decree 152/2006).
<b>Supervisory and Control committee on e-waste management</b>	Collects data, calculates the market share for each producer (to calculate the financial fee for e-waste management), and programmes and performs inspections and controls (art 15, decree 151/2005).		
<b>ISPRA</b>	Responsible for monitoring and collection and elaboration data (art 14, decree 49/2014).		
<b>Producers and retailers</b>	Manage e-waste disposal and treatment themselves or through a third party (at 188, decree 152/2006). Must subscribe to the national register after adhering to one or more collective systems (decree 185/2007). Obligated to comply with individual or collective systems to fulfil their take-back responsibilities and meeting the targets. Obligated to communicate their data (collection, treatments, recovery, and disposal) to the Ministry of Environment to be able to calculate the amount they are required to pay annually (so-called eco-contribution). (art 8, 9, and 10, decree 49/2014).	Covers the cost of household and businesses e-waste management. These costs can be covered individually or collectively (through the collective systems (art 23 and 25, decree 49/2014). Producers need to pay the eco-contribution (art 8, 9, and 10, decree 49/2014). Producers need to pay the cost for monitoring collection and recovery rate, for the functioning of the Supervisory and Control and the Steering committees, and for keeping the National Register (decree 155/2017). Payment of the efficiency prizes in case of virtuous collection centres	Provide information on how to dispose correctly and safely the e-waste (art.13 decree 151/2005) Obligated to inform consumers about e-waste take-back policy “1 against 1” (art 11, decree 49/2014) and “1 against 0” (decree 121/2016). Producers are obliged to provide information regarding the disposal of e-waste (art 26, decree 49/2014). Need to Provide information that enables or facilitate the maintenance, the upgrading or the reparation, and the preparation for reuse or recycling to the

			competent bodies (treatment plants, retailers, or reparation stores) (art 27, decree49/2014).
<b>Collective Systems</b>	Take care of managing e-waste (after collection) for the producers	Pay the treatment plans to separate and manage the first phase of e-waste with the eco-contribution fee paid by the producers.	
<b>CdCRAEE</b>	<p>Optimize the activities of the collective systems; define the general conditions for the waste collection in collaboration with the ANCI (national association of Italian municipalities); establish agreements with the association of workers involved in the disposal of e-waste, to assure the correct treatment of this waste; assure the necessary collaboration among all stakeholders, especially between collective systems dealing with the same kind of e-waste; assure the monitoring of e-waste fluxes, divided by category, and communicate the data to the Supervisory and Control Committee; develop a prevention program for each kind of e-waste (Decree 185/2007).</p> <p>Divides fairly the collection centres among collective systems; support Supervisory and Control Committee in dividing the market shares of collective systems; coordinate the collection of e-waste from the collection centres, informing the collective systems when the e-waste bins are full; collects and monitors the data on collection and treatment of e-waste and shares the information with ISPRA (art. 33 e 34 decree 49/2014; BS1).</p> <p>Developing the standards for e-waste treatment that processing companies need to fulfil to be part of the CdCRAEE system; publishes every year a report on e-waste collection (divided also per regions, provinces and municipalities) and treatment processes (CL1).</p>		Supports the Government in the education of citizens, promoting the correct disposal of e-waste. Supports the collective systems sharing knowledge and expertise for e-waste treatments (CL1)

To have a better comprehension of the governance of the e-waste system, *Figure 5* presents the e-waste life cycle, the stakeholders involved and their interactions, and the information and the economic flows.

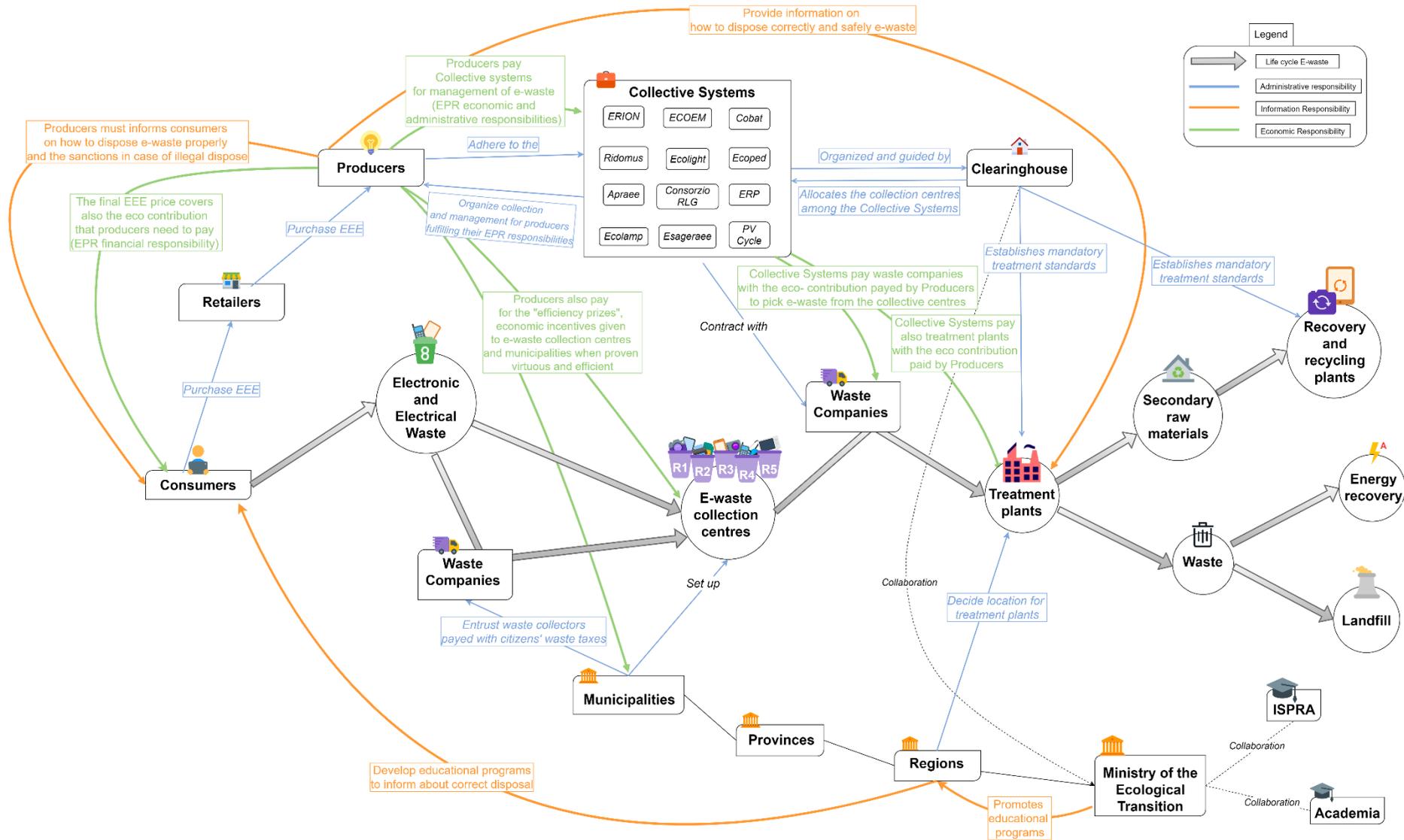


Figure 5: Stakeholders' interactions and EPR responsibilities along the life cycle of EEE

The consumers buy electronic and electrical equipment from retailers or online shops, and they can dispose of their e-waste directly in the retailers' shops according to the "1 against 1" or "1 against 0" policies. These policies established that retailers must take back e-waste when consumers buy another EEE ("1 against 1") or without buying another EEE ("1 against 0") without additional costs for the consumers. Another option for consumers to dispose of their waste is to bring it to the collection centres, specific areas set up by the municipalities where citizens can bring their e-waste, also in this case without any additional costs. The Italian system divides e-waste into 5 categories to which correspond a different way of disposal:

1. R1: fridges, air conditioning, freezers, etc.
2. R2: washing machines, dishwashers, ovens, etc.
3. R3: TV, screens, notebooks, phones, etc.
4. R4: luminaires, photovoltaic panels, small household appliances, etc.
5. R5: lightbulbs, all types of bulbs, etc.

The e-waste in the collection centres is divided into these 5 categories. Once is collected, it is transported to the treatment plants, which dismantle e-waste and sells the valuable components to the recycling plants. The collection is organized by the collective systems, associations of producers that have the responsibility to take care of the end life of e-waste, fulfilling the EPR obligations for the producers. The costs of the activities carried out by the collective systems are covered by the eco-contribution, a fee paid by producers to the collective systems to fulfil their organizational and economic EPR responsibilities. For each product, the collective systems have specific prices (usually euro per tons or euro per product) that producers need to pay to the collective system. Considering that the Italian is a multi-consortium system with 12 collective systems, for concurrency reasons, the prices for each product are not publicly disclosed. However, Stringa from ERION affirmed that the prices are a small percentage of the EEE final price (BS1). These eco-contribution prices are also based on the capacity of the collective systems of dealing efficiently with e-waste, considering that the more efficient the collection and the transport is, the less the producers will pay. In addition, these prices are also influenced by the market price of metals and valuable materials that the treatment plants will sell after the dismantling. The market values of these materials or metals are fluctuant and therefore, when the treatment plants can sell these materials for a higher price, they will lower the price for the collective systems' activities. Lastly, the eco-contribution also covers the so-called efficiency prizes. The producers pay 16 euros/tons to the collective centre in case it was proven virtuous and efficient and able to collect more e-waste (BS1). These prizes are an incentive to make the collection centres more efficient and ameliorate their collection and management system (BS1, BS2). The producers cover the costs of the eco-contribution with the selling price of every new electronic or electrical product to consumers. The legislation is ambiguous whether the eco-contribution should be clearly stated on the receipt when purchasing a new product, therefore, in Italy, the decision of clearly stating the eco-contribution on the receipt is left to producers.

Currently, in Italy, there are 12 collective systems, the PROs, that are organized and guided by the clearinghouse (CdCRAEE). The Collective Systems that are responsible for the collection of household e-waste have to subscribe to the CdCRAEE while the individual and collective systems responsible for professional e-waste collection do not have this obligation. The CdCRAEE was established in 2007 as an institutional organ that has the administrative role of allocating the e-waste collection centres and the quantities of e-waste that each collective system needs to manage based on their market share. The allocation is based on an algorithm with 5 different parameters that need to be satisfied simultaneously: (1) the market share that corresponds to how many products are sold on the market by the producers; (2) the number of e-waste collection centres assigned to each collective system that needs to be proportioned to the market share; (3) a discomfort indicator that takes into account the ease of reaching the collection points or centres in different geographical areas (urban areas, mountains, hills, etc have different peculiarities that can make the fulfilment of the service more or less difficult); (4) having more collection points in the collection centres, meaning the

capacity of dealing with different e-waste category instead of only one; and (5) continuity with collectors whether possible, to not drastically change the allocations every year.

Another role fulfilled by the CdCRAEE is the definition, in collaboration with the Ministry of the Environment (now Ministry for the Ecological Transition in Italy), of the standards for e-waste treatment that processing companies need to fulfil to be part of the CdCRAEE system. The standards are specific for each e-waste Italian category (5 categories) and focused on higher safety measures, higher value retention, proper stakeholder training and legislation compliances (CdCRAEE website). According to Longoni, the standards required by the CdCRAEE are more sophisticated than the certification Cenelec and assure a higher quality of e-waste disposal with all actors involved (CL1). These ambitious and rigour requirements result in a progressive advancement in technological capabilities that is constantly updated to match the standards. In addition to its main role, the CdCRAEE has also a coordination role between the private and public sectors. The CdCRAEE collaborates directly with the Ministry of the Ecological Transition, expressing opinions and suggestions for better management of e-waste. It supports the proper implementation of laws and decrees, collaborating with legislators to improve the clarity of requirements or indicating the absence of fundamental actuation directives. It also collaborates with the associations of retailers, distributors and processing companies and the national associations of Italian municipalities. The agreements taken with these stakeholders are crucial for a cohesive advancement in e-waste management of all actors involved, assuring coordination, and increasing information exchange. The 2016 agreement has been updated on the 10<sup>th</sup>, May 2021 and came into force 30 days later.

Research Institutes have a secondary role of support and control. ISPRA is the national research institute for environmental protection and supports the Ministry in the monitoring of performances. They produce an annual report containing performances, targets achieved, barriers encountered, and future challenges. The academic, public and private universities, advise the government on e-waste and the transition to a sustainable and circular economy.

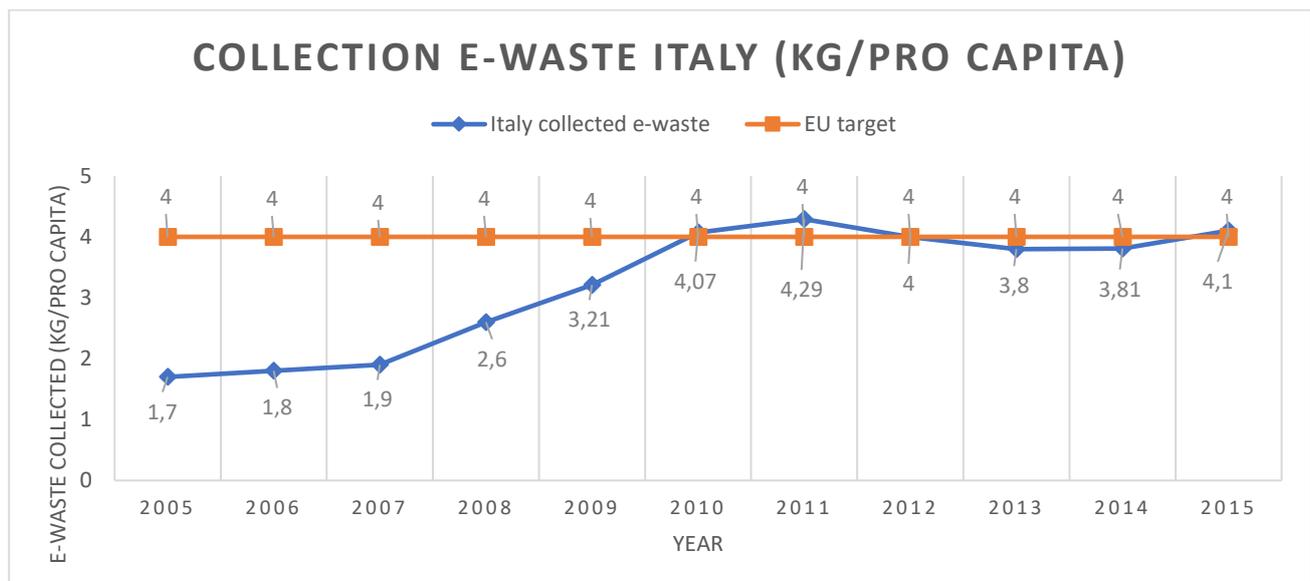
### 4.1.3 Performances

Legislative decrees 151/2005 and 49/2014 set specific goals for the collection of e-waste. To assess if the policy intentions were achieved, the analysis of the performances in e-waste collection is presented. *Table 15* presents the dataset for the years 2005-2020 from both ISPRA (2010) and CdCRAEE (2010-2020). The empty cells show missing data from the sources.

**Table 15:** Dataset from ISPRA and CdCRAEE regarding Italian collection performances in the timespan 2005-2020. Retrieved from ISPRA and CdCRAEE

Year	Italian Collection Rate (in kg/per capita)	EU target 2005-2016 (in kg/per capita)	Italian collection rate (in %)	EU target from 2016 (in %)	Data source
2005	1,7	4			ISPRA
2006	1,8	4			ISPRA
2007	1,9	4			ISPRA
2008	2,6	4			ISPRA
2009	3,21	4			CdCRAEE
2010	4,07	4			CdCRAEE
2011	4,29	4			CdCRAEE
2012	4	4			CdCRAEE
2013	3,8	4			CdCRAEE
2014	3,81	4	35,82%		CdCRAEE
2015	4,1	4	37,17%		CdCRAEE
2016	4,67		40,86%	45%	CdCRAEE
2017	4,89		40,87%	45%	CdCRAEE
2018	5,14		42,84%	45%	CdCRAEE
2019	5,68		39,53%	65%	CdCRAEE
2020	6,14		36,80%	65%	CdCRAEE

Decree 151/2005 set the goal to 4 kg/pro capita of e-waste collected annually until 2016. *Figure 6* shows the Italian performances for the period 2005-2016, with data taken from ISPRA and CdCRAEE reports.

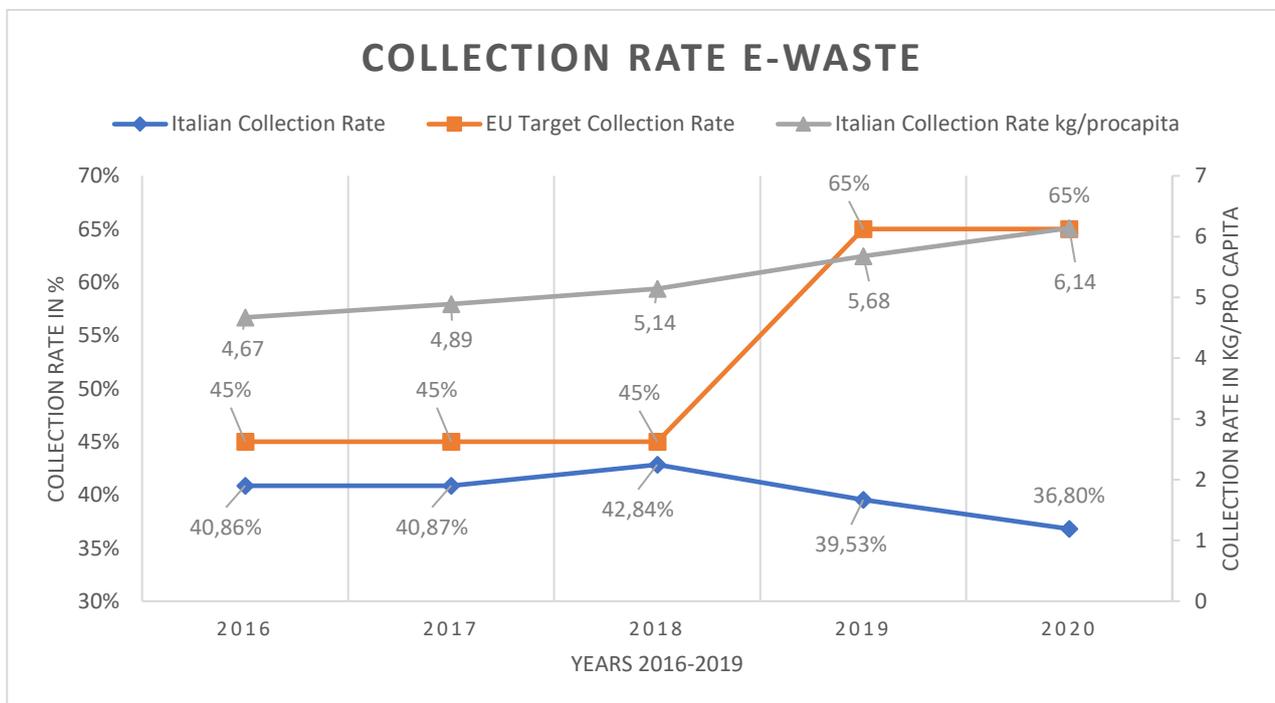


**Figure 6:** Performance collection of e-waste in Italy expressed in kg pro capita between the years 2005 and 2015

A positive trend was established from 2010, where Italy was able to achieve or overachieved almost every year the target of 4 kg/pro capita. Extremely far from the target were the performances till 2008. Regarding

these performances, some considerations need to be done. The data of 2005, 2006, 2007 and 2008 are taken from the ISPRA, the national research institute for environmental protection while all other data are taken from the CdCRAEE annual reports. As mentioned before, ISPRA and CdCRAEE performances are quite different due to different data collection and elaboration methods. ISPRA underlines in their report that the data could have been imprecise because calculated with the bulky waste collection (ISPRA, 2010). Once the CdCRAEE was established and fully functioning (the first report published is from 2009), the performances seem improved. The positive trend can be explained with the different data collection of the CdCRAEE, the introduction of the CdCRAEE itself, but also with a gradual improvement in knowledge and capacity system for correct e-waste disposal and collection.

Regarding the performances 2016-2019, decree 49/2014 establishes that a target of 45% needs to be achieved annually, calculated on the total weight of e-waste collected in a certain year and expressed as a percentage of the average weight of EEE put on the market in the previous 3 years. After 2018, the target passes from 45% to 65% annually. *Figure 7* represents the collection rate trend in percentage and as kg/pro capita. All data in *Figure 7* are taken from the CdCRAEE reports.



**Figure 7:** Performance collection of e-waste in Italy expressed in kg pro capita between the years 2016 and 2020

Even if in 2016, 2017, 2018 the target was almost achieved, in 2019 and 2020 the collection falls far behind the new target. According to Longoni from the CdCRAEE, the collection rate in 2019 and 2020 declined due to the introduction of the “Open Scope” norm, which was not supported by appropriate and timely actuation decree and policies (CL1). The “Open Scope” norm broadened the typology of EEE that will be treated as e-waste, following the European Directive 2012/19/EU (CL1). While this strategy had a positive intention, the absence of actuation decrees stopped the implementation and slowed the collection of these new products. Therefore, the collection rate seems lower because calculate on the EEE put on the market, a quantity that with the effect of the “Open Scope” results substantially higher than previous years. (CdCRAEE, 2021a) Comparing these data with the collection rate expressed in kg/per capita, Italy shows a positive trend, with the quantities collected that increases every year. However, the quantities are not sufficient to meet the targets due to delay in ratification of decrees, a strong presence of free riders, lack of inspection and a weak control system, lack of collaboration between stakeholders and clarity of their role and lower capacities of collecting and treating e-waste in the South of Italy. These issues are explained in-depth in Section 4.2.

#### 4.2 Assessment Italian e-waste management and governance system

In this section, the assessment of strengths and weaknesses is presented. The results are divided into the 4 categories (EPR System, Policy and Regulation System, Stakeholders, and Infrastructures) that are part of the assessment framework. The partial score shows the extent of fulfilment of the indicators (as indicated in Table 12) and the total score shows how close or far Italy is in the 4 categories to the ideal situation. The cells coloured in green highlight good performances, the one in yellow correspond to performances that need to be improved and the ones coloured in red underline that the performances are quite negative and in need of more radical improvements. After the tables, a more in-depth explanation of the findings not previously discussed in the policy and performance analyses is presented.

##### 4.2.1 Assessment of the first category: EPR System

Table 16 presents the assessment for the EPR System category.

**Table 16:** Analytical Framework first category: EPR System.

Category	Indicators	Operationalization	Partial Score	Total Score
<b>(1) EPR System</b>	(1.1) Proper and on-time implementation of EPR for e-waste	(1.1.1) Ratification of the EPR system in the Italian Law system before the deadline according to the European Decree. In case a specific implementation is not explicitly mentioned, adopt the implementation time required by general communitarian law.	Delay in ratification: <b>1</b>	19/28 (68%)
		(1.1.2) Presence of actuation decrees (required by the Italian law to put in force a law)	YES: <b>2</b>	
		(1.1.3) Existence of a take-back obligation (Monier et al., 2014)	YES: <b>2</b>	
		(1.1.4) % of territorial coverage (Monier et al., 2014)	The territory is almost entirely covered: <b>2</b>	
		(1.1.5) National or Eu targets are met	NO: <b>0</b>	
	(1.2) Improve Efficiency	(1.2.1) Improved collection rates since the introduction of the EPR scheme	YES: <b>2</b>	
		(1.2.2) Low operations costs	YES: <b>2</b>	
		(1.2.3) Presence of a Producers Responsibility Organization or a single national PROs	YES: <b>2</b>	
		(1.2.4) Increased data availability and collection	YES: <b>2</b>	
		(1.2.5) Percentage of Free riders (Monier et al., 2014)	The percentage of Free riders deeply affects the system: <b>0</b>	
	(1.3) Improve Recycling	(1.3.1) Improved recycling rates since the introduction of the EPR scheme	YES: <b>2</b>	
		(1.3.2) Developments of markets for reusing secondary raw materials (Watkins et al., 2017)	NO: <b>0</b>	
	(1.4) Improve Eco-design	(1.4.1) Improved product design since the introduction of the EPR scheme	NO: <b>0</b>	
		(1.4.2) Presence of eco-design incentives	YES: <b>2</b>	

As the policy analysis has underlined, Italy ratifies the European directives with a constant delay, which is rarely disproved. Even though the presence of actuation decrees (Legislative or Ministerial decrees) support the proper implementation of the laws, many stakeholders affirm that the administrative slowness and bureaucratic atrophy negatively affects the performances (CL1, BS1, AC1). As mentioned before, there are two types of take-back policies “1 against 1” and “1 against 0”. These strategies, coupled with the adoption and the implementation of the national plan at all levels (regions, provinces, and municipalities), and the

active participation of the private sector, improved the collection rate of e-waste since the implementation of the EPR directive. In addition, the presence of multiple PROs lower the costs of EPR fulfilment for the producers (CL1, BS1) and made easier the fulfilment of all obligations. The presence of PROs increased the data availability and collection since the collective systems must report to the clearinghouse and usually they also publish a sustainability or performance report annually.

Regarding recycling rates, data can be found in the reports of the collective systems but there are no official data produced by the government or by ISPRA regarding this. Not all collective systems have public reports, but ERION publishes every year a sustainability report that contains the recycling targets and the achievement. Considering that ERION manages more than 70% of national e-waste (BS1), their recycling achievements are considered a good representation of the Italian system. The 2019 and 2020 reports from ERION (*Table 17*) shows a positive trend for all 5 categories of e-waste, that overachieve the minimum target set by the European Directive 2012/19/EU for recycling in both 2019 and 2020.

**Table 17:** Percentage of recycled e-waste divided by group (ERION, 2021; ECODOM, 2020)

Year\E-waste group	R1 (%)	R2 (%)	R3 (%)	R4 (%)	R5 (%)
2019	86,2	92,2	91,4	91,4	89,3
2020	86,1	92,5	90,6	89,8	94,8
<i>Eu targets Directive 2012/19/EU</i>	<i>80</i>	<i>80</i>	<i>70</i>	<i>60</i>	<i>80</i>

However, these data are not directly collected and elaborated by ERION because the collective system responsibilities of fulfilling EPR involved the processes until the treatment plants (included). Therefore, how the recycling plants decide to recycle the waste they receive from the treatment plants, is not part of the collective system responsibilities.

The low operations cost is a positive aspect of the Italian system. The eco-contribution that producers need to pay is usually around 2% of the EEE cost (BS1) due to the capacity of collective systems to improve their management and efficiency. As also affirmed by Favot (2016), increased efficiency from the collective systems lowers the eco-contribution fees, attracting more producers. Consequently, a higher number of producers associated with a collective system lower the eco-contribution fees that the system will apply because more producers share the costs of EPR implementation (BS1).

Several issues are occurring in the Italian system as indicated by the analysis. These issues are mainly linked to bureaucratic slowness and the absence of a proper control system in place. In the Italian system, the free riders are intended as people in the management of e-waste who are not operating completely illegally, because they still have the permission to deal with e-waste. They collect, dismantle, and resell e-waste components at a lower price, labelling e-waste as “metal” or “iron”. Their treatments are outdated and unsafe and they do not comply with the most recent standards and certification requirements. Considering their price-competitiveness, many municipalities (that have the freedom to choose the contractor for the waste collection) contract with these professionals rather than subscribe to the CdCRAEE. The problem of the free riders affects not only Italian collection performance but also in economic terms. The formal system pays a more expensive eco-contribution (so also the consumers pay more for the products) to cover the costs of those that do not pay any fee. (CL1, BS1, AC1). It was not possible to quantify the percentage of free riders in comparison to the system. ERION estimates that compared to their treatments plants (around 50 companies), free riders could be around a couple of thousand, showing a significant disproportion between legal and parallel systems (BS1).

Regarding the development of markets to reuse secondary raw materials, this is still in development, but the Italian legislative system does not provide the legal support to proceed. In addition, the absence of clear regulation in the use and reuse of materials affect the entire system, from some pieces of equipment to the entire equipment that cannot be refurbished and sold again. Some examples of repairing and recovering systems are appearing in the national territory, but these realities are still quite isolated.

The most lacking goal of EPR is eco-design. Even though the national government has explicitly mentioned in multiple decrees and allocate subsidies to improve durability and reparability of products, producers seem not prioritizing this aspect (BS1). There are not recorded improvements in the reparability aspect, nor a better design of products, as well as no particular policies or strategies in place. Extremely lacking is the coordination between the public and the private sector, resulting in no strategies to achieve the goal. However, subsidies and incentives are present (according to the legislation) but it was not possible to assess the quantities of those incentives nor if they can properly support producers in shifting the production towards more eco-friendly designs.

#### 4.2.2 Assessment of the second category: Policy and Regulation System

Table 18 presents the assessment for the Policy and Regulation System category.

**Table 18:** Analytical Framework second category: Policy and regulation system.

Category	Indicators	Operationalization	Partial Score	Total Score
<b>(2) Policy and Regulation system</b>	(2.1) Proper implementation and observation of E-waste-related directives	(2.1.1) Presence of RoHS law in Italy (Directive 2002/95/EC)	YES: <b>2</b>	14/22 (64%)
		(2.1.2) Presence of recorded violation of Basel Ban amendment	NO: <b>2</b>	
	(2.2) Adequate rule system for e-waste proper treatment	(2.2.1) The regulation system is easily applicable and comprehensible (Bisschop, 2014)	NO: <b>0</b>	
		(2.2.2) "The more-involved actors consider the allocation of responsibilities and the regulations to be clearly stipulated" (Borner & Hegger, 2018, p.275)	NO: <b>0</b>	
		(2.2.3) "The rules system has been adjusted to accommodate flaws" (Borner & Hegger, 2018, p.276)	NO: <b>0</b>	
	(2.3) Subsidy or tax system	(2.3.1) Presence of a subsidy or tax system that encourage the willingness and support the ability to commit to environmental legislation (Bisschop, 2014)	YES: <b>2</b>	
	(2.4) Presence of planning and forecasting strategies	(2.4.1) Presence of a national plan to reduce e-waste, adopted and implemented to all layers of governance	A plan is present and is widely adopted: <b>2</b>	
	(2.5) Monitor and auditing system	(2.5.1) Presence of a system to trace and track waste flows. If the IT capacity is not available, the condition is fulfilled if actors are willing to share knowledge and data and if an exchange platform is available (Kissling et al., 2013 as cited in Borner & Hegger, 2018)	Presence of a trace-and-track system based on stakeholders' knowledge and data sharing: <b>1</b>	
		(2.5.2) Capacity of performing inspections (Bisschop, 2014)	The responsible control body performs irregular inspections, and the sanctioning system is not efficient: <b>1</b>	
	(2.6) Reporting system	(2.6.1) Presence of a detailed system of reporting	YES: <b>2</b>	
		(2.6.2) The actors involved consider the reporting system clear and transparent	YES: <b>2</b>	

The RoHS directive has been transported with Decree 151/2005 and there are not recorded violations of the Basel Ban amendment. However, in 2021 the European Parliament requested an official Parliamentary question regarding the shipment of waste between Italy and Tunisia (European Parliament, 2021b).

Regarding the rule system, Italy scores quite low, with complex legislation, that often lacks in a timely presence of actuation decrees. In addition, all actors interviewed consider the system largely improvable under the clarity aspect. Even though the allocation of responsibility seems quite clear on the decrees, in practice the responsibilities are shared among various actors and the regulations are not clearly stated. The system does not seem improved from the legislative and political point of view and still suffer from a chaotic management style. However, a national plan for reducing e-waste is widely adopted in all regions and the presence of a subsidy or tax system increase the willingness of stakeholders to commit to the environmental legislation (CL1, BS1).

The positive aspects are jeopardized by an inefficient control and sanctioning system, that perform little inspection where needed (the CdCRAEE reports to the government where inspection should take place, but the inspection do not happen often for unknown reasons) but severely punishes legal systems for small incorrectness (CL1). In addition, the Supervisory and Control committee that was instituted with the specific task of performing inspection and improve the overall control system was not renewed in the past 2 years (CL1, BS1). It is still unknown whether with the new Government it will be reintroduced. Thus, the control and sanctioning systems are considered the most compromising weakness of the system and leave substantial space for free riders, improper disposal and management of e-waste.

The trace and track system is put in place by the private actors but it is not widely adopted by the government as a tool to prevent improper disposal. The clearinghouse keeps track of the e-waste flows that go through the collective system, producing a report every year. The reporting system put in place by the CdCRAEE is detailed and precise and the interviewees identify the CdCRAEE reporting system as clear and transparent. On the contrary of the ISPRA reporting system that is not considered transparent and detailed for e-waste. However, for unknown reasons, the data and reports from the CdCRAEE are not transmitted to the European Union (CL1).

#### 4.2.3 Assessment of the third category: Stakeholders

Table 19 presents the assessment for the Stakeholders category.

**Table 19:** Analytical Framework third category: Stakeholders.

Category	Indicators	Operationalization	Partial Score	Total Score
<b>(3) Stakeholders</b>	(3.1) Defined role of stakeholders	(3.1.1) The stakeholders consider their role clear to themselves and to other actors involved	YES: 2	9/16 (56%)
	(3.2) Inclusion of all stakeholders	(3.1.2) Stakeholders from every level (government, business, waste processors, collectors, producers) are included and the governance is interactive	All/most stakeholders are included but the governance is not interactive: 1	
	(3.3) Clear allocation of responsibilities for stakeholders	(3.3.1) The stakeholders consider their responsibility clear to themselves and to other actors involved	YES: 2	
	(3.4) Coordination between stakeholders	(3.4.1) Stakeholders coordinate their strategies and actions autonomously or through a third entity	YES: 2	
	(3.5) Collaboration between stakeholders	(3.5.1) Presence of a forum for transparent and structured stakeholder consultations	NO: 0	
		(3.5.2) Stakeholders strategically collaborate among all layers of governance and between private and public sector	NO: 0	
	(3.6) Knowledge and expertise exchange system	(3.6.1) "Ability to gain insights into one another's knowledge of processes and approaches through learning and knowledge-sharing programmes across e-waste networks" (Wittstruck & Teuteberg, 2012, p.148 as cited in Borner & Hegger, 2018)	YES: 2	
(3.7) Competition between formal and informal sector	(3.7.1) Presence of a competitive informal sector (Bisschop, 2014)	YES: 0		

According to the interviewees, their roles and responsibilities are perceived as clear, and the coordination is facilitated by the CdCRAEE, which has also the capacity of sharing knowledge and technical improvements through the network. On the other hand, cooperation is theoretically recommended (and explicitly mentioned in different decrees) but practically, it is inconsistent or selective. Not all stakeholders are involved in the planning or directly involved in the governance, which is mainly left to the government. The CdCRAEE can occasionally collaborate with the government but a forum for transparent and structured collaboration and consultation is completely missing. As revealed by the interviews, the government should have put in place a forum for consultation with the private sector, but this did not happen in the past few years (BS1). There was no data to assess if the relationship were fruitful in the last 5 or 10 years and one of the factors could be the extremely instability that characterizes the Italian political situation. As mentioned by Longoni, the modus operandi of the National Government has always been quite similar, with rare touchpoints between the private and the public sectors (CL1). The capacity of sharing information in the e-waste network is guaranteed by the work of the clearinghouse that shares knowledge, processes, technological improvements and know-how among all the collective systems. In this matter, the business sector is extremely cooperative with each other, while the government levels (Ministry, regions, provinces, municipalities) suffers from a strict division of roles that deeply affect the collaboration.

Lastly, the presence of a competitive informal sector jeopardizes the proper functioning of the entire system. The first assumption of this research was that the presence of illegal and criminal activities would deeply affect e-waste management, similarly to other waste issues that happened in Italy. On the contrary, the interviews revealed that just a neglectable percentage of e-waste is managed by organized criminality or

general criminality (CL1, BS1, GOV1, GOV3). The majority of improper management comes from the free riders and the informal sector that are not operating with the standards and regulations put in place by the CdCRAEE and the government (BS2). This extent of freedom that allows the informal sector to operate is directly linked to the lacking capacity of performing controls and the weak and discontinuous sanctioning system.

#### 4.2.4 Assessment of the fourth category: Infrastructure

Table 20 presents the assessment for the Infrastructure category.

**Table 20:** Analytical Framework fourth category: Infrastructure.

Category	Indicators	Operationalization	Partial Score	Total Score
<b>(4) Infrastructure</b>	(4.1) Skilled workforce	(4.1.1) Workforce is skilled and updated to a newer system of disposal thanks to specific training or courses provided by the private actors they work for	YES: 2	12/12 (100%)
		(4.1.2) Lack of willingness/flexibility to change over to new practices from the current system	NO: 2	
	(4.2) Infrastructures' facilities	(4.2.1) Presence of storage/collection facilities, transportation companies, treatments plants, and disposal technology	YES: 2	
		(4.2.2) Presence of high standards that e-waste facilities have to comply to	YES: 2	
		(4.2.3) Presence of certifications schemes for waste companies and transportation companies	YES: 2	
	(4.3) Proper and updated technologies for recycling	(4.3.1) Presence of advanced technologies in the treatment plants	YES: 2	

The infrastructure category is the most performing of the four, with positive performances for all indicators. This result is mainly due to the private sector that is responsible for the practical management and disposal of e-waste. The collective system provides training for their employees and to adapt their system to the newest technologies. The standards for e-waste facilities are provided by the CdCRAEE that develops a set of requirements slightly more demanding and ambitious than the Cenelec certification (CL1, BS1). In addition, these standards are mandatory, thus all e-waste companies need to comply with them and only companies certified with the clearinghouse can collaborate with the collective systems.

Even though the infrastructure category scores the maximum, a critical point is the presence of collection centres and treatment plants in the southern regions. Articles 12 and 13 of decree 49/2014 specifies that collection centres should be in a proportionated number to the populations, but this requirement is not fulfilled in the South of Italy. Many interviewees affirmed that the difference between the North and South of Italy are still significant, with fewer collection points in the South and fewer treatments plants (BS1, AC1, GOV5). The latest CdCRAEE Report shows that of 1050 total treatment plants, 729 are in the North, 148 in the Centre and 173 in the South (CdCRAEE, 2021a). This is also reflected in the provincial performances, as showed in Tables 9 and 10. Even though the top performers are both from the North, the Centre, or the South of Italy, all the bottom performers are from the South and the collection pro capita is significantly lower than the top performers.

In conclusion, the analysis conducted showed multiple issues affecting the Italian governance and management system for e-waste. For a clearer overview, *Table 21* presents a summary of the issues divided by category.

**Table 21:** Summary of perceived issues identified through the analysis

Category of the Analytical framework	Perceived issues identified
(1) EPR system	Delay in the ratification of EPR system and e-waste related decrees National targets are not met Significant presence of free riders Markets for reusing secondary raw materials is not fully developed The system in place does not contribute to the eco-design goal
(2) Policy and regulation system	Unclear allocation of responsibilities for stakeholders Unclear regulation system that makes its applicability difficult and chaotic The regulation system is not adjusted to flaws Weak trace and track system Lack of control and inspection systems
(3) Stakeholders	Governance is not interactive Absence of a forum for collaboration and consultation between stakeholders Significant presence of an informal sector
(4) Infrastructures	Significant differences in e-waste management between the North and the South of Italy

## 5. Discussion

The Discussion section of this thesis is structured as follow. The first sub-section (5.1) discusses the first part of the research question *“how is the governance of electronic and electrical waste management currently organized in Italy?”*. Here, the legislative corpus, the performances and the stakeholders involved are summarized and critically discussed. In the second sub-section (5.2) the second part of the research question *“what are the possible options for improvement?”* is reviewed. This section examines the 4 assessments and presents the recommendations for improvement. Lastly, section 5.3 critically discusses the theoretical implication of the research findings.

### 5.1 Governance of e-waste management in Italy

E-waste governance and management in Italy has been approached through 12 decrees over almost 16 years, since 2005. The legislation incorporates the European Directives, implementing different policies to achieve the targets and requirements. Two sets of issues emerged from the policy analysis.

The first set regards the structure that characterizes all decrees. While the European Directives are transcribed precisely and completely, all directives are implemented (almost) constantly in delay. Even though the delay can be considered neglectable in some cases, it is still an indicator of the administrative inefficiency and bureaucratic slowness that characterise the Italian system (Golden, 2003). Secondly, the language of the decree is mostly vague and recommendatory, the requirements are made to the entire stakeholder sphere, encouraging cooperation and coordination. However, a mandatory language is adopted when addressing the business sector, that is responsible for fulfilling the EPR administrative and economic responsibilities through the collective systems. A negative implication of using vague language in laws and decrees is ambiguity in the requirements that could lead to alternative interpretations (Li, 2017). This is the case of free riders that can still operate, to some extent, under the law but not complying with the most updated requirements. Especially for the CdCRAEE standards of safety and treatment of e-waste, free riders are not complying with the law, but they still can manage e-waste since a proper control mechanism is not in place. As explained in Khetriwal et al., (2009), the adoption of a collective producer responsibility system is more economically efficient and customer-oriented, but it is also more vulnerable to the action of free riders. In addition, a collective system is also less effective for eco-design compared to an individual producer responsibility that is more incentivized to adopt an eco-friendlier design to balance the cost of recovery (Atasu & Subramanian, 2012). Lastly, the more mandatory, specific, and strict language reserved to the business sector gives the impression (shared by the majority of stakeholders interviewed) that the Italian government might be more concerned in assuring the payment of fees and fines in case of non-compliance, more than providing the right tools for correct disposal of e-waste.

The second set of issues focuses on the content of the decrees. Firstly, the European Union divided e-waste into 10 different groups categorized by similar characteristics. Italy, on the contrary, adopts a different grouping system with only 5 categories of e-waste, even though the Italian Legislative Decree 151/2005 presents 10 categories of e-waste. The reasons for this specific division in 5 groups are unknown but it might have been due to the capacity of Italy at the time of disposing properly these waste fluxes (BS1). The first issue of keeping this division arise when Italy needs to communicate the data to the European Union, which are in a different format, produced with a misaligned methodology that results in non-compliance and could lead to failing the targets. A second problem related to the data involves the competent body for reporting, ISPRA. Even though ISPRA methodology is considered less precise and incomplete when reporting e-waste, the data produced by CdCRAEE are not considered and not transmitted to the European Union for unknown reasons. Another point of criticism is the nature of the targets and policies themselves. Even though the decrees produced are a mirror of the requirements established by the European Union, the government absolves its duties focusing almost exclusively on collection targets and recycling targets. Despite these goals being crucial for the correct disposal, extremely lacking is a strategy for prevention and eco-design. Even though the European Directives are also lacking in requirements or target for eco-design specifically, this

negligence is in open contracts with the principles of waste hierarchy and circular economy that needs to drive waste management in Italy. Subsidies and a tax system to improve eco-design are present, but it was not possible to estimate the quantity nor the capacity of these strategies to affect producers' attitude in designing electronic and electrical products.

Regarding the stakeholders involved, Italy organizes e-waste management through a complex system. Adopting the definitions developed in the modes of governance framework by Driessen et al. (2012), the Italian governance results in a hybrid form between public-private and interactive. While the national government has the role of planning and setting targets, the regions, provinces, and municipalities have the operational role of transforming the targets in elaborate plans to meet the goals. At the beginning of the 2000s, the governance was slightly more politics-oriented with a private sector not completely involved and active. Even if the business sector was considered for the different policies, it is only after the introduction of the CdCRAEE, the clearinghouse, that the collaboration between private and public started developing consistently. More interactive relationships took place, with clear responsibilities and targets, coupled with a system of track and trace that allowed a stricter control of performances. Currently, the model of EPR adopted by Italy is multiple PROs with a coordinating clearinghouse and a municipal collection service. The involvement of the society was limited, even though the policies "1 against 1" and "1 against 0" put some responsibilities on the consumers and retailers as well. A broader pool of experts, from the academic world as well the business sector, were consulted to produce integrated policies that benefit from a larger base of inputs (CL1). The improvements in planning and cooperation impacted considerably the performances during the decade 2008-2018 that registered constant improvements and some overachievement in collection targets. The business world showed a significant transformation, from mere executor of basic requirements of the first decree in 2005 to driver of change to fulfil the EPR obligations. In particular, the CdCRAEE, considered one of the most virtuous examples of clearinghouse coordinating PROs in Europe (Kling et al., 2018), has a pivotal role in the system. Being involved so tightly in the evolvement of e-waste management, put producers, retailers, collective systems, waste treatment plants and professionals at the centre of change. The competitive business mindset improved the entire e-waste management, which benefited from technical progress, infrastructural improvements, and an overall updated, safer, and cleaner management. In the past couple of years, the collection registered a decrease, but this might be connected to the new Open Scope norm that does not have actuation decrees and the difficulties related to the COVID-19 pandemic in 2020 (CL1). Thus, the e-waste management organization might be quite complex but reflects the *modus operandi* that characterize Italy: a lacking and chaotic political system is coupled with a strong, organized, and proactive business sector that compensates for the weaknesses of the system and improves the performances.

### *5.2 Assessment of the Italian system*

The assessment of the first category, the EPR System, scores relatively positive with 68% of indicators satisfied (19/28). The presence of actuation decrees and the implementation of 2 different take-back policies have positively affected the collection and recycling rate, which registered steady but positive trends in the last 15 years. The improvements are also due to the presence of 12 PROs, operating on the national territory, that fulfilled the EPR obligations for producers, with low costs and constantly producing data and reports. Some negative aspects affect the system, as the delay in ratification of the decrees and the strong presence of free riders that, among others problem, impede the achievement of the European targets. Regarding the eco-design goal of EPR, Italy reflects a more generalize European trend of not compliance. Although the Italian legislator promotes eco-design with subsidies and tax reductions, ameliorations are still not visible. Not having the possibility of interviewing the government, nor the producers or retailers did not allow a proper overview of these subsidies, the amount allocated, which targets they support nor if many producers use the subsidies or tax reduction system. The interviewees from ERION (BS1) hypothesized that producers are not willing to convert their production towards eco-design due to two main reasons: firstly, the use of

recycled and reused materials is still at its initial phase, therefore the costs to convert the production is not convenient. Secondly, consumers are not used to these types of products, and they are still driven by aesthetics and functionality, rather than durability and reparability (BS1). Thus, coupled with a weak legislative and organization system, there is also the consumers' attitude that does not support the adoption of eco-friendly designs in EEE. Lastly, the development of markets for secondary raw materials was difficult to assess for the lack of data, but the interviewees affirm that a proper and consolidated system is far from being fully functioning. Even though the extraction of valuable materials from e-waste is recognized as a pivotal strategy in achieving sustainable production (Marra et al., 2019), it is particularly important for Italy, that do not possess any natural resources for the extraction of metals (AC1).

As for the first one, the second category, policy and regulation system, scores relatively positively with 64% of indicators satisfied (14/22). Positive aspects are the implementation and observation of e-waste related directives, the presence of a subsidy or tax system, and the adoption of a national plan for preventing e-waste. Due to the many responsibilities given to the CdCRAEE, the clearinghouse was able to establish a detailed, clear, and transparent reporting system, contributing to the control system for e-waste management. On the other hand, the adequate rule system indicator is extremely lacking. The legislation is considered quite complex and only thanks to the support of the CdCRAEE that laws are applied properly and timely (CL1). The government and its ramification at all levels suffer from a chaotic approach that results in an unclear division of responsibilities. An example is the division of responsibilities between municipalities, provinces, and regions that, on the decrees, is clear and structured. However, this does not correspond to the perception of stakeholders, that consider the legislation difficult to implement because chaotic and unclear. This approach affects not only the performances but also the capacity of accommodating flaws and improving the system. Another point of criticism is the monitor and auditing system. The trace and track system works only if all actors are registered with the CdCRAEE, requirements that it's mandatory for all actors in the business sector (producers, retailers, collective systems, treatment plants and recycling plants) but not mandatory for the municipalities that can entrust a free rider to take care of e-waste disposal instead of a collective system (BS1). There are no requirements for the municipalities and considering that the free riders do not operate completely against the law, the sanctioning system is extremely difficult, almost impossible to implement (CL1). Another clear example of the weak control and inspection mechanism is the sudden disappearance of the Supervisory and Control Committee. This committee was established by law with decree 151/2005 and was responsible for controlling the proper management of e-waste, programming and performing inspection and controls. Longoni from the CdCRAEE affirmed that the disappearance of this committee left an administrative hole that is vaguely filled by the financial section of the national police, which was not informed about this new responsibility (CL1). This inefficient management cannot support the controls necessary to the proper functioning of the EPR system, but the impossibility of interviewing the government left the doubts regarding the choice of not renewing the committee and the shift in responsibilities allocation unsolved.

The most lacking category of the four is the stakeholders, scoring 56% of indicators' satisfaction (9/16). The major problematics are related to the collaboration, coordination, and exchange of information among stakeholders. Collaboration and coordination are established and structured among the business actors and the government layers, but it is not happening between the two sectors. This is also due to the previous national government, that according to Longoni, did not want to improve the collaboration between the public and private sectors and never established a forum for consultation (CL1). Considering how successful and beneficial is the collaboration between the actors in the business sector, the strict division between the public and private sectors should be abandoned for more interactive governance. The last and major point to ameliorate is the presence of a competitive informal sector and free riders. According to the majority of stakeholders (especially according to the CdCRAEE that knows how the informal sector can operate on the entire national territory), the most effective tool that must be implemented is a proper control and inspection

system, coupled with stricter and clearer rules that do not allow freedom of interpretation. As previously mentioned in the thesis, it would have been interesting to interview the government to understand the reasons why this is not happening. However, during the interviews with regions and provinces, it emerged that the interviewees do not identify the criminal or informal activity as deeply affecting the system, but more as a marginal problem of the system (GOV1, GOV2, GOV3). This different perspective on the criminal or informal activities on the system is also part of the problem that could be (at least partially) solved by more collaboration and consultation between the sectors.

Lastly, the highest-scoring category is the infrastructure, which achieves 100% of indicators' satisfaction. The business sector, and especially the CdCRAEE, is the main responsible for this accomplishment. A skilled workforce and proper and updated technologies and infrastructure is the result of having the CdCRAEE responsible for elaborating the standards for the disposal, treatment, and recycling of waste. In addition, the standards and certification for waste companies are mandatory to be registered with the CdCRAEE, and this does not allow improper treatment in the official e-waste management stream. Nevertheless, some critical points can be discussed. Firstly, the assessment is the results of the study of the documents provided by the stakeholders, coupled with their interviews. Even though these are valuable and trusted information, they still represent only a part of the stakeholders. Secondly, the difference between the North and South of Italy are present also in e-waste management. In the North of Italy where the waste structures and the control system are more developed, the management is more performing, while in the South the performances are significantly lower than average. The North is advantaged by more structural and consolidated capacities (as more collection points or centres around cities or more metabolized knowledge about waste-related issues). On the contrary, the South is still behind in meeting the requirements or even organizing the separate collection (in some municipalities, a proper separate collection of waste was implemented only a few years ago).

### *5.3 Possible Improvements of the Italian System*

Considering the weaknesses identified in the Italian System, this sub-section presents the recommendations, based on stakeholders' inputs and the theoretical background. The first set of recommendations are addressed to the political sphere, in particular the government. To improve the legislation, the Government should train administrative officials to publish on-time decrees and policies, with a clear and mandatory language and a precise allocation of responsibilities. A good starting point to incentivize the eco-design principle of EPR would be to set precise targets for recycled material in new products or reparability, durability, etc instead of vague recommendations. Specifying a goal or a percentage to achieve would make the transition towards eco-friendly design more rapid and it could also be less difficult to improve a better tax system in case of non-compliance. In addition to this, the government could incentive the use of second-hand EEE and to do this, it should simplify the legal and bureaucratic problems related to the difficulties in opening second-hand or repairing shops. The control system could benefit from the restoration of the Supervisory and Control Committee, which coupled with a stronger trace and track system could avoid the loss of e-waste streams. the government (through the financial section of the police) should be more systematic with the fines and sanctions for non-compliance and work in tighter collaboration with the CdCRAEE. Linked to this, a stronger and systematic collaboration between the public and private sectors could substantially improve the overall system, especially in the policy-making moment that could benefit from different inputs and perspectives. The Government should incentivize more repairing, reusing and secondhand shops, proving the right legislation to implement these options to disposal. This would decrease the disposal and also provide an alternative to consumers that do not want to dispose their partially functioning products, but that currently do not have a fair choice (repairing is usually more expensive or complex than buying a new EEE). In addition, the legislation should also simplify the process to open and administrate collection points, which could decrease the scope of action of the informal sector or free riders.

Lastly, the Government could allocate more resources on the education to proper disposal, especially small EEE that is often found in the general waste, even if in little percentages (GOV1).

The second set of recommendations is addressed to the private sector. Even if the business sector is quite advanced and essential in the Italian system, more involvement of retailers and producers in educating citizens about the importance of disposing e-waste properly could be beneficial. In addition, supported by the action of the Government, more collection points and treatment plants should be placed in the Italian territory. This not only would improve the collection rate, especially in the Centre and the South of Italy but would also encourage consumers to bring their e-waste to the collection points. Lastly, also the business sector could push for more touchpoints with the government, not only to improve the situation but also to vocalize their needs and make clear when improvements are needed.

#### *5.4 Theoretical Reflection*

After the research on the e-waste governance and management in Italy, this sub-section reflects on the contribution of this research and the case study on Italy to the theoretical discussion on EPR and e-waste governance.

As envisioned by Lindhqvist (2000), the EPR is a policy strategy that aims at decreasing the environmental impact of a product, shifting the responsibility of the end-of-life stage to the producers. The introduction of the EPR system in Italy contributes to a better organization of collection and recycling and more efficient disposal. The organization has developed and improved in 15 years and higher collection targets were achieved. However, as for many other countries in Europe and not, EPR is still a weak system for the improvement of eco-design.

This thesis confirmed some of the weaknesses identified by the literature, in particular a lack of proactiveness in taking responsibilities beyond the collection targets and little promotion of other circular strategies rather than recycling (Vermeulen & Campbell-Johnston, 2021). Targets and standards are weakly enforced, and this led, among other reasons, to failing the targets. One of the main weaknesses that affect the entire system is the strong presence of free riders, which the EPR system is still not able to address and reduce properly (Vermeulen & Campbell-Johnston, 2021). This finding was in contrast with the initial hypothesis that the organized criminality would have deeply affected the system. On the contrary, the research showed that criminality is partially involved in e-waste management and the free riders are one of the major issues. Freeriding is not a specific issue of Italy, but a common issue in the European Union that needs to focus on monitor and control systems (Baldé et al., 2020) and it is also a problem connected to the choice of adopting a collective producer responsibilities system rather than an individual system (Ketriwhal et al., 2009). Italy tried to contain the problem by making mandatory the registration for businesses to the CdCRAEE, but still, many free riders can avoid the legal streams due to the vagueness of the legislation. Regarding this, the hypotheses that a clear responsibilities' division among stakeholders (Corsini et al., 2017; Monier et al., 2014), the clear and transparent legal and economic framework (Campbell-Johnston et al., 2021; Monier et al., 2014) and a structured surveillance (Monier et al., 2014) and control system (Baldé et al., 2020; Favot et al., 2016; Forti et al., 2020) are fundamental for the proper functioning of EPR are confirmed. Especially in Italy, these aspects were recognized as crucial and still in need of improvements for the e-waste sector.

One of the most positive aspects of the Italian system is the organization through a clearinghouse and multiple PROs that are responsible for fulfilling the majority of EPR requirements. Shifting responsibilities from the political side to the business side was extremely beneficial for the Italian system. More centralized governance would have negatively affected the performances, considering the lacking political system that characterizes Italy. On the contrary, the deep involvement of the business sector improves the overall system and fill some of the gap left by politics, which is usually more focused on immediate results (as collection and recycling goals) rather than a more long-term vision and planning strategy. Considering this, it is important

to recognize that different models of EPR function better in different contexts, and each country customizes the organization also based on their governance capacities.

Regarding the framework adopted for the assessment, the policy and regulation system, the stakeholder and the infrastructure categories have been proven appropriate for studying e-waste governance in Italy. This approach could be useful also in other countries, considering that Lindqvist (2000) stressed the importance of coupling the EPR principle with policy instruments to achieve sustainable solutions. In addition, the role of stakeholders and the level of infrastructures are pivotal factors that determine a successful or improvable e-waste management, and the capacity of the system to avoid illegal or harmful procedures.

## 6. Limitation and Recommendation for Future Research

Before the conclusion, this final section aims to highlight and discuss the limitations of this thesis and provide some recommendations for future research.

Some limitations of the research process should be noted. Due to time constrain, one of the major limitations was conducting the explorative research, analyzing the legislation and the policies, in parallel with the stakeholder analysis. Even though notable information has been collected through the stakeholders and the document they produced, it would have been advisable to first analyze in-depth the legislation, to have a better set of questions when conducting the interviews. The limitation has been partially managed by sending further emails to the interviewees, in some cases also doing a second interview, but this resulted in a fragmented collection of data that slowed the research. Second, too many resources were allocated in contacting all political levels (government, regions, and provinces). This strategy has been carried on for a precise goal, but it also slowed the research and did not achieve the envisioned goal. A different strategy should have been implemented: focusing more on the business sector that was quicker in replying and more available for interviews and questions and allocate a fixed number of hours to spend in trying to reach the political side.

Regarding the methodology, some aspects could have been improved. First, focusing on the actor and policy content features of the Modes of Governance framework (Driessen et al.,2012) was functional for the research, but future research should also try to incorporate the institutional features to have a complete overview of the governance style adopted.

Second, some indicators in the assessment framework could have been better framed or more specific to avoid bias in the interviews and in the results. An example is indicator *4.2 Infrastructures' facilities* which one operationalization is *4.2.1 Presence of storage/collection facilities, transportation companies, treatments plants, and disposal technology*. This operationalization assessed the presence of these infrastructures on the entire national territory but does not grasp the different geographical areas. The limitation was also the results of the little literature found specifically on Italy, and the thesis still adopted an exploratory approach for some aspects never researched before. However, to fill this gap, a broader literature could have been beneficial especially for the operationalization.

Third, the empirical results need to be considered in light of some limitations. The policy analysis was limited by the personal assessment of the language used and the clarity of decrees and articles. Then, the research was affected by the availability of stakeholders. In particular, it was not possible to interview the government, any producer, any treatment or recycling plant employees. Very little information has been gained through the interview with Puglia Region, Latina province and the municipality of Manfredonia. Consequently, the results were influenced by the stakeholders interviewed and their vision and knowledge of e-waste management. Even though the interviewees were fundamental actors of the system, it would have been useful to have a complete overview of the system, interviewing both the private and the public sectors. In addition, interviewing more provinces and regions would have supported the understanding of social and territory differences in Italy, strengthening the results section. Future research should focus on gaining more information from the political side and combining them with the data from the business sector.

Third, concrete data or reports regarding the economic fees, the eco-contribution, and the tax and subsidies system were lacking. It was not possible to assess the recycling phase of e-waste management, due to missing data on the number of recycling plants and their distribution, the type of recycling put in place and the quantities recycled. Some information was taken from the report of the collective systems, but there was no primary data on recycling in Italy.

Lastly, it was not possible to assess concretely the real impact of the free riders nor of the criminal activity. Very little information was available on free riders, mainly from the interviews and some information from

the reports. It was not possible to estimate how many free riders are operating, what is the legislative hole that allows them to operate, and the revenues that they subtract from official streams. The different perceptions that the governmental level and the business have regarding free riders and the informal sector is also an obstacle that does not allow to address and resolve this problem. Further research could explore this difference in perspectives, as well as study in-depth the free riders and informal sector phenomena. A stronger understanding of which are the factors that allow free riders to operate would provide a solid starting point to eventually solve the problem. In addition, it would contribute to at least reduce the action of the informal sector, strengthening legality and proper management in e-waste governance.

## 7. Conclusion

The thesis had the aim of increase the organizational understanding of e-waste management in countries adopting the Extended Producer Responsibility system. To do so, the research focused on the governance of e-waste and the EPR implementation with a case study in Italy, following the research questions: *“How is the governance for electronic and electrical waste management currently organized in Italy? And what are the possible options for improvement?”*.

The results showed that Italy published 12 decrees over 16 years regarding waste management and specifically about e-waste. These decrees are the transposition of the European Directives and the implementation of the EPR system for e-waste management. Italy developed a complex bureaucratic system to fulfil the organizational, economic, and informative responsibilities of EPR, which were divided among different stakeholders. The National Government, mainly the Ministry of the Environment, has the role of adopting and elaborating a national plan for e-waste management. The regions and the provinces organize and control the management while municipalities manage the logistic of collection and the reporting. The producers have the economic and organizational responsibilities of e-waste that are fulfilled through 12 collective systems coordinated by the clearinghouse. The collective systems collect e-waste from the collection centres set by the municipalities, transport it to the treatment plants that dismantle and treat waste. The valuable components and materials are sold to the recycling plants, the rest of the materials are converted into energy or sent to landfills. The economic responsibility is mainly on the producers that pay the so-called eco-contribution which covers the collective system's activities (collection and treatment) and the efficiency prizes. Municipalities cover the costs of setting up the collection centres through the citizens' waste tax.

Regarding performances, Italy registered a constant improvement since the first introduction of EPR in 2005, being able to achieve the target in 2010, 2011 and 2012. Even though the Italian collection in kg/pro capita grew also after 2013, the European goals were not achieved. The introduction of the EPR system benefited the organizational and economic management but the eco-design goal is not impacted. The introduction of two take-back policies, the presence of subsidies in protection of the environment and low operational costs for e-waste management are some of the positive aspects identified through the analysis. In particular, the outstanding capacity of the business sector coordinated by the clearinghouse creates a strong and efficient system to manage e-waste and balance the weaknesses of the political and legislative sectors. However, many issues affect the Italian system and jeopardize the capacity of achieving the targets. The analysis of strengths and weaknesses was divided into 4 categories: EPR system, Policy and regulation system, Stakeholders, and Infrastructures. The main issues identified are a delay in the ratification of the EPR and e-waste related directives, an unclear allocation of responsibilities and unclear regulations. These issues, coupled with a weak control and inspection system, leave space for action to free-riders and the informal sector. Lastly, strong differences are still present between the North and the South of Italy, which collection is affected by fewer collection capacities and centres and fewer treatment plants.

Even though the thesis replied to the research questions, some limitations need to be mentioned. The first and most important aspect that limited this research was relying deeply on the stakeholders. Even though most of the information were accessed through the interviews, the information would have been more complete if more stakeholders would have participated. Especially considering the limited political availability, the research suffered from an incomplete overview of governance and management. Limited data on specific aspects was also a major limitation. Few economic data (eco-contribution and subsidies system on top) affected the full understanding of the economic side of EPR implementation. A similar issue occurred in the study of the informal sector and the free riders, which are identified as a major negative aspect of the Italian system, but it was not possible to have a concrete assessment of their action. Specifically, little information about the economic revenues that they subtract from the formal system were available, and the reasons that impede the government and legislator to take concrete actions against them. Future

research could focus on expanding the knowledge regarding free riders and informal sectors, quantifying the economic impact on the Italian system and understanding what are the legislative holes that allow their (partially legal) actions. In addition, more efforts should be put in interviewing the political side, primarily the Government but also more regions, provinces, and municipalities.

In conclusion, the governance and management of e-waste is a complicated and urgent task. Exploring the EPR implementation in the Italian context increased the comprehension of e-waste governance and management from an organizational point of view. The structure of the thesis allowed a concrete assessment of success factors and implementation barriers in Italy, a country adopting the EPR system for e-waste. More generally, exploring the policies adopted, the stakeholders involved, and the assessment of points of strengths and weaknesses contributed to the scientific knowledge regarding the EPR system for e-waste. The research confirmed the assumption vastly found in literature, that applying the EPR ameliorates efficiency and recycling and increasing collection rates. On the other hand, it is also shown that EPR does not contribute substantially to the eco-design goal, especially when a collective producers responsibility system is adopted. The study of Italy also confirmed that free riders are a major problem in the collective system, coupled with weak control and monitor systems. Nevertheless, collective systems benefit from lower costs and shared technological knowledge that in Italy is guaranteed by the clearinghouse and an efficient business sector.

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## Appendixes

### Appendix 1: Literature review on EPR application, and e-waste governance and management in Italy.

Title of the Article	Author(s)	Year	Main findings
The reverse supply chain of the e-waste management processes in a circular economy framework: Evidence from Italy	Isernia, Passaro, Quinto & Thomas	2018	The paper analyses the territorial differences regarding WEEE collection performances, the role of collection centres, with a specific focus on the performances at the provincial level. The article has two main results. First, in Italy is present a territorial difference between areas regarding e-waste collection rate and e-waste collection centres, where generally the North performs better than the South. Second, it is confirmed the positive correlation between e-waste collection and the presence of collection centres. The majority of underperformers are located in the South of Italy, which did not implement an e-waste collection system before the introduction of the EU waste management system and lack in investments for infrastructures.
The ratio of EPR compliance fees on sales revenues of electrical and electronic equipment in Italy. A circular economy perspective	Favot, Veit & Massarutto	2018	The paper aims to partially understand whether the compliance fees on e-waste, calculated on the real end-of-life costs, encourage a more circular behaviour, with a case study in Italy. The focus was to calculate the EPR fees paid by the producer of household EEE in terms of sales revenues. The results show that the ratio slightly increased from 0,50% in 2009 to 0,53% in 2011 but then progressively decrease to become 0,38% in 2014. According to the authors, with the new collection rates targets established by the European Union, the ratio will possibly increase in the next years. Thus, the EPR policies should focus also on the eco-design goal of EPR to incentive an eco-friendlier approach for the producers.
E-waste collection in Italy: Results from an exploratory analysis	Favot & Grassetti	2017	The paper analyses the influence of the collection phase on the EPR system through an economic assessment based on socio-economic, demographic, technical-organizational and control variables. The results have confirmed the hypothesis: "the presence of e-waste collection points has a positive effect on the results of e-waste collection; southern regions underperform in comparison to central and northern ones; the proportion of household waste collected separately is correlated with the overall e-waste collection results." (p.225) Interesting finding regards the gender lens, where to higher female population corresponds higher collection of e-waste, and the population indicator, that shows the population density negatively affects collection rates.
The evolution of the Italian EPR system for the management of household Waste Electrical and Electronic Equipment (WEEE). Technical and economic performance in the spotlight	Favot, Veit, & Massarutto	2016	The paper analysed the household WEEE management over time, focusing on the technical and the economic performances. Regarding the technical performances, calculated through the performance indicators shows that the target (4kg/inhabitant) was nearly achieved in the 5 years studied (2009-2014) but the new EU targets will put major pressure on the system. For the economic performances, the authors determined that the product costs decreased by more than 35% between 2009 and 2014, mainly since costs of competitions and learning effects were absorbed during those 5 years. In addition, the fees per tonnes collected that producers are charged with from the collective systems, decrease by more than 42%. One of the main limitations observed by the authors is the lack of transparency and data, especially data on costs, that jeopardize the full comprehension of the EPR mechanism.
Why manufacturers of electrical and electronic equipment (EEE) create producer responsibility organizations (PROs) to comply with the WEEE directive? the case of ERP Italia SRL with focus on costs	Favot	2015	The paper specifically analyses the role of producer responsibility organizations (PROs) in EPR schemes with a case study (ERP ITALIA S.R.L.). The research investigated the capacity of this specific PRO of fulfilling the physical, economic, and informative responsibilities of its affiliated producers. Physical duties are fulfilled by taking care of collecting, treating, and recovering e-waste from the collection points. Italian PROs are organized under the national clearinghouse that manages all PROs operating in the national territory. Thanks to the presence of the clearinghouse, the transaction and monitoring operations costs are reduced. The economic responsibilities are on the

			producers that need to cover the costs of the physical duties. The author researched the internal costs for ERP ITALIA S.R.L. during 2010-2011-2012, showing that total treatment and logistic costs decreased. The reasons are linked to an amelioration of e-waste processes that resulted in decreased costs for the producers associated. Lastly, informative responsibilities are fulfilled by the clearinghouse that shares knowledge and research among all PROs, increasing competition that reduces take-back costs. The research showed the central role of the clearinghouse and the fundamental function of competition in decreasing costs for all Italian PROs.
Extended producer responsibility and e-waste management: do institutions matter?	Favot	2014	The paper performed a literature review on EPR for e-waste applying the theoretical framework of the New Institutional Economics (NIE). According to this perspective, institutions play a fundamental role in reducing transaction costs. Therefore, the introduction of EPR as a policy to improve the collection rate of household e-waste was successful because the EPR changed the property rights towards the producers internalizing the negative externalities. In support of this, the author conducted a case study in Italy, where the financial and physical responsibilities of managing e-waste are organized by the collective system (the PROs) under the clearinghouse. This confirms the initial hypothesis that institutions matter in dealing with e-waste externalities and EPR implementation played a pivotal role in changing property rights.
A statistical analysis of prices of electrical and electronic equipment after the introduction of the WEEE directive	Favot & Marini	2013	The paper investigated whether the introduction of the WEEE Directive (with the EPR principle) has produced an increase in prices in the EEE. The research has covered 27 European Member states for 6 categories of EEE and the results are an increase of: <ol style="list-style-type: none"> <li>1. 1,29% for large household appliances</li> <li>2. 1,26% for small electrical household appliances</li> <li>3. 3,38% for reception, recording, reproduction of sound and pictures equipment</li> <li>4. 3,69% for photographic and cinematographic equipment and optical instruments</li> <li>5. 2,31% for information processing equipment</li> <li>6. 0,71% for personal care equipment</li> </ol> With an average increase of 2,19%, the paper showed that the introduction of the WEEE Directive had an impact on EEE prices and consumers.
Extended Producer Responsibility for packaging wastes and WEEE - a comparison of implementation and the role of local authorities across Europe	Cahill, Grimes & Wilson	2010	The paper analyses the implementation of the EPR in 11 European countries according to five indicators: stakeholders and responsibilities, compliance mechanisms, the role of local authorities, financing mechanisms, and merits and limitations. The analysis involved 11 European countries and the main findings for Italy are: (1) Producers (and exporters) and Importers are obliged to register individually to fulfil the take-back policy. (2) The B2C and B2B producers can comply with EPR individually or collectively. (3) The physical responsibility is on distributors and municipalities, that are also responsible for setting up the collection points. (4) The financial responsibility involves distributors, municipalities, and producers.

## Appendix 2: Example of coding and link to the drive folder

Category	Indicator	Stakeholders	Original Code	Translated Code
1. EPR System	1.1.4 Territorial coverage	Favot	“al nord ci sono i centri di raccolta diffusi e gli impianti di trattamento, infatti la raccolta/gestione dà buoni risultati” “Carenza centri di raccolta (soprattutto al sud) anche per problemi amministrativi e di gestione”	in the north, there are widespread collection centres and treatment plants, therefore the collection/management gives good results. Shortage of collection points (especially in the south), also due to administrative and management problems.

### *Link to the Drive folder*

<https://drive.google.com/drive/folders/1LpQOKeoAh3Da5RaoVi6pyRc89iDgr-lc?usp=sharing>

### **Appendix 3:** List of Italian Decrees regarding e-waste with link to the Official Gazette of the Italian Republic

**Legislative Decree 25 July 2005 n°151** (Decreto Legislativo 25 Luglio 2005, n°151)

[https://www.gazzettaufficiale.it/atto/serie\\_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2005-07-29&atto.codiceRedazionale=005G0178&elenco30giorni=false](https://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2005-07-29&atto.codiceRedazionale=005G0178&elenco30giorni=false)

**Legislative Decree 14 April 2006 n°152** (Decreto Legislativo 3 Aprile 2006, n°152)

<https://www.gazzettaufficiale.it/dettaglio/codici/materiaAmbientale>

**Ministerial Decree 25 September 2007 n°185** (Decreto Ministeriale 25 Settembre 2007, n°185)

<https://www.gazzettaufficiale.it/eli/id/2007/11/05/007G0201/sg>

**Ministerial Decree 8 April 2008** (Decreto Ministeriale 8 Aprile 2008)

<https://www.gazzettaufficiale.it/eli/id/2008/04/28/08A02762/sg>

**Ministerial Decree 8 March 2010, n°65** (Decreto Ministeriale 8 Marzo 2010, n°65)

<https://www.gazzettaufficiale.it/eli/id/2010/05/04/010G0087/sg>

**Ministerial Decree 14 March 2014, n°49** (Decreto Ministeriale 14 Marzo 2014, n°49)

<https://www.gazzettaufficiale.it/eli/id/2014/03/28/14G00064/sg>

**Decree 31 May 2016, n°121** (Decreto 31 Maggio 2016, n°121)

<https://www.gazzettaufficiale.it/eli/id/2016/07/07/16G00131/sg>

**Decree 10 June 2016, n°140** (Decreto 10 Giugno 2016, n°140)

<https://www.gazzettaufficiale.it/eli/id/2016/07/23/16G00150/sg>

**Decree 17 June 2016, n°155** (Decreto 17 Giugno 2016, n°155)

[https://www.gazzettaufficiale.it/atto/serie\\_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2016-07-05&atto.codiceRedazionale=16A04938](https://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2016-07-05&atto.codiceRedazionale=16A04938)

**Decree 25 July 2016, n°188** (Decreto 25 Luglio 2016, n°188)

<https://www.gazzettaufficiale.it/eli/id/2016/08/12/16A05934/sg>

**Decree 9 March 2017, n° 68** (Decreto 9 Marzo 2017, n°68)

[https://www.gazzettaufficiale.it/atto/serie\\_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2017-05-27&atto.codiceRedazionale=17G00081](https://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2017-05-27&atto.codiceRedazionale=17G00081)

**Decree 3 September 2020, n°118** (Decreto 3 Settembre 2020, n°118)

<https://www.gazzettaufficiale.it/eli/id/2020/09/12/20G00136/sg>

**Appendix 4:** Minimum recovery target for e-waste set by the European Directive 2012/19/EU. The same targets are found in the 5<sup>th</sup> Appendix of the Italian Ministerial Decree 49/2014.

Minimum targets from 12 August 2012 until 14 August 2015.

1. For large household appliances automatic dispensers:
  - a. 80% must be recovered
  - b. 75% must be recycled
2. For IT and telecommunications equipment and consumer equipment and photovoltaic panels:
  - a. 75% must be recovered
  - b. 65% must be recycled
3. For small household appliances, lighting equipment, electrical and electronic tools, toys, leisure and sports equipment, medical devices and monitoring and control instruments:
  - a. 70% must be recovered
  - b. 50% must be recycled
4. For gas discharged lamps, 80% must be recycled

Minimum targets from 15 August 2015 until 14 August 2018.

1. For large household appliances automatic dispensers:
  - a. 85% must be recovered
  - b. 80% must be prepared for re-use and recycled
2. For IT and telecommunications equipment and consumer equipment and photovoltaic panels:
  - a. 80% must be recovered
  - b. 70% must be prepared for re-use and recycled
3. For small household appliances, lighting equipment, electrical and electronic tools, toys, leisure and sports equipment, medical devices and monitoring and control instruments:
  - a. 75% must be recovered
  - b. 55% must be prepared for re-use and recycled
4. For gas discharged lamps, 80% must be recycled

Minimum targets from 15 August 2018.

1. For temperature exchange equipment and large equipment (any external dimension of 50 cm):
  - a. 85% must be recovered
  - b. 80% must be prepared for re-use and recycled
2. For screen, monitors, and equipment containing screens having a surface greater than 100 cm<sup>2</sup>:
  - a. 80% must be recovered
  - b. 70% must be prepared for re-use and recycled
3. For small equipment and small IT and telecommunication equipment (both with no external dimension more than 50 cm):
  - a. 75% must be recovered
  - b. 55% must be prepared for re-use and recycled
4. For lamps, 80% must be recycled