

## Full length article

# Toward design principles for sound e-waste governance: A research approach illustrated with the case of the Netherlands

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## ABSTRACT

To address the increase in the amount of Waste of Electrical and Electronic Equipment in Europe (WEEE), in 2003 the European Commission issued its WEEE Directive, introducing an extended producer responsibility (EPR). While there is arguably a relationship between modes of e-waste governance and the successful handling of e-waste, the empirical evidence explaining the performance of different modes of e-waste governance is limited. We address this knowledge gap by proposing a framework for analysing and evaluating e-waste governance, inspired by literature on WEEE, reverse logistics and environmental governance. This framework distinguishes between four success conditions that are seen as indicators for the performance of e-waste governance: inclusion of all stakeholders, overall strategic collaboration, an adequate rule system and knowledge sharing/performance management. In addition, the framework distinguishes between different modes of e-waste governance which are assumed to influence the extent to which the success conditions are met. We applied the framework to the case of Dutch e-waste governance to test its usefulness and derive initial lessons and good practices from it. Our findings show that the Dutch e-waste governance arrangement is performing relatively well in terms of meeting the success conditions. We identified some concrete local (pilot) approaches that added an interactive twist to the Dutch e-waste system, which appears to be conducive to the fulfilment of success conditions. These findings suggest that a combination of ‘hard’ public-private and ‘soft’ interactive modes of governance – combining the strong points of formal rules and voluntary action taking – is desirable.

## 1. Introduction

Waste of Electrical and Electronic Equipment (WEEE) from households, hereafter referred to as ‘e-waste’ is a highly complex waste stream, which is rapidly increasing in size (Kumar et al., 2017). Various WEEE management practices exist in different countries (Kilic et al., 2015; Ongondo et al., 2011). In 2003 the European Commission issued its WEEE Directive (Govindan et al., 2015; Khetriwal et al., 2011). In this Directive, the collection, sorting, and disposition alternatives for e-waste from households are to be addressed by extended producer responsibility (EPR). EPR implies that producers are responsible for the end-of-life management of their products with the aim of implementing and optimizing a reverse logistics supply chain (Agrawal et al., 2015). In such a reverse logistics supply chain, different possibilities for the end-of-life management of WEEE are considered and applied, each of them moving ‘further backwards’ on the supply chain (Kilic et al., 2015). These possibilities include the repairing of products; their reuse, possibly after refurbishment; remanufacturing; or breaking WEEE down into raw materials to allow for raw material recycling. Reverse logistics

can bring products back to retailers, distributors, manufacturers and to the raw material stage respectively (Agrawal et al., 2015; Kilic et al., 2015).

Reviews of EPR approaches suggest large inter-country differences in terms of legal implementation, and involved actors and their responsibilities, amongst other factors (Cahill et al., 2011; Favot, 2015; Kiddee et al., 2013; Ongondo et al., 2011; Queiruga et al., 2012; Ylä-Mella et al., 2014). National implementation varies for instance due to the influence of pre-existing policies and systems (Cahill et al., 2011). Some countries have had take-back systems in place prior to the WEEE Directive, while others developed legislation and the EPR system based on the WEEE Directive (Cahill et al., 2011, pp. 458–460). In a recent study, governance and legal issues, along with technical and socio-economic barriers have been identified as crucial barriers to effective WEEE management (Kumar and Dixit, 2018). In the French Midi-Pyrénées Region it was found that the existing EPR approach was governed by fragmented regulations, and lacked the involvement of recovery-recycling and social economy companies as well as consumers (Bahers and Kim, 2018). Further, the involvement, role and responsibility of

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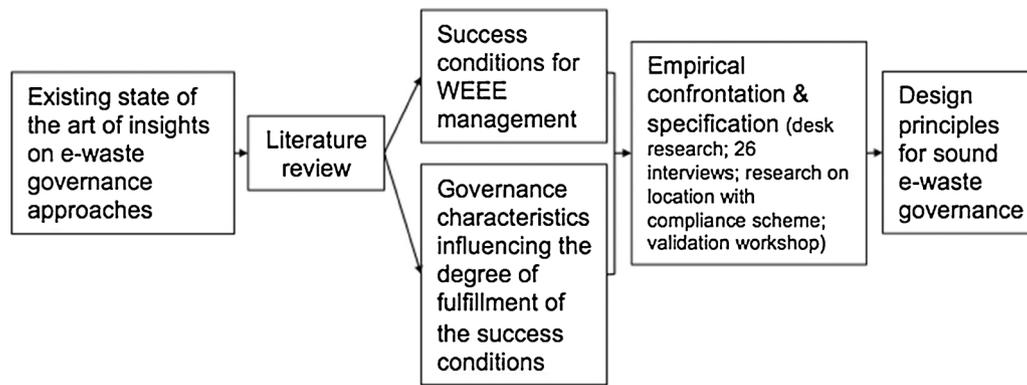


Fig. 1. Research framework outlining the conceptual and methodological steps taken.

different actor groups (private actors, (local) governments, socially responsible enterprises and compliance schemes<sup>1</sup>) differs per WEEE approach (Cahill et al., 2011; Hickle, 2014, p. 56,61-62; Khatriwal et al., 2011, pp. 957–958; Ylä-Mella et al., 2014, p. 42).

There have been, for instance, major differences in the design of compliance scheme systems and in the allocation of responsibilities among municipalities and producers for setting up systems that facilitate the return of WEEE (Cahill et al., 2011, pp. 465–468). Borthakur and Govind (2017) found that the practices and involvement of consumers vary largely between countries, both between (developing and developed) countries and within countries. Moreover, countries differ greatly in the amount of e-waste that is historically present as well as existing management approaches for WEEE (Johnson et al., 2018; Awasthi and Li, 2018).

To adequately understand, explain and evaluate changes in terms of the involved actors and forms of steering the WEEE reverse logistic, a governance perspective may provide an appropriate lens, with ‘governance’ understood as the policies formulated and implemented in dynamic contexts by an ensemble of actors, institutions and content (Driessen et al., 2012, pp. 143–145; Hickle, 2014). Such a perspective may provide the basis for deriving recommendations for e-waste governance, and particularly the implementation of EPR. However, literature on e-waste governance is still in development. Studies have taken some steps in making *analyses* of the governance of EPR, which is often influenced by the “political context of a particular jurisdiction” (Hickle, 2014, p. 59). Regarding systematic *evaluations* of these e-waste governance approaches, much less work has been done. Literature on WEEE suggests that engagement of local authorities in the implementation of the national EPR system leads to more positive results (Cahill et al., 2011). Literature focusing on the reverse logistics or supply chain management of WEEE found success conditions – as discussed in some detail in Section 3 (Janse et al., 2010; Wittstruck and Teuteberg, 2012). But this literature has predominantly focused on the logistic modelling of the reverse supply chain in terms of optimal sites, capacities of collection centres, inspection centres, remanufacturing facilities and recycling plants (Kilic et al., 2015). More detailed empirical insights into the relationship between the underlying governance characteristics and the relative success of e-waste governance approaches are still emerging.

In view of the observed knowledge gap, this paper aims to contribute to literature on e-waste governance by setting up and empirically illustrating a framework for explaining and evaluating the success of e-waste governance approaches. It thereby addresses the main research question of: which governance characteristics improve the chance of a successful outcome of e-waste governance approaches,

characterised by Extended Producer Responsibility? It does so by bringing the success conditions documented by others together in one framework; exploring the extent to which meeting the success conditions might be explained by underlying governance characteristics, and subsequently showing the relevance of the success conditions and governance characteristics in an empirical case.

To achieve the research goal, the following steps have been taken. Section 2 describes the methods. Section 3 introduces a framework for the analysis and evaluation of e-waste governance approaches. Section 4 applies the framework to the empirical case of the Netherlands, leading to the first results on the framework’s applicability and implications of beneficial arrangements for e-waste governance. Section 5 and 6, respectively, provide the discussion and conclusion.

## 2. Methods

We developed a framework for analysis and evaluation of e-waste governance arrangements through a Systematic Literature Review (Berrang-Ford et al., 2015; Bilotta et al., 2014; Haddaway and Pullin, 2014). See Fig. 1 for a detailed explanation of the chosen research framework. We used search terms such as “(modes of) governance”, “WEEE strategies”, and “reverse logistics” in Scopus and Google Scholar. Next, papers on potential success conditions for the reverse logistics of WEEE were searched for by using terms such as “success\* conditions”, “potential” “impact” and “effectiveness”. These terms were used to further select within the literature dealing with reverse logistics, since it is especially in this literature that the facilitation of and barriers to implementing and managing reverse logistics is being discussed (Agrawal et al., 2015, p. 81; Janse et al., 2010, p. 495). Approximately 70 papers were looked at more closely. We zoomed in on papers with a geographical focus on Europe and the U.S. dealing with e-waste and especially on papers that were published after the WEEE Directive was issued. In addition, we looked at papers with a comparatively high citation index (as a proxy for the paper’s influence on the literature). Insights from these papers were used if they provided clear evidence, as judged by the authors, for a relationship between aspects of governance and success conditions.

As a second step, to show the analytical added value of the framework, further operationalise it and explore the relationship between success conditions and governance characteristics (dependent and independent variables respectively), we applied it to the case study of the Dutch compliance scheme system for consumer e-waste. See Fig. 1 for a detailed explanation of the research framework.

The Netherlands, as a EU Member State, is facing the challenge of applying the EPR system as stipulated in the WEEE directive. The country appears to be relatively successful. It has been reported that 44% of e-waste put on the Dutch market (320,000 tons) was collected and treated in 2014 (Nationaal (W)EEE Register, 2015). Herewith, the total collection in 2014 almost achieves the target of 45% by 2016

<sup>1</sup> Compliance schemes, also called Producer Responsibility Organization (PRO), take over the producer’s responsibility for introducing a system of collection, sorting, and disposition alternatives of WEEE (Khatriwal et al., 2011, p. 957).

stipulated by the WEEE Directive, but not the goal of 65% by 2019 (European Union, 2012; Nationaal (W)EEE Register, 2015). Moreover, the Netherlands has a diversified and multi-faceted governance approach reflecting different kinds of EPR implementations. Hence, we expected the Dutch case study to be a rich case study allowing for the identification of good practices.

Due to the explorative nature of the research field, mostly qualitative data and methods have been applied (Verschuren and Doorewaard, 2010). The data collection and its validation included a content analysis utilising legal European and national documents, reports on the Dutch WEEE system, and a number of documents, such as webpages of actors within the Dutch WEEE system (e.g. European Union, 2014, 2012; Huisman et al., 2012; Inspectie Leefomgeving en Transport, n.d.; Nationaal (W)EEE Register, 2015; Rijkswaterstaat Leefomgeving, n.d.; Staatscourant, 2014; Vereniging Producentenverantwoordelijkheid Nederland, 2015; Weee Forum, 2011). During part of the data collection and analysis period (February–March 2016) one of the researchers was based at the location of a Dutch compliance scheme. Being located there provided further insight into the WEEE system through participatory observation (Verschuren and Doorewaard, 2010, p. 179).

As a next step in the field research, 26 qualitative semi-structured interviews with representatives of different actors in the field (see Table 1) were conducted. Qualitative interviews made the integration of multiple perspectives of the WEEE system possible, allowing an encompassing insight into structure, functioning and overall processes (Weiss, 1994, p. 9). The interviews discovered opinions of the characteristics of modes of governance as well as the necessary information to determine the extent to which the success conditions were met (Brinkmann, 2013). The interviews were based on a general interview guideline, available as supplementary document, with main topics and follow-up questions based on the categories identified within the conceptual framework (Weiss, 1994, p. 48). If necessary, the questions in the guideline were slightly adjusted to fully fit the interviewees' background. The interviews were held with the main actor groups in the collection, sorting, and disposition systems of WEEE in the Netherlands: compliance schemes, municipalities, waste management companies, social reuse initiatives, (local) sorting and treatment facilities, consumer organisations, government representatives, and branch organisations for each actor group. In addition to interviewees with a broad overview of the Dutch WEEE system, stakeholders participating in recent local and social sorting and disposition approaches were selected.

**Table 1**  
List of interviewees.

Interviewed organisation	Number of interviewees
Two national compliance schemes	7
Association of WEEE producers	1
International WEEE treatment facilities	3
EERA, European Electronics Recyclers Association	1
UNETO-VNI (Dutch branch organisation for installers and technical retailers)	1
BKN, Branch association for reuse and recycling companies	1
NVRD, Koninklijke Vereniging voor Afval- en Reinigingsmanagement (Dutch association for municipalities and public organisations involved in waste management)	1
Milieu Centraal (organisation doing research and providing communication on sustainable consumption)	1
International EEE producer	1
Ministry of Infrastructure and the Environment	1
Rijkswaterstaat Leefomgeving (Office of Public Works)	1
Human Environment and Transport Inspectorate, Ministry of Infrastructure and the Environment	1
Local sorting and treatment facility	2
Dutch municipalities	2
Social reuse centre	1
United Nations University	1

Thus, an encompassing insight into the Dutch WEEE system was guaranteed. Apart from one interview, all interviews were face-to-face.

The preliminary findings were validated in a workshop conducted on 20 June 2016. Four key stakeholders related to Dutch WEEE system participated. They were representatives of public-private waste management companies, treatment facilities and a collective of municipalities.

Data analysis was an iterative process taking place during the field research phase and refined after the validation workshop. The categories contained in the conceptual framework were used to code the data (Weiss, 1994, pp. 151–153). In addition, more inductive coding also took place. For validation purposes, the workshop has been summarised and compared to the results and recommendations at that point.

### 3. Conceptual framework

#### 3.1. Introduction

The conceptual approach in the paper consists of two steps: an analysis and evaluation of e-waste governance approaches. Our criteria for evaluating the performance of e-waste governance approaches is the extent to which four success conditions for improving the reverse logistics of WEEE have been met. We see this performance of the e-waste governance approaches as our dependent variables. This performance is subsequently linked to our analysis of the governance characteristics, which is our independent variable.

The reason for using success conditions as the object of the evaluation is that literature still provides limited insights into the outcomes of e-waste governance arrangements (Hickle, 2014). It is problematic to directly link certain e-waste and reverse supply chain strategies to specific quantifiable indicators for the impact of these strategies. For instance, it has been claimed that the environmental and social impacts of production networks, e.g. in the apparel industry, are often not measured due to limitations in the science of sustainability measurement and in transforming data into information (O'Rourke, 2014). A study on assessing the impact of sustainable supply chain governance approaches highlights that an actual impact evaluation is complex and cost intensive, but can be approached for instance by the impact potential (Vermeulen and Metselaar, 2015).

Therefore, rather than taking such quantifiable indicators as our dependent variable, we focus on four success conditions for the WEEE system distilled from literature: inclusion of all stakeholders; overall strategic collaboration among actors; presence of an adequate rule system; and presence of knowledge sharing and appropriate performance measurement. By conceptualising the dependent variable in terms of success conditions, we focus on the direct outputs of governance processes that can be attributed to these governance processes with a high degree of certainty, rather than their arguably more indirect and more difficult to measure outcomes and impacts.

To determine how the success conditions may be influenced by characteristics of modes of governance, we turn to environmental governance literature. This rich and diverse literature includes contributions from various disciplinary perspectives. More sociologically inspired studies provide profound analyses and explanations of dynamics in systems of production and consumption (e.g. Spaargaren, 2011; Reckwitz, 2002; Mol and Spaargaren, 2000). This work provides encompassing frameworks for analysing, amongst other issues, how demand for products and services is constituted (Shove et al., 2012), to what extent an ecological restructuring of production consumption systems can be witnessed (Mol and Spaargaren, 2000) and how dynamics in consumption practices in specific empirical domains can be explained (Spaargaren, 2011). Other contributions have adopted perspectives inspired more by insights from the policy and political sciences. This strand of literature includes more normative literature, indicating amongst other issues the need for stimulating participatory

approaches or public-private governance (e.g. Meadowcroft, 2007) but it also includes recent scholarship arguing in favour of making detailed empirical studies of how steering of developments in society is taking place (e.g. Arnouts et al., 2012; Hysing, 2009; Driessen et al., 2012). This literature provides inspiration for making explorative analyses of modes of governance, and therefore we turn to this literature.

Driessen et al. (2012), building upon and inspired by other scholars, provide analytical guidance by distinguishing between five modes of governance: centralised, decentralised, public-private, interactive and self-governance. These are different ways of steering developments in society with different roles for actors belonging to the domains of state, market and civil society. Central and regional/local actors are in the lead in the case of centralised and decentralised governance. Public-private governance entails a joint effort by governmental and market actors. In interactive governance, civil society actors are also involved. Self-governance means that primarily actors from market and civil society will participate, albeit always within the boundaries set by public actors.

In principle, EPR can be pursued through public-private governance and interactive governance. EPR is assumed to function as a policy hybrid “that is underpinned by regulatory measures that built [sic] upon features of a market-based instrument with producers assuming responsibility and thus management for achieving the goals and objectives” (Hickle, 2014, p. 59). Driessen et al. (2012, p. 152) allocated EPR to public-private governance (market stakeholders have some degree of autonomy within pre-determined boundaries). Notwithstanding, an interactive governance (whereby, as well as governments and market stakeholders, civil society also plays an important role) (Driessen et al., 2012, p. 146), seems also to be an applicable mode for EPR. For instance, there has been involvement of social economy enterprises when approaching WEEE (Ylä-Mella et al., 2014, p. 42). Driessen et al. (2012, p. 146) gave a detailed overview of governance features related to the two modes of governance under consideration – public-private governance and interactive governance. These features pertain to characteristics of the actors involved, the institutionalisation of their interactions; and the content of what specific governance modes

produce, amongst other things in terms of the types of goals set and the instruments used. Table 2 summarises some key characteristics of both modes of governance that will be used to inform an explorative analysis of modes of e-waste governance in the Netherlands.

The next sub-sections provide a first step towards synthesising existing but scattered bodies of literature connecting the governance process with the success of an EPR approach to e-waste. We do this by introducing each success condition in turn and providing a first exploration of relevant features of public-private and/or interactive governance that might influence this success condition; noting, however, that the type and direction of this influence is an empirical question. Table 3 provides a summary of the success conditions and indicators that will be introduced in more detail in subsequent sub-sections.

Fig. 2 summarizes the main elements in the conceptual framework that resulted from the literature review. As the figure shows, although the literature provides some ground for speculation about the relevance of certain governance features for meeting the success conditions, the exact relationship between governance characteristics and the extent to which the success conditions have been met needs to be determined through empirical research.

### 3.2. Inclusion of all stakeholders

The development of WEEE systems has been supported by establishing a dialogue between all involved stakeholders (Queiruga et al., 2012, p. 62). According to Cahill et al. (2011, p. 455–478) some countries have achieved successfully positive engagement among all stakeholders, including local authorities. Inclusion can be triggered for instance by establishing a “forum for transparent and structured stakeholder consultation” (Cahill et al., 2011, p. 47).

There may be constellations with central government agencies initiating change to multiple actors from various levels of government, the private sector, and civil society (Driessen et al., 2012, p. 146). Actors involved in the implementation of collection, sorting, and disposition alternatives of WEEE have been found to range between the private domain, the public domain and civil society (Cahill et al., 2011;

**Table 2**  
key characteristics of public-private and interactive governance (based on: Driessen et al., 2012).

	Public-private governance	Interactive governance
<b>Initiating actors</b>	Central government agencies are the initiating actors; private sector is granted a preconditioned role	Multiple initiating actors
<b>Policy levels involved</b>	Local to international policy level	Multiple policy levels
<b>Division of responsibilities over involved actors</b>	Autonomy of market stakeholders within predetermined boundaries	Equal roles for all network partners
<b>Resources influencing power relations</b>	Power is based on competitiveness; contracts and legal resources; legitimacy (agreement on relations and procedures)	Power based on legitimacy (e.g. with formal or informal agreements) trust, and knowledge
<b>Features regarding content: goals and targets</b>	Uniform goals, targets actor specific	Tailor-made and integrated goals and targets
<b>Mechanisms of social interaction</b>	Private actors decide autonomously about collaborations within top-down determined boundaries	Social learning, deliberations and negotiations'

**Table 3**  
Success conditions and indicators.

Success condition	Indicators	References
Inclusion of all stakeholders of WEEE reverse logistics	Consolidation of all relevant actors in a (exchange) forum	Cahill et al. (2011); Queiruga et al., (2012, p. 62); Favot (2015)
Overall strategic collaboration among actors of e-waste reverse logistics	Positive and trustful relationship, aligned waste management strategy	Janse et al. (2010, p. 502); Queiruga et al. (2012); Cahill et al. (2011)
Adequate rule system for the WEEE reverse logistics	Clear allocation of responsibilities and regulations. Rule system is adjusted to changes in its environment.	Cahill et al. (2011); Queiruga et al. (2012)
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.	Kissling et al. (2013); Queiruga et al. (2012); Scruggs et al. (2016); Janse et al. (2010); Kumar and Putnam (2008); Wittstruck and Teuteberg (2012); Sarkis et al. (2010); Hickle (2014); Tonjes and Greene (2012)

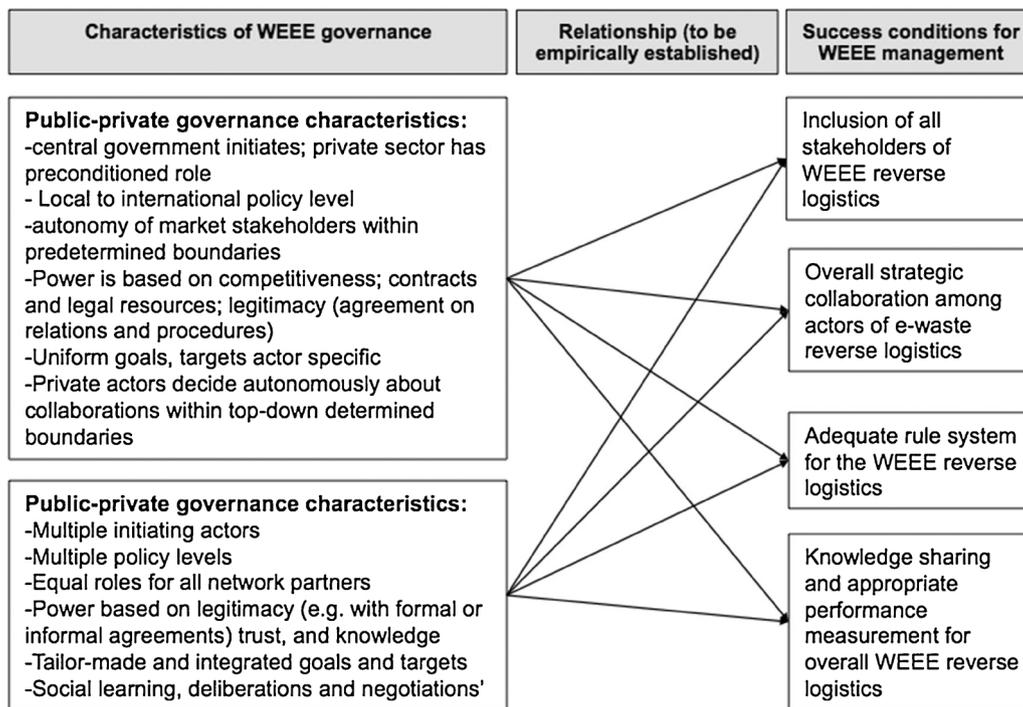


Fig. 2. Conceptual framework resulting from the literature review.

Mayers and Butler, 2013, p. 287; Ylä-Mella et al., 2014). Often EPR is stipulated through regulation, between producers and governmental authorities (Hickle, 2014, p. 56). Cahill et al. (2011) and Favot (2015, p. 1601) found that the chance for success is higher if actors from different policy levels are involved. For instance, it has been claimed that when local authorities have also been in charge of building up the collection infrastructure within the WEEE EPR, “mechanisms for communication, coordination and support (financial and advisory)” have developed, having a positive effect (Cahill et al., 2011, p. 478).

This suggests that an interactive governance approach, in which multiple actors ranging from government at different levels, the private sector and civil society are amongst the initiators, might be conducive to stakeholder inclusion as it may stimulate the involvement of all actors at later stages, such as the design and the implementation phase. An equal involvement of all network actors based on legitimacy appears to be possible. Against this is the autonomy of market stakeholders, acting within a preconditioned role defined by governmental regulations and competitiveness.

### 3.3. Overall strategic collaboration

Reverse logistics refers to the action required to collect and recover used products from customers to allow their proper disposal and to retrieve value (Agrawal et al., 2015). A strategic partnership with all supply chain partners was found to be an important facilitator in managing reverse logistics in a study focusing on the consumer electronics industry (Janse et al., 2010, p. 502), and is thus considered as a success condition of e-waste governance approaches. As mentioned, EPR is considered as a hybrid governance approach, with the many different parties involved interacting with each other (Hickle, 2014, p. 57). Having successful working relations among stakeholders in EPR for e-waste has “implications for the long-term stability of the system” (Cahill et al., 2011, p. 478). Because of the interdependencies between different actors in the case of EPR, it seems especially important to establish connectivity between actors and to adjust activities with other actors in the reversed supply chain. Queiruga et al. (2012, p. 63, 57), focusing on the evolution and factors influencing the development of the WEEE system in Spain, argued for instance that strategic decisions

on WEEE management are taking time and are affecting businesses, but that cooperation among actors is especially crucial.

The success condition can be considered to be fulfilled, when the WEEE actors have a positive and trustful relationship. That implies that the stakeholders are collaboratively integrated or aligned in different approaches to WEEE, following for instance a shared waste management strategy regarding reduction, reuse, and recycling.

Since a wide range of different types of actors needs to be involved in e-waste governance (Huisman et al., 2012), strategic collaboration focusing on the whole reverse supply chain might be influenced by the mechanisms of social interaction that are in place (Driessen et al., 2012, p. 146). When considering public-private governance and interactive governance as viable for EPR, the mechanisms can in principle range from the ability of private actors to decide autonomously to collaborate within determined boundaries, or interactively, including social learning, deliberations and negotiations. Goals and targets, which can be uniform, more specific or tailor-made (Driessen et al., 2012, p. 147) is another governance feature relatable to the fulfilment of a collaborative WEEE approach. Moreover, the power base of actors is a crucial feature influencing collaboration (Driessen et al., 2012; Meadowcroft, 2007; Tenbense, 2005). Actors in the EPR WEEE system might derive power from competitiveness, contracts and legal resources in public-private governance. However, the power base could also be stipulated by legitimacy such as agreements, but also knowledge or trust (Driessen et al., 2012, pp. 146–148).

### 3.4. Adequate rule system

In broad terms institutions, which have been considered as “rules of the game in a society” (North, 1990, p. 3), appear to affect the success of WEEE strategies if they are adequate (Cahill et al., 2011; Young, 2003). Having defined roles and responsibilities for each stakeholder appears to give more positive results (Cahill et al., 2011, pp. 455, 468, 478). In the case of Spain, an adjustment of the rule system addressed the problem of free-riders and has been considered as a development factor for the WEEE system (Queiruga et al., 2012, p. 62). It is assumed that the rule system is adequate if the more involved actors consider the allocation of responsibilities and the regulations to be clearly

stipulated. If there is an adjustment of the rule system over time to accommodate flaws, it is considered to be a positive sign in contributing to the fulfilment of an adequate rule system.

The role of institutions is double-sided: they can cause, but also confront, environmental problems (Young, 2003). Essentially, the fit, interplay, and scale of the institutions are crucial and need to be adjusted (Young, 2003, p. 377). The rules of interaction describing the system are of interest. These rules might be formal or informal and related to public-private or interactive governance (Driessen et al., 2012, p. 146).

### 3.5. Knowledge sharing and appropriate performance measurement

The ability to gain insight into one another's knowledge of processes and approaches (e.g. regarding toxic substances or working safety) through learning and knowledge-sharing programmes across WEEE networks is of crucial importance (Wittstruck & Teuteberg, 2012, p. 148; Sarkis et al., 2010, p. 347). Related to this, an appropriate performance measurement system of reverse logistics is needed (Hickle, 2014, p. 58; Parajuly et al., 2017; Tonjes and Greene, 2012, p. 769). The tracing of chemicals through the (reverse) supply chain requires information systems that allow for achieving follow-up information on chemicals through the entire supply chain (Scruggs et al., 2016, p. 166). Kissling et al. (2013, p. 24) found that transparency and "track-and-trace capability from collection to preparation for re-use to re-distribution (and to recycling and disposal if relevant) of used products" is a success factor, especially in Europe. However, in practice this is seldom available, hindering data collection as well as the overall comparison of different approaches (Hickle, 2014, p. 58; Janse et al., 2010, p. 501). Both knowledge sharing and performance measurement require adequate IT support (Janse et al., 2010, p. 501; Kumar and Putnam, 2008, p. 311), which is seen as a development factor (Queiruga et al., 2012, p. 62). We consider this success condition to be fulfilled if actors are largely willing to share knowledge and if there are specific platforms available for knowledge exchange. Moreover, an appropriate performance measurement and information system for WEEE reverse logistics should be in place that involves all actors in the respective case and is considered to be transparent by the actors involved.

Knowledge sharing and appropriate performance measurements might be relatable to governance features such as the goals and targets, since their direction and type might influence the possibility to assess and share recent developments. So far, it remains unclear which type of goals and targets, namely the interactive tailor-made and integrated goals and targets, or the more uniform goals of public-private governance approaches (Driessen et al., 2012, p. 147) are facilitating success. The mechanisms of social interaction might also influence the approach to performance measurement, such as social learning within interactive governance.

## 4. An empirical illustration: the case of the Dutch e-waste system

### 4.1. Introducing the Dutch e-waste system

The Dutch e-waste system has a relatively advanced and diversified approach compared to other developed countries. The approach reflects different kinds of EPR implementations that can also be found in other developed countries.

At the national level, the Ministry of Infrastructure and the Environment brought the European WEEE Directive into Dutch legislation: a regulation called 'Regeling AEEA', (regulation on discarded electric and electronic equipment) introduced on 14 February 2014 and partly adjusted on 27 January 2016 (Inspectie Leefomgeving en Transport, n.d.; Staatscourant, 2014). Prior to the WEEE Directive there had been a national legislation on WEEE since July 2004 (Cahill et al., 2011, p. 459).

Within the Regeling AEEA, producer responsibility implies that producers and importers (referred to collectively as producers in the following) of EEE are jointly responsible for the equipment that they put on the market once it has reached the disposal stage (Inspectie Leefomgeving en Transport, n.d.). The producers must set up the logistics for waste management and need to take financial responsibility (Inspectie Leefomgeving en Transport, n.d.; Rijkswaterstaat Leefomgeving, n.d.). The financial responsibility for the collection and treatment of the WEEE is based on the amount of EEE put on the market by the producer (Inspectie Leefomgeving en Transport, n.d.). Producers are responsible for the achievement of a minimum collection rate (Inspectie Leefomgeving en Transport, n.d.). Producers putting EEE on the Dutch market can choose to fulfil their "obligation either individually or by joining a collective scheme" (European Union, 2012, p. 41) and thus turn to a compliance scheme (Staatscourant, 2014).

The collection, sorting, and disposition alternatives of WEEE were managed at the time of the research by two national compliance schemes in the Netherlands (Vereniging Producentenverantwoordelijkheid Nederland, 2015). The first compliance scheme in place (in 1999) was the NVMP association, together with its executing organisation Wecycle (NVMP, 2013). In 2013, a second compliance scheme entered the market called Weee Nederland (Weee Nederland, 2015).

The Dutch system has adopted a "chain responsibility", implying that producers, municipalities, retail stores, and treatment facilities have responsibilities for WEEE (Inspectie Leefomgeving en Transport, n.d.; Rijkswaterstaat Leefomgeving, n.d.; Staatscourant, 2014). For instance the mayor and alderman are held responsible, either independently or in cooperation with representatives of other municipalities, for the separate collection of WEEE from private households (Staatscourant, 2014), distributors must provide collection at retail stores free of charge if the sales area related to EEE is at least 400m<sup>2</sup> (European Union, 2012, p. 45), retailers must also provide return opportunities for small WEEE if an end-user wants to return a similar product to that being purchased (European Union, 2012, p. 45), while treatment facilities for WEEE are responsible for achieving minimum (recovery and recycling) targets, which vary by WEEE category (Inspectie Leefomgeving en Transport, n.d.).

With the Regeling AEEA, an independent reporting and registration process for e-waste, a minimum treatment standard and a formal council for actors involved in the e-waste approach have been introduced. These recent developments have led to a general opening of the e-waste market for new actors.

Within the Dutch system, collection, sorting into different treatment categories and actual treatment takes place. The treatment may include different steps depending on the treatment category, for instance, (manual) sorting, dismantling, depollution, shredding, and further sorting of the shredded materials to eventually process them into new raw materials. The final processing steps probably take place beyond the Dutch borders. Additionally, there appear to be new developments within the Dutch compliance scheme system with new local initiatives taking up manual sorting and disposition alternatives of WEEE, integrating people outside the labour market. The local approaches are conducting collection, sorting, and (final) treatment for some WEEE categories, but might involve additionally: (limited) pre-sorting at municipal collection points, manual depollution and dismantling followed again by (final) treatment.

Fig. 3 provides a first overview of the extent to which the Dutch e-waste system has fulfilled the success conditions and the possible relationship with the respective success conditions and governance characteristics. The upcoming sections discuss both in some detail.

### 4.2. Most stakeholders included due to interactive governance characteristics

Since most stakeholders identified at national and local level in the Dutch WEEE system seem to be included due to the existence of

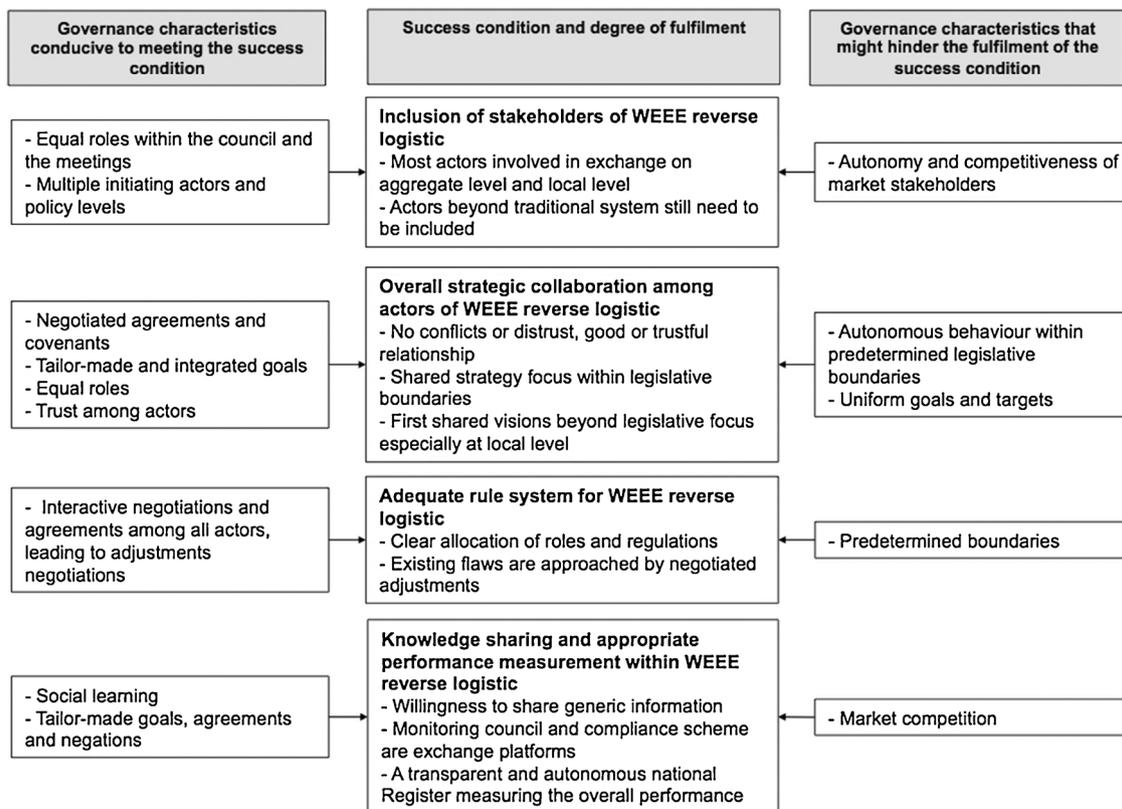


Fig. 3. Degree of fulfilment of success conditions coupled with reliable governance characteristics.

exchange platforms, the success condition seems to be almost fulfilled. However, not including stakeholders beyond the established WEEE system reveals a failure to fulfil the success condition completely, which could be related to public-private governance characteristics. The implementation of the platforms can be related to interactive governance characteristics.

At national level, in addition to the national government represented by a state secretary of the Ministry of Infrastructure and the Environment, compliance schemes and thus producers, branch organisations (of treatment facilities, (online) retail stores, waste management companies and municipalities) are also involved in a forum, namely a monitoring council (*Nationaal (W)EEE Register, n.d.a; Staatscourant, 2014*). The introduction of a council can be considered as a consolidation platform on an aggregate level during the design and implementation processes of the WEEE Directive in the Netherlands, also enabling possible difficulties around legislation of the overall WEEE system to be addressed. The council was initiated by all involved actors or their representative branch organisations, being a sign of interactive governance. Another sign of interactive governance is that the council is established on a shared agreement on equal roles and procedures; namely a covenant among the stakeholders.

At local level, several characteristics of the existing interactive governance might facilitate the inclusion of stakeholders in the design and implementation processes. To begin with, multiple actors initiated the approaches to WEEE, ranging from local sorting and treatment facilities, local governments and compliance schemes, which may also lead to their further inclusion. Equal roles among the actors, compared to the situation at national level, may also have had an influence. Within recent local WEEE approaches, continuous meetings among the main stakeholders are held. In addition, even citizen participation is partially planned.

The interactive governance characteristics might have triggered the overall fulfilment of the success condition. There appear to be equal roles at local and national level, and legitimacy based on agreements.

Moreover, multiple policy levels are involved, namely on the one hand local government and on the other hand national government, in subsequently introducing the monitoring council in the Regeling AEEA, after the WEEE Directive. Nevertheless, the autonomy of (market) stakeholders and competitiveness among actors still exists; evidence for a public-private stakeholder position (Driessen et al., 2012, p. 146). These characteristics might have hindered the inclusion of stakeholders beyond well-established models for WEEE, especially at aggregate level. For instance, it must be considered that the monitoring council mainly includes the traditional parties addressed in the national legislation. The council yet has to focus on other parties, such as social re-use shops (Kringloopwinkel).

#### 4.3. Overall strategic collaboration in place with interactive characteristics

Prior to the introduction of the previously mentioned council there were some conflicts and a lack of trust among actors, especially between producers and recyclers, but these have improved greatly due to the introduced interactive (governance) approaches. The willingness to strategically collaborate beyond the legal framework is limited within the general WEEE system, which can be related to public-private governance characteristics. However, strategic cooperation turning towards innovative approaches to WEEE beyond the legislative regulations are developing within the local pilot approaches, which are reliable to interactive governance approaches. The success condition is almost completely fulfilled.

Since the introduction of a formal monitoring council evaluating and advising on various topics based on a common covenant (*Nationaal (W)EEE Register, n.d.a; Staatscourant, 2014*), and thus an agreement on a higher shared goal, the relationship within the overall Dutch WEEE system has been tremendously enhanced. The introduction of such a council could be taken as an interactive instrument since it is based on a covenant (Driessen et al., 2012, p. 147). There is obviously always some sort of tension present among actors; nevertheless, most interviewees

mentioned either that there are no conflicts or distrust or that there is even a good or trustful relationship among the actors in the Dutch WEEE system.

The interviews showed that most actors are driven by a desire to be compliant with the national legislative framework, which is assumed to steer their willingness to strategically collaborate to fulfil the requirements. Some interviewees mentioned their efforts to achieve set-up targets of the existing legal situation of the WEEE system, which seem however to reduce the development of tailor-made approaches.

Since the legal framework focuses on the collection and recycling of WEEE (European Union, 2014; Staatscourant, 2014) and not too much on re-use options, stakeholders' strategic focus might be predetermined to some extent. Different approaches are, to a certain extent, collaboratively combined, but collection, sorting, and eventually recycling appears to be the main object of most of the actors in the WEEE system. The stakeholder position of the Dutch WEEE system might be influenced by public-private governance since the market stakeholders are autonomously acting within the predetermined WEEE legislation (Driessen et al., 2012, p. 146). Additionally, actor-specific targets and competitiveness are reducing a shared vision on the waste management approach. Thus, these public-private governance characteristics might hinder collaboration beyond legislation.

Nevertheless, recent local WEEE approaches are triggering the fulfilment of a shared strategy focus in the Dutch WEEE system in an interactive manner. To begin with, compliance schemes have started to mediate amongst different actors to find shared strategies, including municipalities, local sorting centres, which are also turning to depollution, dismantling and partly even treatment, and social re-use shops. In addition, some producers and treatment facilities are also interested in taking new approaches to waste management including strategic collaborations, as long as it allows competition. These local approaches are based on interactive mechanisms of social interaction, interactive goals and targets leading to legitimacy among all actors, based on agreements on roles and procedures, trust, and knowledge (Driessen et al., 2012, pp. 146, 147).

#### 4.4. Adequate rule system in place with interactive characteristics

The rule system of the Dutch WEEE system is broadly speaking adequate, since most interviewees agreed that the legal framework clearly stipulates the allocation of responsibilities. Interviewees argued, for instance, that the law on WEEE at a national and European level is distinct as “it makes clear who is responsible” for the WEEE and “it gives clear target amounts” for instance in terms of recycling and recovery rates.

As mentioned, in Dutch legislation a “chain responsibility” is present, implying that municipalities, retail stores, and treatment facilities have responsibilities, as well as producers (Inspectie Leefomgeving en Transport, n.d.; Rijkswaterstaat Leefomgeving, n.d.). For instance, the Regeling AEEA implies that producers and importers of EEE are jointly responsible for the equipment that they put on the market at the stage of its disposal (Inspectie Leefomgeving en Transport, n.d.). Further, distributors must provide free of charge collection at retail stores with a certain size of sales area, when customers want to return a similar product to that being purchased, also if it is an online purchase (European Union, 2012, p. 45; Inspectie Leefomgeving en Transport, n.d.; Staatscourant, 2014), while treatment facilities for WEEE are responsible for achieving minimum (recovery and recycling) targets, which vary by WEEE category (Inspectie Leefomgeving en Transport, n.d.).

Three recent developments at national level have contributed to the rule system's adequacy. Firstly, a Register has been introduced which collects and aggregates data from producers and treatment facilities and reports to the Ministry of Infrastructure and the Environment, who use it as preparation for enforcement (Nationaal (W)EEE Register, n.d.a; Nationaal (W)EEE Register, n.d.b; Nationaal (W)EEE Register, n.d.c).

Secondly, treatment facilities are required to fulfil a minimum standard, called WEEELABEX. The certification grants normative technical and management requirements for operators to correctly handle WEEE<sup>2</sup> (Staatscourant, 2014; Weee Forum, 2011). Thirdly, the aforementioned monitoring council evaluates and gives advice on various topics, such as the achievement of the collection targets stipulated by the WEEE Directive, research, and how to report to the Ministry of Infrastructure and the Environment as well as to the European Commission (Nationaal (W)EEE Register, n.d.a; Staatscourant, 2014). The adjustments enable an opening up of the market, as treatment facilities independent of a compliance scheme can prove their fulfilment of a minimum standard and report their amounts to an independent Register (Vereniging Producentenverantwoordelijkheid Nederland, 2015).

Despite the relative adequacy of the rule system, some actors have pointed out flaws within it, for instance regarding the definition of roles in the Dutch WEEE system. These pertain to the enforcement of legal requirements, and it appears to be unclear which role compliance scheme systems are taking on the system from a legal perspective. This ambiguity raises the question: who would be in charge if issues arose, such as unmet targets? The situation might be relatable to market stakeholders acting within predetermined boundaries, instead of multiple actors with equal roles and involvement in the initial set-up of the rule system.

It is counted in favour of the rule system that there are continuous adjustments to overcome flaws over time, for instance within the monitoring council. This flexibility and adjustment is thus considered a positive sign for the adequateness of the rule system, which might be relatable to interactive governance characteristics, for instance through deliberations and negotiations among actors in the monitoring council.

At a local level, municipalities are free to decide on their waste management approach, including WEEE. In local WEEE approaches, embeddedness still occurs in the overall legal system, including its benefits and flaws. It has been argued that new legislation might be initially intimidating for local sorting and treatment approaches. An example is the introduction of the WEEELABEX certification process. Nevertheless, they have managed, which is proof of a functioning rule system. Additionally, meetings among the involved actors appear to have served to adjust the approaches, following an interactive mechanism of social interaction.

#### 4.5. Knowledge sharing and performance measurement occurring with interactive characteristics

Interviewees were, in general, willing to share information within the WEEE system; however, competitiveness, a sign of public-private governance, might hinder exchange at operational level. An increased exchange has been noted within the recent local approaches, relatable to agreements and negotiations being part of interactive governance. Knowledge exchange platforms exist, and a performance measurement and information system is also in place with a national Register and the WEEELABEX standard.

Besides generic information focused on performance measurements, the operational information of chain actors is considered private and confidential. Some interviewees mentioned that increased competition might lower the willingness to share information publicly; for instance, commissioned research on the national WEEE system. Thus there is willingness to share information on general aspects, but not at an operational level.

Due to the overall position of the compliance scheme in the system, it has been argued that the compliance scheme takes the role of a knowledge platform among its partners. The compliance scheme is also

<sup>2</sup> Operations within the WEEELABEX standard for WEEE “may include collection, handling, shipping, sorting, storage, transport, trading, treatment or preparing for re-use” (Weee Forum, 2011, p. 4).

the link between actors in terms of reporting. The monitoring council, furthermore, can be seen to be an additional knowledge exchange platform for all chain actors. It has been argued that the monitoring council has information sharing as one of its functions, focusing largely on legal issues. It seems that each actor of the WEEE system is a member of a branch organization. The branch organization can also be considered as an information exchange platform, but again focusing on more general issues such as legal aspects.

With regard to the performance measurement and information sharing, an autonomous national Register has been installed, to which producers report the number of products put on the market, and treatment facilities have to register and report their fulfilment of the legal WEEELABEX certification, treated quantities and the eventual treatment results (Vereniging Producentenverantwoordelijkheid Nederland, 2015). The Register is an independent institution and is thus reliable and neutral (Nationaal (W)EEE Register, n.d.a). Most interviewees agreed that the current WEEE system with its certification standard and Register is transparent, as it can be used to reveal who is certified. By utilizing a Register and the WEEELABEX standard, it becomes possible to include WEEE flows in performance measurement that have been encountered outside the compliance scheme system, but are fulfilling the standard. In terms of an information system, it seems that different approaches are followed by the compliance schemes. IT systems are in place to follow up the waste management system.

Within local approaches, there appears to be an increased sharing of operational information among partners beyond the compliance schemes. Again, exchange of knowledge can be related to interactive governance; for instance, in the case of social learning, part of the mechanisms of social interaction. It is also apparent that there is a strong focus on a shared performance measurement, namely evaluations over time based on agreements and negotiations among actors. This, again, is a sign of the prevalence of interactive governance. Within the local approaches, further tailor-made goals are outlined and agreed upon, which may have a further influence on the adjustment of tailor-made performance measurements, being an interactive characteristic of goals and targets.

## 5. Discussion

We started with the observation that detailed and systematic studies of the governance of the reverse supply chain for WEEE in the context of extended producer responsibility are needed. Existing studies on management characteristics of the WEEE reverse supply chain (e.g. Kilic et al., 2015) and governance success conditions (e.g. Cahill et al., 2011; Queiruga et al., 2012) need to be complemented with more studies into the governance characteristics that help to meet these success conditions. The framework developed in this paper has brought together four success conditions for e-waste governance (inclusion of all stakeholders, overall strategic collaboration, an adequate rule system and knowledge sharing/performance management) and has related these to governance characteristics, both at the theoretical (Section 3) and empirical level (Section 4). This endeavour has shown that the quality of the joint effort made by the actors involved is of crucial importance.

Empirical confrontation of these success conditions has confirmed their analytical added value and enabled us to investigate how governance features influence them. In the Dutch situation, we found both dynamism over time and intra-country variation in terms of the modes of governance present, which gives the findings some degree of robustness. The establishment in 2014 of a monitoring council consisting of the Secretary of the Ministry of Infrastructure and the Environment, producer foundations, compliance schemes, treatment organisations, municipalities, public waste management companies, retail shops and the Register has contributed to a better overall strategic cooperation. The recent emergence of local initiatives departing from the mainstream approaches has also added a more interactive twist to e-waste

governance approaches and helped to promote hitherto underutilised ways for dealing with e-waste such as labour-intensive refurbishment and re-use options. We identified some barriers related to public-private governance as it is present in the overall WEEE system. This system, for instance, only slowly started to follow approaches that include actors beyond the market and government, namely civil society, in the form of social re-use shops. The WEEE legislation predetermines the main strategy focus of the actors involved in the WEEE system, namely collection, sorting, and eventually recycling, hindering the inclusion of re-use approaches.

Our study has shown the usefulness of taking governance success conditions rather than 'hard' outcome indicators (such as collection rates) as the dependent variable. First, there is the pragmatic reason of limited data availability and methodological problems associated with the direct linking of governance characteristics to hard outcome indicators (Rossi et al., 2004). Second, there is variation in what different e-waste governance approaches produce in terms of societal impact. Some local schemes, besides contributing to the goals stipulated in the WEEE Directive, also contribute to other 'societal goods' such as the integration of people at a distance from the labour market, or promoting environmental awareness through the promotion of refurbishment and re-use approaches. A research approach focusing only on 'hard' output indicators would have missed these dynamics.

The framework as well as the findings derived from the application of the framework allow this study to contribute to the two main bodies of literature it draws upon: environmental governance literature and literature on WEEE management. Regarding the former, the study adds to an emerging body of literature (Hysing, 2009; Driessen et al., 2012) that aims to provide cumulative empirical insights into (the effects of) environmental governance modes in different societal domains in different geographical contexts. This particular case is another example in which we see a *combination* of modes of governance (ibid) rather than an universal and irreversible shift 'from government to governance'. This study observes that actions by central and regional governments are not disappearing. They remain, and are being complemented with other modes of governance, in this case public-private and interactive governance.

Regarding literature on WEEE management, the study links up with and complements recent studies (e.g. Kumar and Dixit, 2018; Bahers and Kim, 2018; Hickie, 2014). Others have also pointed to the importance of strategic and inclusive approaches that include all relevant actors in the (reverse supply) chain (Bahers and Kim, 2018). These notions have been further unpacked in the current paper and a start has been made with drafting explanations for why relevant success conditions might have been met. With this, our paper has taken further steps towards unpacking the notion of 'sound e-waste governance', the importance of which is increasingly recognised in literature (e.g. Kumar and Dixit, 2018).

## 6. Conclusion

The Dutch e-waste governance system is moving in the direction of a combined public-private and interactive governance mode. In the Netherlands this has proven to be a fruitful approach. Through public-private governance, governmental actors have set clear and measurable targets in terms of collection rates for actors involved in e-waste governance. The coordinating roles played by the monitoring council and compliance schemes, as well as the increasing involvement of civil society actors and socially responsible entrepreneurs in the e-waste governance system, ensures that connectivity between chain actors is being achieved and that a range of technical solutions is being considered.

A lesson might be that deliberation, but also monitoring and enforcement, should take place at the level of the whole reverse supply chain network. Such monitoring and enforcement can be mandated by governmental actors, or these governmental actors can do the monitoring themselves. In addition, regional or national level governments

can decide to actively organize such deliberation. Taking this route would mean that public-private governance will be strengthened.

But the Dutch example also suggests that such ‘hard’ approaches need to be complemented with ‘softer’ approaches like the more local ones discussed in the paper, because they operate at the local level, complementing the WEEE system. As niche developments embedded in the mainstream, they may help to explore alternative ways to govern e-waste together with stakeholders such as compliance schemes, including potential ways to combine improvements in reverse supply chain management with other ‘societal goods’ such as integrating people at a distance from the labour market. The challenge is to stimulate and nurture such local initiatives. What such ‘stimulating and nurturing’ would entail in practice is still to be further explored. In any case, it seems safe to write that such local initiatives need some degree of protection, as suggested amongst others by Schot and Geels (2008). This might imply that these initiatives are not narrowly evaluated solely on, for instance, the collection and recycling rates they help to achieve, but with an open mind for the other societal goods they might produce.

We hope that the research approach followed in this paper will inspire other scholars to conduct comparative studies into e-waste governance approaches. A critical review of the framework used, combined with a further extension of the empirical knowledge base, might further corroborate and refine the findings contained in this paper. In line with others (Bahers and Kim, 2018; Borthakur and Govind, 2017) we recommend to, furthermore, engage in a thorough assessment of consumers’ e-waste practices and the governance thereof.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.resconrec.2018.02.013>.

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