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Minimizing Macro-Level Uncertainties for Quality Assurance in Reverse Logistics Supply Chains of Demolition Waste

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Abstract: In light of the increasing detrimental effects on sustainability, the reverse logistics supply chain (RLSC) has emerged as one of the remedies in the construction industry, whereby the bulk of demolition waste (DW) is returned into the production cycle. Quality assurance (QA) plays an important role in RLSCs, which needs an information-rich environment enriched with external stakeholders' influence strategies. However, due to ineffective external stakeholders' influence, useful information is not available, making macro-level uncertainties for QA. Given this, the current study aimed to identify the macro-level uncertainties for QA in the RLSC of DW. The study used a qualitative approach involving 21 semi-structured interviews representing five external stakeholder categories. The study found the regulatory uncertainties are the root causes that propagate through incentivizing and contractual uncertainties to influence QA in the RLSC. The external stakeholders could employ measures such as 'reforming regulatory instruments', 'employing effective incentivizing schemes' and 'active involvement of forward supply chain actors' to minimize uncertainties at their source. The external and internal stakeholders can use these findings as a roadmap to determine suitable measures to overcome macro-level uncertainties in the RLSC. Furthermore, the study paved an avenue to integrate stakeholder theory and organizational information processing theory (OIPT) in future research.

Keywords: demolition waste; external stakeholders; organizational information processing theory; macro-level uncertainty; quality assurance; reverse logistics supply chains; stakeholder theory

Citation: Wijewickrama, M.K.C.S.; Rameezdeen, R.; Ochoa, J.J.; Chileshe, N. Minimizing Macro-Level Uncertainties for Quality Assurance in Reverse Logistics Supply Chains of Demolition Waste. *Sustainability* **2021**, *13*, 13069. https://doi.org/10.3390/su132313069

Academic Editor: Castorina Silva Vieira

Received: 17 September 2021
Accepted: 16 November 2021
Published: 25 November 2021

1. Introduction

Construction and demolition waste (CDW) contributes to the largest waste flows, constituting 30–40% of the total solid waste [1]. CDW is generated from construction, renovation, and demolition activities [2]. The demolition waste (DW) holds more than 50% of the total CDW, with a high heterogeneous blend of inert and non-inert waste with hazardous and non-treated materials [3]. Thus, DW management is a significant challenge for the construction industry [4]. The reverse logistics supply chains (RLSCs) are becoming popular among practitioners in the construction industry as a viable approach to managing fast-growing volumes of DW. RLSCs possess operational stages such as dismantling, on-site processing, off-site resource recovery, landfill and marketing of reprocessed products [5]. The reverse logistics (RL) performance is decided based upon the rate of landfill diversion and waste recovery [6]. Therefore, products with quality equal to or higher than virgin materials are a significant performance criterion for RL implementation in the construction industry [7].

The inferior quality of re-processed products is a significant barrier to RL adoption [6,7]. The quality of products does not happen by accident. Instead, the production process should be appropriately managed to ensure satisfactory and consistent quality [8,9]. Given this, quality assurance (QA), a process-centred and planned approach, plays a vital role in the RLSCs to produce final products with quality compliance to the end-user expectations [10]. Many previous studies have highlighted the importance of useful information for quality management practices in the RLSCs [5,10,11]. According to Lotfi et al. [12], useful information means an organized set of knowledge that helps make an array of decisions and guided actions. Chileshe et al. [5] found that lack of useful information is the root cause of quality issues in re-processed products. Jayasinghe et al. [11] postulated that information and quality are key aspects of RL performance, which connect each other with external stakeholders' influence. Correspondingly, Wijewickrama et al. [10] proved that QA in the RLSCs is a system integrated and coordinated in an information-rich environment, supported by external stakeholders' influence strategies.

As with any unconventional practice, RL's widespread adoption does not happen without external stakeholders' support [13,14]. The seminal study by Carter and Ellram [15] asserted that all activities of an organization in a RLSC are affected by four types of external stakeholders: customers (i.e., end-users), suppliers, competitors, and government agencies. All these external stakeholders employ different strategies to influence an organization's RL activities. For instance, Rebehy et al. [16] highlighted that RL implementation in Brazil is receiving stimulus from federal government regulatory enforcement. Chileshe et al. [6] found that as the end-user, the Department of Planning, Transport and Infrastructure (DPTI) in South Australia (SA) has developed specifications to inform the RL organizations of product quality control and compliance requirements. Wijewickrama et al. [17] found that government and professional groups act as information brokers who generate preliminary but important information for stakeholders to process their internal information. Interestingly, the literature around stakeholder theory also affirmed that the external stakeholders, through their influence, generate and provide useful information for internal stakeholders to make decisions needed to perform their jobs [18,19]. With this, the current study conceptualizes the external stakeholders' influence strategies, which generate and provide information as 'external stakeholders' information-centric influence strategies'.

However, ineffective external stakeholders' influences prevent successful RL adoption. Govindan and Bouzon [20] found that a lack of legislation or inappropriate laws is a major global barrier to waste management. The authors further asserted that lack of support and poor coordination from customers hinders the RL implementation. When the external stakeholders' influence strategies are not effectively implemented, the useful information needed for the RL implementation is not made available to internal stakeholders. According to the Organizational Information Processing Theory (OIPT), lack of useful information creates 'uncertainties' that will lead to information processing needs (IPNs), to which the organization must respond effectively to meet the expected performance [21,22]. The uncertainties that arise from external factors outside the supply chain, which are not within the direct span of control of the organizations in the supply chain, are defined as 'macro-level uncertainties' [23–25]. An organization needs to identify uncertainties at a macro-level because not having them identified has an adverse impact on organizational performance [24,25]. Given this, the current study argues that internal stakeholders in the RLSCs encounter macro-level uncertainties due to ineffective information-centric influencing strategies employed by external stakeholders. These macro-level uncertainties create IPNs for internal stakeholders to respond appropriately [26]; otherwise, they would not perform QA effectively and efficiently. Therefore, investigating the macro-level uncertainties for QA in the RLSCs, becomes relevant and timely.

Despite the presence of many studies on RL around other industries, they might not necessarily be applicable to the explanation of several issues within the context of the construction industry [6]. Furthermore, the managerial knowledge from other industries could not be applied in the construction industry since it has a unique role in driving

activities [27]. In the construction context, most of the previous studies have focused attention on mapping the existing trends and suggesting further research directions to promote RL in the construction industry, largely by conducting review studies. Hosseini et al. [28] were the first to conduct a qualitative meta-analysis to identify the factors that influence the adoption of RL in the construction industry. After that, other researchers subsequently expanded the field of investigation. However, the body of knowledge on RL lacks much empirical evidence to support its widespread use [26,29]. Most previous empirical studies have been done to conceptualize the notion in the construction industry because the research on RL is still in its infant stage in the construction context [30,31]. For instance, while some of the previous studies have found advantages of adopting RL in the construction industry [32], another cluster of studies have been done to identify the barriers for the implementation and measures to overcome them [30,33]. As asserted by Bouzon et al. [34], "understanding the factors that influence the implementation of reverse supply chain systems is one of the first steps for companies to get interested in RL issues" (p. 14). Given this, Chileshe et al. [6] conducted the foremost empirical study to provide a comprehensive description of the environmental factors which drive the RL implementation in the construction industry. Herein, the authors found that regulations, license and government are the external drivers which promote RL in the construction industry. Wijewickrama et al. [35] subsequently expanded upon this earlier work and identified that external stakeholders through information-centric strategies such as regulating, monitoring, leading, incentivizing, demolition approval, forming contracts and specifications influence the QA in the RLSC of DW. Both these studies, however, emphasized that external stakeholders' influence does not always act as a driver but would also become a barrier for the RL implementation in construction. For instance, the study by Wijewickrama et al. [35] proffered as the similar way the external stakeholders' influence strategies promote the QA, the lapses and issues of the same strategies would create uncertainties for the QA in the RLSC of DW. Even though studies have identified external factors that influence the RL implementation, none have investigated the source of macro-level uncertainties from this external influence, which impacts QA in the RLSC of DW. On this note, to fulfil this knowledge gap, the current study aims to identify macro-level uncertainties for QA that arise from external stakeholders' influence in the RLSC of DW and propose minimisation measures. Given this, the following research questions were developed to guide this study:

RQ1. What are the macro-level uncertainties for QA in RLSC of DW that arise from external stakeholders' influence?

RQ2. How could these uncertainties be minimized from the external stakeholders' perspective?

This study was conducted in SA because it was the highest-ranked jurisdiction in Australia for waste management, with a waste recovery rate of 85% and a recycling rate of 80% [36]. Furthermore, being the leader in innovative waste management in Australia, SA reached 90% diversion rate of CDW in the year 2020, and this is expected to increase by 5% at the end of the year 2025 [37]. Therefore, understanding the existing industry's deficiencies and corresponding measures is imperative in achieving this target successfully.

The study's findings are expected to contribute to the theory building by adding new insight into stakeholder theory and OIPT. Accordingly, the study put forward the proposition that the external stakeholders' influence creates macro-level uncertainties, leading to IPNs in an organization. In terms of practical implications, the study's findings could raise awareness of internal stakeholders in the RLSC about the macro-level uncertainties they need to manage to assure their process quality. Besides, the findings will also provide a 'road map' for external stakeholders to develop appropriate measures that they need to employ to minimize macro-level uncertainties, which source from their influence for successful QA in the RLCS of DW.

The following sections of the paper are structured as follows: Sections 2 and 3 outline the literature review and research methodology, respectively. Subsequently, the results of

the study are presented, followed by the discussion of the results. The final sections of the paper are sequentially arranged as the implications of the study and the conclusions.

2. Literature Review

The current study identifies the following two knowledge gaps based on the literature review of previous empirical and theoretical studies. The empirical studies around the RLSC of DW, on the one hand, have not used a theoretical base to explain the influence of its external stakeholders. On the other hand, the existing theoretical studies have not described the macro-level uncertainties that arise from external stakeholders' influence strategies with data from practical contexts. The following sections explain each of these knowledge gaps comprehensively.

2.1. Theoretical Background of the Study

After the publication of 'Strategic Management: A Stakeholder Approach' by Freeman (1984), the interest in stakeholder literature has considerably grown [38]. A stakeholder is defined as "any group or individual who can affect or is affected by the achievement of the firm's objectives" [38] (p. 46). As this definition signposts, stakeholder management could be explored from either of the following two perspectives: (1) the focal organization/supply chain/project perspective and (2) the external stakeholders' perspective. The current study focuses on the external stakeholders' perspective, which has not attracted much attention from previous studies compared with the other perspective [39].

Even though the internal stakeholders are directly involved in organizational decision making, the external stakeholders do not have any formal authority to become involved but could passively influence decision making [40]. External stakeholders employ various strategies to influence the focal organization's decisions directly or indirectly [39]. According to Frooman [41], influence strategies are attitudinal and behavioural gestures the external stakeholders use to amend a target's behaviours to achieve their expected goals. This study further highlighted that power is a significant determinant of influence strategies. Co and Barro [42] proposed a dual characterization of stakeholders' influence strategies as aggressive and cooperative. Herein, the aggressive strategies are cohesive and forceful attitudes or behavioural gestures that stakeholders employ to alter the target's behaviour. Alternatively, cooperative strategies are forceless attitudes or behavioural gestures that voluntarily alter the target's behaviour in the most acceptable way. External stakeholders' influence strategies would differ depending on their potentials to influence an organization [18,38,43]. Accordingly, some stakeholders employ strategies to support an organization to achieve its goals, while others demonstrate non-supportive potentials due to their interests [18,43]. All these stakeholder types employ aggressive and cooperative strategies to exert their supportive or non-supportive influence over organizational performance.

An organization has a relationship with its external stakeholders through a mutual exchange of money, material, and information [44,45]. The focus of this study is on information flow, which steers the other two flows as well. The external stakeholders produce useful information required for knowledge-based decision making in an organization [17,19]. Through different influence strategies, the external stakeholders provide this information to the internal stakeholders, and thus, external stakeholders' influence strategies are a good source of information for internal stakeholders. However, the internal stakeholders encounter difficulty obtaining useful information when many external stakeholders are associated with an organization, and the majority are not within their control [46]. Besides, Kembro et al. [47] emphasized that when the external stakeholders exist further upstream (i.e., organization's suppliers) and downstream (i.e., organizations which deliver products to the final customers) in the value chain, it is more challenging to interact with them and, thus, difficult to receive information. In some cases, the external stakeholders are unwilling to provide information for internal stakeholders [19,46]. Some stakeholders are unaware that the information they possess could benefit the internal stakeholder in achieving their

goals [17,19]. Due to these facts, lapses exist in external stakeholders' influence strategies, and thus, the internal stakeholders would be devoid of useful information.

From the stakeholder theory perspective, external stakeholders are a significant source of uncertainty for an organization [48,49]. Ward and Chapman [48] stated that these uncertainties may differ with the stakeholder's type, how they could influence, and the influencing target. From the OIPT perspective, Galbraith [22] asserted that organizations encounter uncertainties when useful information is not available when they are needed. The theory posits that the uncertainties arising from the organization's environment create IPNs, which the organization must manage appropriately [50]. Previous researchers introduced these uncertainties either as 'environmental uncertainties' [21,26,51] or 'macro-level uncertainties' [23–25]. However, the current study suggests that the uncertainties encountered by an organization/supply chain due to the influence of external stakeholders are 'macro-level uncertainties'. As per the OIPT, to cope with uncertainties and resultant IPNs, the organization needs to either reduce uncertainties or increase its information processing capabilities (IPCs) to enhance the internal information flow [22]. Reducing uncertainties is a proactive and effective strategy that organizations should consider when managing uncertainties [52]. However, as the macro-level uncertainties arise from issues beyond organizations' control, the external stakeholders can minimize them at their source by employing different strategies.

Despite adopting stakeholder theory and OIPT separately in previous studies, to the authors' best knowledge, none of the previous studies combined them to explain an issue with data from real-world scenarios. Therefore, the current study is aimed at filling this gap by identifying macro-level uncertainties source from external stakeholders' influence and how these uncertainties could be minimized at their source within the context of RLSC of DW.

2.2. Empirical Background of the Study

Reverse logistics (RL) is defined as the reverse flow of forward logistics, that steer the construction industry to adopt a closed-loop supply chain, enabling a paradigm shift towards a circular economy [53]. Unlike in other industries, the RLSC in the construction industry constitutes several organizations with diverse interests that are responsible for different RL practices [11]. In general, the demolishers dismantle, collect, sort, and transport recovered waste to an off-site resource recovery facility and contaminated waste to landfills [11,26]. On the other hand, the waste processors have their own transfer stations, material recovery facilities (MRFs), landfill depots and compositing depots [54]. Furthermore, in SA, most waste processors are engaged in re-processing and marketing their products to the secondary market. In summary, as demolishers and waste processors, two primary internal stakeholder organizations are involved in the RLSC of DW in SA.

RLSC is subjected to many different barriers. Of all, the negative perception of end-users about the quality of re-processed products has been identified as a make-or-break barrier for the RL implementation in the construction industry [7,33,55]. While compounding this negative perception, some studies have also highlighted that end-users had experienced quality issues in re-processed products in practice [6,7]. The final product quality depends on the performance quality of the activities at each stage in a supply chain [9]. Therefore, irrespective of the industry, QA plays an important role in the RLSC, ensuring its process quality to produce a quality output [8,10].

The QA is a process-centred, systematic and planned approach that roots in the manufacturing industry [56]. The primary purpose of QA is to assure the process quality, which in turn produces a quality output that conforms with the customer requirements [57]. As proclaimed by Fox [58], each task in the production process should be carefully examined to identify and eliminate quality issues during the QA process. The author further asserted that QA process constitutes of four elements namely, 'documentation required', 'the item being worked upon', 'the equipment being used to perform the task' and the 'person carrying out the task'. Correspondingly, Wijewickrama et al. [10] expanded upon this earlier work, and established that QA in a RLSC is a system of four elements: process,

people, policy and technology. The author further revealed that, to integrate these four elements, an information-rich environment should exist for QA in a RLSC, which external stakeholders should support and promote.

The influential study by Carter and Ellram [15] indicates that the external environment influences the RL performance. The study showed that a greater understating of the supply chain could be achieved through examining the external environment's influence over the RLSC. Due to the intrinsic differences between internal stakeholder organizations, the external stakeholders' influence strategies differ [59,60]. Interestingly, a number of studies identified the external stakeholders' influence as drivers [1,60,61] and barriers [61,62] for the RL implementation in the construction industry. For instance, Rodríguez et al. [61] mentioned that through its national Act, the Spanish government defines stakeholders' responsibilities in promoting the RL practices in the construction industry. Then again, the same Act does not disclose the requirements related to managing hazardous waste. Therefore, despite external stakeholders' influence strategies acting as drivers, any lapse in the strategy will be a barrier to successful RL implementation.

The external stakeholders' influence strategies generate and provide useful information for the internal stakeholders in the RLSC of DW. Wijewickrama et al. [17] found that the government, as the most influential external stakeholder, provides useful information to the internal stakeholders in a RLSC by employing three strategies: regulating, subsidizing, and leading. The authors further clarified that the external professional communities provide information to the internal stakeholders via standardizing, educating, informing, and leading. Wijewickrama et al. [63] accentuated the importance of the information provided by external stakeholders as they become the base for internal stakeholders to process most of their in-house information. However, the RLSC in the construction industry has not benefited from a well-structured information flow [5]. It has been found that the entire supply chain is deficient in useful information needed for decision making, resulting in fragmentation and many uncertainties [64]. Since the external stakeholders' influence is the main source of information in a RLSC, the ineffective external stakeholders' influence strategies could be a persuasive cause for information deficiency in the RLSC of DW. Therefore, the external stakeholders' influence strategies and absence of useful information (i.e., uncertainties) in the supply chain could be dependable and related.

Despite the availability of many systematic literature reviews (SLRs) on the RLSC of DW, e.g., [10,14,60,63], only a few empirical studies have been conducted around the area under study. Moreover, these previous empirical studies have been limited in identifying EoL phase activities while outlining associated advantages [32], barriers [30,33], and drivers [6,31]. Still, none has used a theoretical base to understand the social context of the RLSC of DW. A theory that underpins a study is often viewed as a lens to examine the socio-technical context of an issue under investigation [65]. Herein, the theory is intended to explain 'how' and 'why' things happen, focusing on data collection and providing a basis to conduct the analysis. Given this, the current study uses the stakeholder theory and OIPT to explain macro-level uncertainties for QA in the RLSC of DW.

3. Research Methodology

This section briefly discusses the research approach, data collection and participants, data preparation and analysis, and the study's trustworthiness.

3.1. Research Approach

The qualitative approach was adopted, as it was considered appropriate for the study due to the exploratory nature of this topic. Pillay and Mafini [66] stressed that the qualitative approach is most suitable for applying in contexts rarely being researched. According to Merriam [67], "the key philosophical assumption upon which all types of qualitative research are based is the view that reality is constructed by individuals interacting with their social worlds" (p. 6). Furthermore, the author mentioned that "reality is not an objective entity; rather, there are multiple interpretations of reality" (p. 22). Therefore, the qualitative approach

enables an understanding of the multiple realities over an issue that changes with different settings. The RL notion is still hardly being researched within the context of the construction industry [7]. Moreover, van den Berg et al. [26] argued the uncertainties that arise due to the external environment at the end-of-life building (EoLB) stage could be changed as many stakeholders interact with each other. Thus, multiple interpretations of reality could exist based on different stakeholders to explain the issues under consideration of the current study. Accordingly, the study demanded an exploratory understanding of uncertainties arising from external stakeholders' influence strategies, which could be achieved through the qualitative approach [68]. While the theoretical background argues the lapses in the external stakeholders' influence strategies lead to uncertainties, this has not been explored in any context. Therefore, in-depth semi-structured interviews are applicable for exploratory qualitative research, primarily in this context, since the stakeholders' influence strategies are subjective [69].

3.2. Data Collection and Participants

Carter and Ellram [15] asserted that customers, suppliers, competitors and government agencies could influence the RL performance, irrespective of the industry. Representing three of these categories, the state and local government agencies, forward supply chain -downstream and upstream actors are the external stakeholder categories in the RLSC of DW in SA [37]. Non-government organizations (NGOs) were also incorporated as they play a critical role in waste management [70,71]. A total of 21 interviews were conducted with these external stakeholder categories. In addition to interviews, documents were also collected and reviewed to develop a converging line of inquiry as suggested by Creswell and Creswell [72] and Yin [73]. Table 1 outlines the profile of interview participants and documents reviewed under each category of stakeholders.

Table 1. Profile of interviewees and referred documents.

No.	Stakeholder Category	Code	Designation	Work Experience (Years)	Referred Documents
1	State government agencies	SGA01	Senior Environmental Advisor	10	Acts, regulations, standards, guidelines, code of practices, licenses, organizational websites
		SGA02	Regulatory Manager	11	
		SGA03	Senior Environmental Advisor	22	
		SGA04	Environment Protection Officer	5	
		SGA05	Regulatory Manager (Construction and Building)	20	
		SGA06	Chief Executive	28	
		SGA07	Deputy Chief Executive	5	
2	Local government agencies	LGA01	Team Leader Waste Management	8	Acts, guidelines, organizational websites, demolition approvals (including decision notice)
		LGA02	General Manager (Development and Community)	23	
		LGA03	Development Officer	24	
		LGA04	Manager (Planning and Development)	13	
3	Non-government organizations	NG01	Managing Director and Principal Consultant	18	Organizational websites
		NG02	Managing Director and Principal Consultant	22	
		NG03	Environmental Consultant	20	
4	Forward supply chain -upstream actors	FUA01	Managing Director	23	Contract document
		FUA02	Design and Construction Manager	32	
		FUA03	Managing Director	22	
5	Forward supply chain -downstream actors	FDA01	Senior Sustainability Advisor	15	Master and sustainability specifications, organizational website
		FDA02	Senior Engineer	30	
		FDA03	Principal Sustainability Advisor	13	
		FDA04	Project Manager	6	

A combination of purposive and snowball sampling techniques was used to recruit interviewees. Since the interviewees targeted for the study were not easily accessible and responsive, five seed participants were initially selected from each category using purposive sampling to initiate the chain referral process in the snowball sampling [74]. All the interviewees who participated showed their willingness and interest in the study. In addition, all of them are well-experienced in their particular domain: 11 have more

than two decades of experience, while six have more than a decade of experience (see Table 1). The quality of data in a qualitative study could be enhanced by incorporating experienced and knowledgeable interviewees [18] who are willing to participate in the study [75]. When data quality is rich, the sample size becomes inconsequential for a qualitative study [76]. The study further mentioned that saturation is the basis for deciding the sample size of a qualitative study. Herein, saturation means "the collection of new data does not shed any further light on the issue under investigation" [76] (para. 2). Many previous studies have reported a different range of sample sizes as being sufficient for reach saturation in a qualitative study: at least six [77], 20 to 30 [78], 25 to 30 [79], four to 87 [76], at least 20 [80]. In the current study, the interviews were conducted until new themes were not derived from the last two interviews, regardless of the initial interviews. With this, the data saturation was achieved after doing 21 interviews. Despite the criticism of the small sample size of qualitative research, Smitt [81] elucidated that "rich knowledge and small samples purposefully chosen are thus unique strengths of qualitative research, not weaknesses" (p. 139).

The interviews were conducted from September 2020 to February 2021. Due to the COVID-19 pandemic, 13 interviews were done virtually via Microsoft teams and Zoom, and the remaining were face-to-face. Interviews lasted between 40 and 60 min, and in some cases, this varied because of the response time.

Codó [82] stated that "one important weakness of interviews is that there may be limits to the amount and kinds of details the researcher is able to gather" (p. 162). Similarly, the authors from experience in their research group of the similar context investigated presumed that the external stakeholders would not properly respond when they directly inquired about uncertainties arising from their improper influence over the RLSC of DW. Herein, if the questions were directly asked without any provision, the interviewees would be incapable of recalling what these uncertainties were because they were not familiar with this theory-based terminology (i.e., uncertainty). Even if the definition of uncertainty was provided, the interviewees would be reluctant and frightened to provide answers about uncertainties that evolve from 'their improper influence' over the RLSC of DW. According to Codó [82], the interviewees refrain from answering sensitive questions if they were asked directly. Congruently, none of the interviewees would be please to admit that they are not properly influencing the RLSC of DW. Therefore, the authors were aware that asking questions directly about 'uncertainties due to improper influence' would be inappropriate in this research context. In such circumstances, Codó [82] highlighted that, instead of asking direct questions, what the "researchers can do is try to modify interviewees' perception of the event as more or less formal and of the relationship with their interlocutor" (p. 164). With this, the authors decided to first ask about the demographic data of the interviewees, followed by their involvement in the QA of the RLSC of DW. After that, the interviewees were asked about the gaps they found in the existing processes and then the improvements that could be taken to bridge those gaps. The authors observed that the interviewees were becoming less formal, relaxed and confident when answering because the questions were inquired on the gaps in the existing overall processes that they are aware of related to the CDW management. Herein, 'existing processes' refer to the regulating, subsidizing, leading, standardizing, educating and informing processes that external stakeholders were undertaking for promoting the RLSC of DW [17]. In summary, the authors conducted the interviews with the insight of identifying the gaps in the existing processes of the external stakeholders, which indirectly invites them to explore the macro-level uncertainties that internal stakeholders encounter for QA in the RLSC of DW.

3.3. Data Preparation and Analysis

Conventional content analysis was employed in this study because it explores a phenomenon that has not been extensively researched [83]. The following five-step data analysis process by Creswell and Creswell [72] was followed to analyse the findings of the interviews: (1) organize and prepare data for analysis, (2) review the data, (3) code all of the data, (4) generate a description of themes, and (5) represent the description

and themes. Herein, as the first step, the audio-recorded interviews (recorded under the consent of interviewees) were transcribed. A complete set of transcripts was organized, prepared and finalized to start the data analysis. Second, the transcripts were optically scanned to understand the content's depth and breadth. Further in this step, an iterative review of all the transcripts was done to understand a broader meaning of interviewees' excerpts. The transcripts were read and re-read, and relevant notes were taken on any initial reflections, issues, and ideas promoted from the reading. Hammersley and Atkinson [84] recommended this approach as it advocates the researchers to familiarise themselves with data, and such notes later will benefit them in presenting the findings. The third step, which is the coding of transcripts, was initially organized into preliminary open codes, then combined to form axial codes using NVivo 12 software. As the fourth step, the axial codes were further refined and categorized to create selective codes, which are the study's final themes. Finally, the descriptions and themes were represented using narrative passages as in this study to convey the findings of the analysis.

3.4. Trustworthiness of the Study

In qualitative research, trustworthiness means the degree of confidence (rigorous) in data, interpretations, and the methods used to ensure the quality of the study [85]. Similar to all scientific inquiry, qualitative research should fulfil four criteria to ensure the study's trustworthiness: truth value, applicability, consistency and neutrality [86,87].

First, truth-value means "the confidence in the truth of the findings" [86] (p. 79), which could establish the credibility of the study [88]. The study incorporated interviewees with an average experience of 18 years and holding senior and decision-making positions in the external stakeholder organizations to establish the truth value. All these interviewees expressed their willingness and interest in taking part in the study. This study also employed data triangulation by incorporating different document sources (see Table 1) to support the interview findings. The credibility was further enhanced by member checking [6]. Herein, the transcriptions were sent back to the interviewees to verify their excerpts; however, not all interviewees contributed to this. Second, applicability refers to the degree to which the findings could apply in other contexts [86], or otherwise, how the study might generalize. Often, there is no mention of generalizability in qualitative research other than as a limitation or weakness of the study [81]. Unlike quantitative studies, the readers have much work to evaluate how the results apply to new situations in qualitative studies [89]. Even if statistical generalization is not possible for qualitative research, Smith [81] asserted four types of generalizations that can be made from qualitative research. These could include one or more combinations of naturalistic, transferability, analytical and intersectional generalizability. In this study, as for naturalistic generalization, the study presents illustrative quotes from interviewees and documents reviewed (see Section 4), facilitating to resonate the interviewees' experiences with the readers' personal experiences. A thick description was made, enabling transferability about the research setting, study participants and observed processes. Due to this, the readers can make a good judgment by applying all or part of the findings in a different setting. Finally, both consistency and neutrality were achieved through data triangulation and audit trail. Herein, consistency was about the idea that the same findings would generate if the study was repeated with the same procedure [87]. The author further explained that neutrality is the degree to which the findings are free from biases, motivations, interests and perspectives of the researchers [86]. Both these criteria could be ensured through an audit trail that helps an external auditor understand the transparency of the research path [90]. This study achieved this by providing a complete description of decisions made during the research process, sampling, and research materials utilized. Furthermore, through data triangulation, the study showed that the interview findings were consistent with the findings of documents reviewed, and thus, they are free from researchers' bias.

4. Results

As described in Section 3.3, the collected data from semi-structured interviews were analysed following the five-step data analysis process of Creswell and Creswell [72]. Herein, the first two stages of the process could not be explained in detail (other than the brief explanation in Section 3.3), because otherwise, they would increase the article length unnecessarily. However, in steps three and four, the coding was begun sequentially following open, axial and selective coding, which are the most important steps of making analytic interpretations of the collected data. Herein, as for open coding, the collected data was separated into meaningful parts and assigned a preliminary label explaining the segment's core subject [91]. Then, these assigned labels were further sifted, refined and categorized into similar codes, known as axial codes. Axial codes that closely related to each other were further consolidated to form selective codes of the study. These codes were derived both deductively and inductively. For instance, codes such as 'regulatory uncertainty' were allied with the pre-established codes from literature, and these are known as deductive codes. On the other hand, some of the codes were also derived from the collected data (e.g., incentivizing uncertainty), forming inductive codes. Table A1 in Appendix A illustrates an example of how coding was performed for 'regulatory uncertainty'. In the final step, the derived codes were narratively documented as in this section to present the findings of the study.

Accordingly, in this section, we report on the following three major macro-level uncertainties for QA due to external stakeholders' influence strategies from the analysis: (1) regulatory uncertainties, (2) incentivizing uncertainties, and (3) contractual uncertainties. Secondly, the results of how the external stakeholders could minimize the uncertainties are also presented.

4.1. Macro-Level Uncertainties Due to the External Stakeholders' Influence Strategies

The internal stakeholders of the RLSC of DW (i.e., demolishers and waste processors) faced three macro-level uncertainties due to external stakeholders' influence strategies: regulatory, incentivizing and contractual, leading to IPNs for QA in the RLSC. Herein, regulatory uncertainties are mainly originated from ineffective influence strategies of state and local government agencies. The incentivizing uncertainties are due to the lapses in cooperative strategies employed by all the external stakeholders. The influences from forward supply chain -upstream and downstream actors mostly create contractual uncertainties for QA in the RLSC of DW. The following sections will explain each of these uncertainties comprehensively.

4.1.1. Regulatory Uncertainties

In SA, both state and local government agencies are engaged in regulating the RLSC of DW. However, as shown in Figure 1, common themes across the interviews are the 'lapses in existing state government regulations', 'issues with the demolition approval process', and 'improper monitoring', which lead to regulatory uncertainties for QA in the RLSC of DW. Each of these themes will be discussed in the following sections.

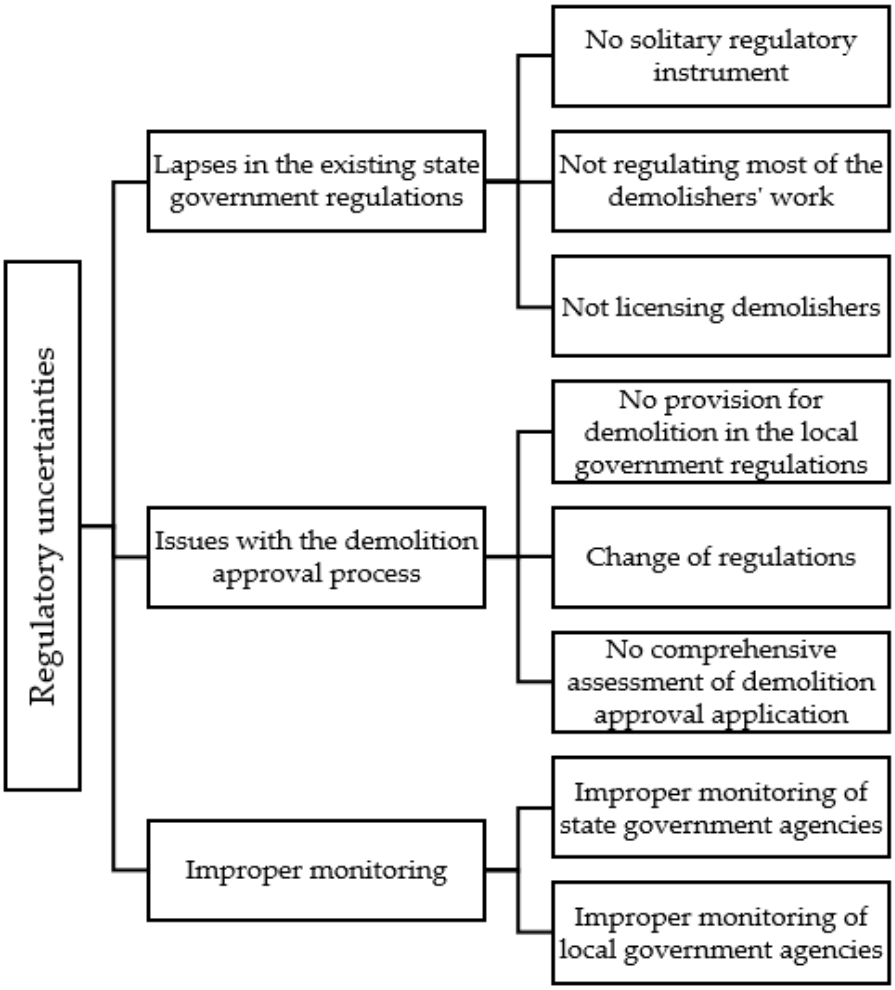

Figure 1. Regulatory uncertainties for quality assurance in the reverse logistics supply chain.

Lapses in the Existing State Government Regulations

The Environmental Protection Act 1993 (administered by Environment Protection Authority [EPA] SA) and Work Health and Safety Act 2012 (administered by SafeWork SA) are the state legislative instruments available to regulate CDW management in SA. The former legislative instrument's primary purpose is to protect the environment, while the latter is for workers' health, safety, and welfare. Therefore, there is no solitary regulatory instrument exclusively for CDW management in SA. Furthermore, the existing legislative instruments do not regulate demolishers' work except the asbestos removal and transportation. Interviewee SGA02 stated that: "In the demolition industry, no legal instrument administers source separation or dismantling. They have to remove all the asbestos in a certain manner, so that is SafeWork SA; they do that." Interviewee SGA01 explained this in detail:

> The regulation under EPA only considers the waste once it leaves the site. Because after leaving the site, only EPA consider it as waste. After that, only re-processing can happen and licensing, but if it's processed on-site, it goes from there straight to the quarry and use your rehabilitation, without any further processing, no license, no regulation.

Since there is no legislative influence, none of the state government agencies has developed standards or guidelines to provide useful information to pursue the demolisher's work. Even though mandatory requirements exist as per the legislative instruments for all the MRFs to be licensed by the EPA, demolishers do not have such a requirement unless they engage in asbestos removal, transportation, disposal, and on-site or off-site re-processing.

Issues with the Demolition Approval Process

The local government agencies play the role of gatekeeper in SA, principally influencing the demolishers by granting the demolition approval. Each local government agency has its development plan developed by customizing the provisions in the Development Act 1993 as per the administrative area's social, cultural, geographical, and financial conditions. Through this, the local government agencies dictate the necessity of approving the demolition with the building approval. However, even a private certifier could grant the building approval. In such circumstances, the local government agencies are responsible only for issuing the development approval in terms of their assessment. Consequently, the local government agencies rarely ask for information related to general waste management in a demolition project. Interviewee LGA02, explained: "For the application, the basic assessment is undertaken, and generally, that will be granted consent with conditions. So those conditions generally don't extend to you have to reuse this material in this way, or you have to recycle it." This was further affirmed when referring to the templates of demolition approval applications developed by different local government agencies.

The local government agencies do not conduct a comprehensive assessment of the demolition application because they do not have the authority to do so per the existing legislation. At the time of data collection, the local government agencies administer the Development Act 1993 to approve the development applications. Interviewee LGA02 mentioned that this Act does not include a single provision related to the demolition. However, after 19 of March 2021, the Development Act was transformed into the Planning, Development and Infrastructure (PDI) Act 2016, enabling every local government agency to work under one development plan. Noticeably, the new PDI Act also does not consider demolition as a form of development, and thus, the demolishers do not need to apply for demolition approval. This was explained by Interviewee LGA04: "In that new Act, demolition as such is not a form of development. So, they're talking about having most demolitions not require any approval in the new planning system. In which case, local government agencies would have no statutory responsibility linked to demolition whatsoever."

The interviewee further highlighted that even though the earlier process of approving the demolition work had significant gaps, it provided a stringent impetus for the demolishers to assure their work quality. Since the latest Act does not mandate application for the demolition approvals, the demolishers will encounter huge uncertainty to execute their work in the future.

Improper Monitoring

Since EPA SA does not license the demolishers (except for friable asbestos transportation and disposal), they are not monitoring their work. Similarly, as SafeWork SA's role is to offer a safe and healthy workplace, they only have the legality in monitoring asbestos handling and removal at demolition work. Therefore, none of the state government agencies monitors the bulk of their normal work other than asbestos management. Furthermore, even if all the waste depots and MRFs are licensed, the EPA is also not often engaged in monitoring their work. Herein, Interviewee SGA03 explained: "we operate a risk-based system for monitoring our licensees. And so, we have a minimum number of site visits we might have to do to a particular risk category of the operator on an annual basis." As for the same point, Interviewee SGA01 stressed that in most cases, EPA SA monitors the work of large-scaled licensed MRFs since their complicated processes are more adversely affecting the environment than in small and medium scale waste processors.

Even if local government agencies grant the demolition approval, they are not attentive to whether the demolishers follow QA practices to yield a maximum recovery rate. The Development Act 1993 [92] broadly dictates that the local government agencies in its building inspection policy must specify "A level or levels of audit inspections to be carried out by the council on an annual basis with respect to building work within its area (including building work assessed by private certifiers under Part 12)" (p. 11). The Act defines the building works as "work or activity in the nature of the construction,

demolition or removal of a building (including any incidental excavation or filling of land)" (p. 3). Even if there is a legislative requirement, the local government agencies do not monitor demolishers' work. Both Interviewees LGA01 and LGA02 highlighted that local government agencies monitor the work-in-progress of new developments but not the demolition work except during a community complaint. Interviewee LGA03 also affirmed this: "With demolition, we usually don't go out to do demolition inspections; and the legislation doesn't say we have to do inspections for demolitions." In summary, even if the existing Act does not mandate granting demolition approval, it dictates the local government agencies to monitor the demolition work. However, the findings indicate that some Interviewees are not aware of that, and they are also not engaged in monitoring, raising uncertainty for demolishers.

4.1.2. Incentivizing uncertainties

The external stakeholders could incentivize the RLSC through subsidizing, informing and education. When there are lapses in these incentivizing strategies, useful information will not be communicated to internal stakeholders, creating uncertainties, as explained as follows. A summary of these findings is depicted in Figure 2.

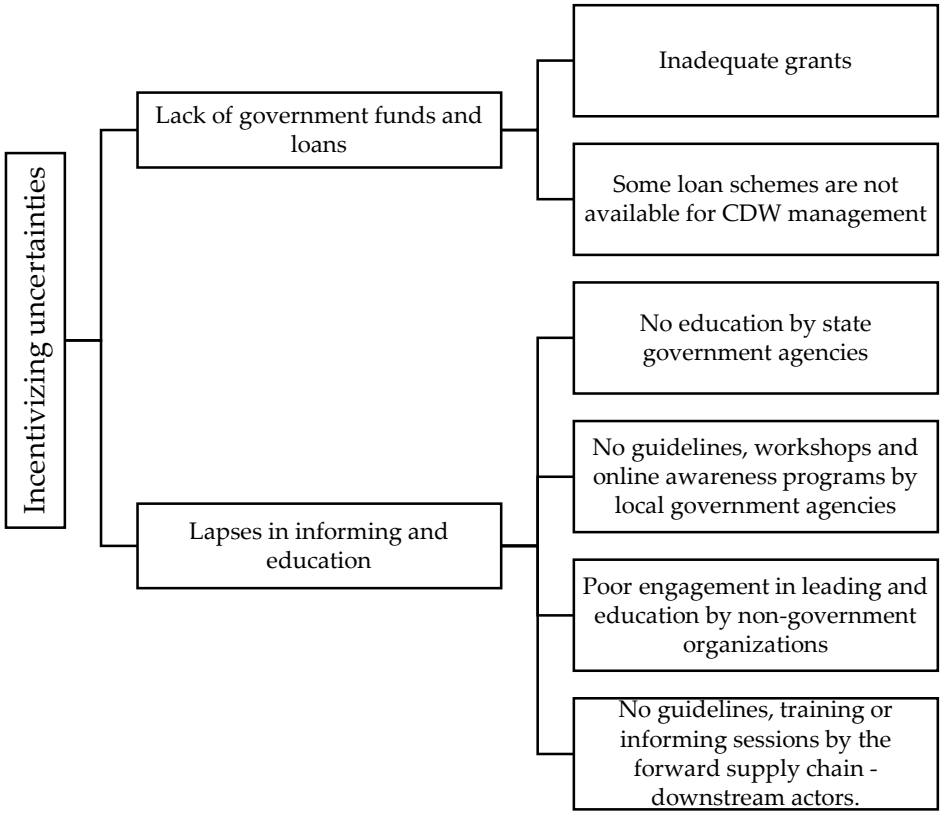

Figure 2. Incentivizing uncertainties for quality assurance in the reverse logistics supply chain.

Lack of Government Funds and Loans

One of the prime roles of GISA is to subsidize the different industries to embrace the circular economy through developing infrastructure and technologies to process and create new products from waste [37]. As a result, GISA has introduced many funding options to different businesses and industries in the SA context. According to the GISA website [93], these grants and loan schemes are only for specified recipient groups. Generally, they are offered for local government agencies, NGOs, research institutes and businesses that produce, manufacture, sell or promote re-processed products in the SA. However, it was observed that most grants with significant values are only offered for projects targeting one or more waste streams from municipal, commercial and industrial sources such as plastics,

paper and cardboard, glass, scrap metal, textiles and e-waste. Noteworthily, some grants such as 'Recycling Infrastructure Grants', which are available to invest in equipment, technology and processes to recover, handle and process recyclable materials, were not made available for CDW management. Noteworthily, except GISA, other state and local government agencies do not even have jurisdiction to provide funds or loans to promote RLSC in the construction industry.

Lapses in Informing and Education

As the custodian of the waste strategy of SA, GISA is responsible for influencing the internal stakeholders by providing assistance, advice and guidance [37]. Herein, GISA has a role in informing the internal stakeholders on waste management and resource recovery and encouraging the industry practitioners to contact them whenever they need assistance to solve their issues related to waste management. However, Interviewee SGA07 mentioned that even though GISA is educating the actors engaged in other waste management streams, they have not been dynamically involved in CDW management. Even state government agencies such as EPA are not actively educating internal stakeholders in the RLSC of DW. Interviewee SGA01 stated that: "As a regulator, we don't. If we're asked to give a presentation on the waste-derived fill standard, we will do that. But we do our best to inform, but we're not an actual education facility with a regulator."

The local government agencies significantly manage kerbside waste, food waste and other hard waste streams but not the CDW. There are many guidelines, workshops and online awareness programmes developed by these local government agencies to inform the community about the importance of source separation and recycling of other waste streams. For instance, Interviewee LGA03's council has developed 'Residential Waste and Recycling Guidelines for New Developments' to help the developers and community establish effective waste and recycling systems in their new developments. This was further confirmed when referring to the local government agencies' websites. Every local government agency has an informative website that communicates best practices of other waste management streams through animated videos and frequently-asked-questions-type guidelines. Notably, there is no such comprehensive description for CDW management. Interviewee LGA03 explained: "But concerning demolition sites, that's more controlled by the builders as such. And we don't; we haven't picked that up at all. I think it's more to do with the legislation, not allowing us to do it."

The state government agencies' poor engagement in leading and education discourages the NGOs' involvement in the sector. Interviewee NG03 mentioned that NGOs need government funding and initiation to engage in educational programmes and encourage industry compliance with existing regulations. With government support, many promotional and educational programmes have already been completed by his company targeting other streams of waste management. Herein, the interviewee shared one of the education programmes that his organization conducted concerning construction waste management.

> So, when this 'Clean Site program' was introduced, the EPA initiated this. GISA puts money in to allow partnerships to be developed with major big construction companies. So yeah, lack of funding is the only reason. Well, if it's not a government focus, why should it be a non-government?

Furthermore, the lack of regulatory requirements also leads to an absence of NGOs' influence over the RLSC. For instance, Interviewee NG01 revealed that his organization develops waste management plans for the developers based on the 'Better Practice Guide Waste Management for Residential and Mixed-Use Developments' developed by GISA, Renewal SA and Property Council of Australia. The local government agencies request this waste management plan to provide approval for the development. However, the interviewee criticized the fact that similar requirements are not available for any practice related to DW management, and thus their involvement in this sector is minimal.

Furthermore, the forward supply chain -downstream actors do not lead the waste processors to produce quality output. For instance, the master specification currently available

to outline products' quality and performance criteria is huge, complicated, and not user-friendly. Herein, Interviewee FDA03 stated that, "I understand that master specification is a pretty enormous thing and may be difficult for our contractors to get their head around. A pavement material supplier, in all likelihood, wouldn't be aware of the sustainability specification." Herein, the Interviewee criticized DPTI, as the key end-user of re-processed products in SA, for not developing any guidelines or not conducting any training or informative sessions to make it easy for suppliers to understand the specification, what is allowed currently and how to go about getting materials approved. Noteworthily, these approaches have been successfully implemented in other jurisdictions, including Victoria.

4.1.3. Contractual Uncertainties

The internal stakeholders of the RLSC of DW are connected with the forward supply chain actors at two points. First, when a facility is about to be demolished, the builder or client (i.e., upstream actors) employ a demolisher to undertake work. Second, after producing re-processed products, the waste processors connect with potential customers (i.e., downstream actors) interested in using the re-processed products. These upstream and downstream actors influence the demolishers and waste processors, respectively, through forming contracts. Even though forming contracts is an information-centric influence strategy, it has issues, as discussed below, which lead to contractual uncertainties. A summary of these findings is illustrated in Figure 3.

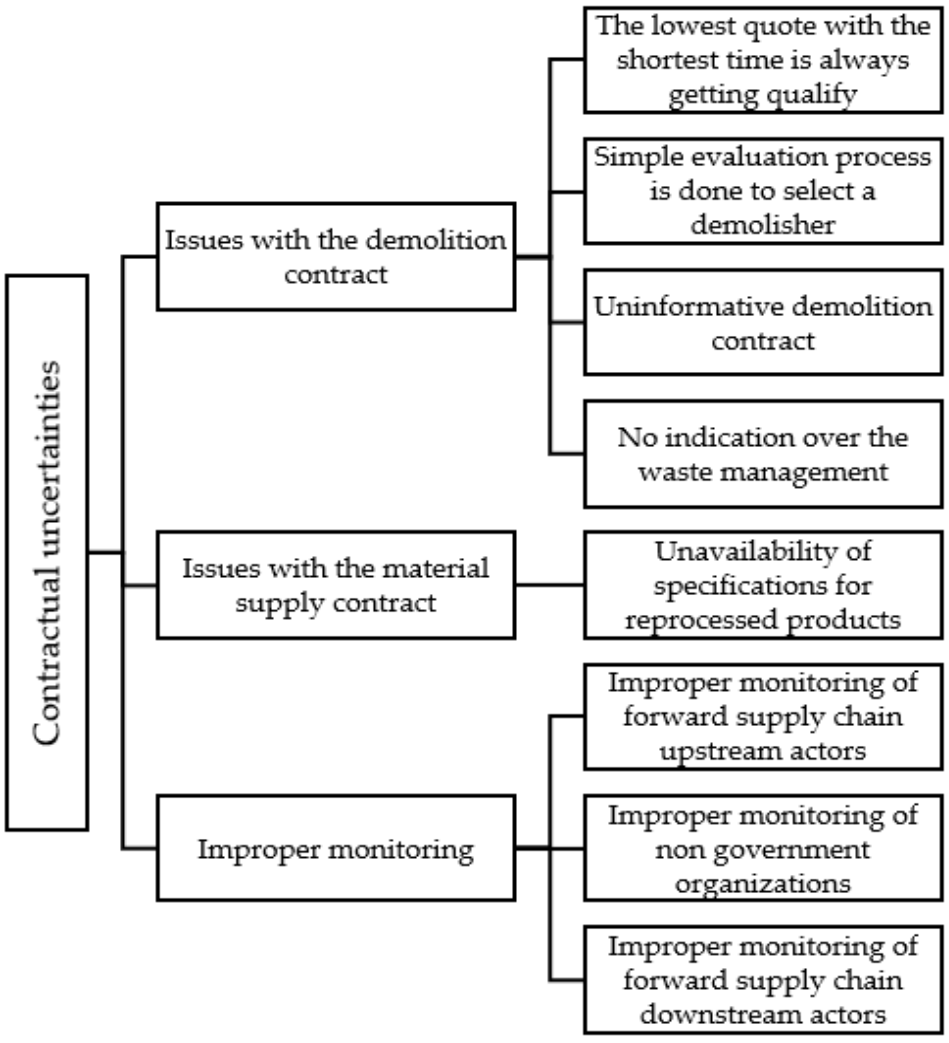

Figure 3. Contractual uncertainties for quality assurance in the reverse logistics supply chain.

Issues with the Demolition Contract

Before commencing demolition, the contractor offers an 'invitation to tender' for demolishers and asks them to submit a quote for the work. According to Interviewee FUA03, the contractors generally seek to employ demolishers who have done their previous jobs. When there is a low quote with a short duration, Interviewee FUA01 mentioned that the contractors are aware that demolishers have not considered and are not prepared to follow QA practices including dismantling, on-site sorting, waste recovery, and salvaging. Yet, the lowest quote with the shortest time is often selected to make a profit out of the work. Therefore, only a simple evaluation process is typically done to select a demolisher for the job. Consequently, in most cases, the contractors do not provide much information about the project with the 'invitation to tender' for demolishers to be concerned when preparing their estimate. When referring to a contract document (between a demolisher and Interviewee FUA01's company), this was further affirmed, as it outlined that the demolishers have not provided the opportunity to visit the site before commencing the demolition.

After selecting a suitable demolisher, a contract is formed between the demolisher and the main contractor (sometimes with the client). According to Interviewee FUA03, this contract is simple and reasonably similar for every project. The interviewee further mentioned that this contract does not indicate any condition related to DW management unless in exceptional circumstances such as planning to apply for a green start rating or if it is a heritage-listed building (as per the regulatory requirements). Herein, Interviewee FUA02 stated that, "from a demolition waste management perspective, it is quite simplistic, to be honest, demolish and dispose of existing structures and improvements as potential drawings, specifications and reports." Conforming, in the contract that was referred, none of the conditions was related to the demolition method, on-site sorting, waste management procedure, and tools and equipment to be used. Therefore, the demolition contract only informs the demolisher to complete the job within the agreed-upon time and cost without worrying about the waste management aspect.

Issues with the Material Supply Contract

A major part of re-processed products is utilized in civil and infrastructure projects in SA. DPTI is the principal end-user of re-processed products in SA. Through contractors of their civil projects, the DPTI provides information (via a material supply contract) for the re-processors on the quality requirements of re-processed products. For this, DPTI has developed a master specification that comprehensively describes all the material tests that need to be undertaken to ensure final products' quality. This enables the department to communicate the standard end-user requirements across the construction industry to supply materials. The master specification has separate sections as 'sustainability in design' and 'sustainability in construction', helping the designers and contractors identify key material categories that DPTI allows to replace those virgin materials with re-processed materials. The DPTI does not force the project actors through this sustainable specification but encourages them to optimize re-processed materials. However, Interviewee FDA02 highlighted the fact that the waste processors need to produce these products based on the quality and performance requirements in the master specification since the DPTI has not developed specifications exclusively for re-processed materials.

> The specifications are set up for virgin materials. We would need all the rules sorted out and some tests specially developed to check those products to use recycled materials. When we have recycled materials that we want to put into a base course material, special tests are developed for checking whether it's suitable.

This indicates that there is a need for specifications for re-processed products in SA. Furthermore, it is not feasible to compare the quality of re-processed products with virgin materials' specifications. Therefore, Interviewee FDA02 stressed the need for having separate specifications for re-processed products to inform the waste processors of the quality and performance criteria that end-users expect from their products.

Improper Monitoring

Despite a demolition contract made, Interviewee FUA03 revealed that contractors or clients are not engaged in monitoring the demolishers' work unless there is a special requirement from the client, which would seldom occur. Interviewee FUA02 elaborated:

> Like there's too much time pressure. And it's not by choice of any of us. It's not something that's usually, and the clients putting their project out to tender, they are getting faster and faster. So, I don't think there's a lot of time to do something much slower on-site.

In some of the government-led projects, the NGOs are employed to monitor the demolishers' work. Herein, Interviewee NG02 shared one of his experiences of monitoring a bushfire demolition project in which he used his expertise to make it a success. Since it was a government-led project, GISA, as the project client, incorporated the consultancy organization to monitor the demolisher's work. He further mentioned that private clients would never employ a non-government consultant to monitor demolishers' work without any government mandate because they significantly value time and money rather than waste recovery.

Similarly, the DPTI does not engage in monitoring re-processors' work and does not encourage the contractors to do so. Interviewee FDA02 underpinned that instead of monitoring, the DPTI provides negative feedback for suppliers if products do not comply with their specifications. This will be considered a negative point when procuring those suppliers in future projects.

4.2. Measures to Minimize Macro-Level Uncertainties

The following are three measures that the external stakeholders could employ to minimize the macro-level uncertainties arising from their influence strategies as discussed: (1) reforming regulatory instruments, (2) employing effective incentivizing schemes, and (3) active involvement of forward supply chain actors.

4.2.1. Reforming Regulatory Instruments

The most frequently mentioned strategy (as per total coded reference count in NVivo 12) to reduce most uncertainties was reforming the regulatory instruments. Interviewee LGA02 underlined that there is an opportunity to reform the state government legislation to mandate the QA practices in demolition if only the community presumes that it is an aspect to be considered in the development process. Herein, the interviewee explained this in detail as follows:

> The PDI Act would probably be the point that would make it, and you would put some additional requirements for demolition into the legislation that councils would use. And that might be something along the lines of a plan that outlines how much of this building will be recycled. We say 30% of the materials in this building should be recycled. And then the developer or the builder or the demolition company has to demonstrate how they're achieving that 30%.

In addition, Interviewee LGA03 suggested that the existing legislation could be reformed to put a target for builders to reuse a particular amount of materials recovered from the demolition for their new development. The builder should demonstrate how they are going to achieve this when applying for the development approval. Furthermore, Interviewee SGA06 highlighted that: "local councils could mandate preparing waste management plan and following approaches like Design for Deconstruction (DfD). They also need to administer waste management plans or monitor the demolition sites." The local government agencies should also ask for a security bond before approving the development application and keep it without refunding until the builder proves they have followed the DW management procedures stipulated in the demolition application. Herein, Interviewee NGO02 stated that:

> The council would ask to lodge $1000 and ask the builder to show what he has done to recover waste. And then once it's done, the local council repay the builder $800 and keep $200 for their effort. So, there are two reasons why that builder got to make sure he does the right thing. One is he wants his $800 back. And the other one is he gets his approval to build.

Interviewee SGA03 underpinned that none of the state regulatory instruments in SA mandates dismantling, on-site separation and preparing and complying with a demolition waste management plan. The interviewee further stated that:

> EPA needs to intervene at the demolition site level and require a waste management plan and individual skip bins for segregating materials. If we were presented with the facts that waste management plans drive this additional resource recovery amount, then that would be something the existing legislation has to consider.

All these interviewees highlighted the necessity of reforming state and local regulatory instruments to reduce the existing uncertainties. As discussed in Section 4.1.1, none of these existing regulatory instruments exclusively focus on CDW management: the waste stream that grew by 32% per capita over the past 13 years, with most growth among other streams of waste [36]. The interviewees' excerpts reveal that many legislative instruments administered by different regulatory bodies over one particular aspect make it difficult for external stakeholders to understand their legislative responsibilities. In shedding light on this, Interviewee SGA03 highlighted the need for a solitary regulatory instrument for CDW management with a set of comprehensive provisions exclusively for DW management and one regulatory body responsible for administering the entire instrument.

4.2.2. Employing Effective Incentivizing Schemes

This measure is exclusively aimed at minimizing the incentivizing uncertainty. This could be implemented through introducing effective government subsidiary schemes and informing and education as explained in the following sections.

Government Subsidiary Schemes

Interviewee SGA07 admitted that the available funding schemes of GISA had not provided many incentivizing opportunities to upgrade the RL performance in the construction industry. However, he mentioned that to achieve 95% of the CDW diversion rate in 2025 as per South Australia's Waste Strategy 2020–2025, GISA attempts to restructure the available funding schemes by setting more funding opportunities for RLSC in the construction industry. Notably, Interviewee SGA06 stated that even though enough funding schemes are available, the construction industry is reluctant to utilize them to invest in infrastructure and technologies to upgrade their operations.

Interviewee LGA04 mentioned that his local government agency had developed a policy to incentivize the RLSC of DW. Herein, the interviewee broadly explained this as follows:

> So, this council has a policy in place that says we're willing to spend up to 20% more for procurement if it's for a recycled product. If that kind of market intervention strategy was in place, state governments and every local government plus major builders had some kind of policy saying they are willing to make cost sacrifice to have recyclable products.

This type of measure encourages and leads the internal stakeholders to produce more re-processed products with better quality. As Interviewee LGA04 mentioned, state government agencies and end-users (i.e., DPTI) could employ such an incentivizing approach when procuring materials for their projects. However, it is doubtful whether the private end-users would follow such an approach without any legislative obligation since their prime focus is on profit maximization.

Informing and Education

Although EPA's primary role is to regulate, it could also educate the internal stakeholders of RLSC. Interviewee SGA03 highlighted the face that, "we want to educate them if someone's doing the wrong thing, we'd correct them rather than take them to court, set them on the right path. That's our preferred approach. But if that doesn't work, then obviously, we're going to have to prosecute them." The interviewee further stressed that even if EPA is not actively engaged in education, the organization website is a rich educational platform for self-researching internal stakeholders to grab knowledge required for QA in the RLSC of DW. Furthermore, GISA has a role in informing and educating. Interviewee SGA06 revealed that there is a strategic plan with GISA to educate waste processors in SA. Herein, Interviewee SGA06 stated: "We have been discussing with the Waste Management Association and the Australian Council of Recyclers to have certificate level accreditation for waste management recycling etc. [..] So, we encourage associations to develop the core content and work with TAFE and others to deliver qualifications."

Moreover, DPTI is also planning to follow the strategies exerted by Major Road Projects Victoria through their 'Ecologiq program' and the 'Recycled First' policy. Interviewee FDA03 explained this as follows:

> DPTI started last year but hasn't finalized with recycled materials policy, an information pack to make available on our website to help explain to suppliers what is currently allowed and how we facilitate the use of recycled materials in our projects. This policy helps people navigate that and say, well, currently, these percentages are allowed, and these are the master spec references where you can find that.

The interviewee also mentioned that the DPTI is planning to conduct a series of webinars for waste processors to explain the applications where they can use re-processed products.

Interviewee NG03 stated that the NGOs in SA also could educate internal stakeholders in the RLSC of DW, as in the other industries if there is government involvement. Interviewee NG01 detailed that his organization could inform the demolishers and builders on effective and efficient ways of managing DW if the local government agencies ask for a DW management plan through a developed guideline, as in residential and mixed-use developments. Therefore, NGOs could also employ informing and educating measures to reduce uncertainties if only they get the lead from the government agencies.

4.2.3. Active Involvement of Forward Supply Chain Actors

The active involvement of forward supply chain actors could minimize most contractual uncertainties for QA in a RLSC. This could be achieved by developing specifications for re-processed products and employing sustainable procurement.

Specifications for Re-Processed Products

The unavailability of specifications exclusively for re-processed products is a macro-level uncertainty experienced by waste processors in the RLSC. For this, both EPA and DPTI have capabilities in developing specifications. Herein, Interviewee SGA03 shared one of his experiences where a large-scale waste processor in SA received EPA approval for a specification submitted to use waste fines from the trommel process as alternative daily cover in landfills. However, EPA does not commonly engage in this in the actual context due to two reasons. The first reason is that only large-scaled waste processors with a robust economic profile could develop in-house specifications, which is time-consuming and expensive. Second, the EPA does not approve specifications of a wide range of products due to the scarcity of internal resources.

Interviewee FDA03 highlighted that DPTI is currently updating its specifications for pavement materials by specifically allowing re-processed materials. The interviewee further mentioned that all the states in Australia have become aware that they need to increase the use of re-processed materials due to the waste export ban aroused from China's

National Sword policy. Therefore, there is a national-wide impetus to develop specifications for re-processed products.

> All of the executives across the road agencies are connected and said, no, we need to increase the use of these products in road construction. Then, Austroads, which is formed by all of those member agencies, said, well, to facilitate that, we will do some work to develop model specifications for these new materials.

Interviewee FDA02 pointed out that the DPTI is developing performance specifications for asphalt instead of classic recipe specifications. This means DPTI has given the flexibility to suppliers to produce products incorporating different degrees of re-processed materials, but they have to demonstrate the product's performance through approaches such as 'quality labelling'. Even though this measure can overcome the issue, it has not been frequently employed. As in the case of the EPA above discussed, the waste processors cannot develop such quality labels since it consumes a lot of money and physical resources. Moreover, the DPTI does not have the internal resources to check all the specifications submitted for approval. Therefore, effective government incentivization schemes should be employed, especially by GISA, to support the authorities to develop specifications for re-processed products.

Sustainable Procurement

The forward supply chain -upstream actors could provide information for internal stakeholders through the demolishers' procurement process. Interviewee UA02 noted that the contractors could consider waste recovery experience, in-house workers' qualifications, and available technology and equipment when procuring a demolisher for their work, a process that does not currently exist. Interviewee FUA01 disclosed that the contractors could communicate all the QA procedures that demolishers should comply with through their contract. The interviewee further highlighted that such a kind of sustainable procurement only could happen if there is a regulatory compulsion from local government agencies or special requirements that would seldom arise from the client.

Interviewee FDA03 stated that DPTI has plans to implement a new procurement approach followed by the Victorian Transport and Infrastructure Department. Accordingly, the client could use the tender process to ask contractors to acknowledge what they can offer as re-processed materials and products with recycled content. Interviewee FDA03 explained this in detail as follows:

> I've just tried to use the traditional process to get the tenderers to answer another question: how do you propose to optimize recycled content in this proposal? I'm hoping that this will mean that they spend time early on engaging with the suppliers of recycled materials to work out what they can offer and hopefully allow enough in the contract in their program and their budget to ensure that we can deliver on those commitments.

This type of approach could help develop the relationship between waste processors and contractors before initiating the project. Therefore, most end-user requirements will be communicated in advance, supporting the waste processors to produce better quality products.

5. Discussion

Building upon the findings from the content analysis, the macro-level uncertainties for QA, the reasons for those uncertainties and ways to manage uncertainties are discussed in detail as follows.

5.1. Macro-Level Uncertainties for Quality Assurance

Flynn et al. [24] asserted that complicated and dynamic situations that are ambiguous and ill-structured had created macro-level uncertainties in the manufacturing industry. The authors explained that, in situations of macro-level uncertainties, the required information is not available, and sometimes, available information is unclear or provides multiple

interpretations of the environmental aspects, which is also congruent with the case of RLSCs in the construction industry. Correspondingly, the study found that, due to the complicated external environment, the RLSC has encountered three macro-level uncertainties: regulatory, incentivizing and contractual, impacting the QA in the RLSC of DW. Figure 4 shows the summary of these uncertainties, including details on 'how' they form and 'who' is responsible for forming them. Accordingly, both regulatory and contractual uncertainties are originated due to lapses and issues in aggressive influence strategies of external stakeholders. In contrast, as outlined in Figure 4, the lapses and issues in cooperative influence strategies cause incentivizing uncertainties.

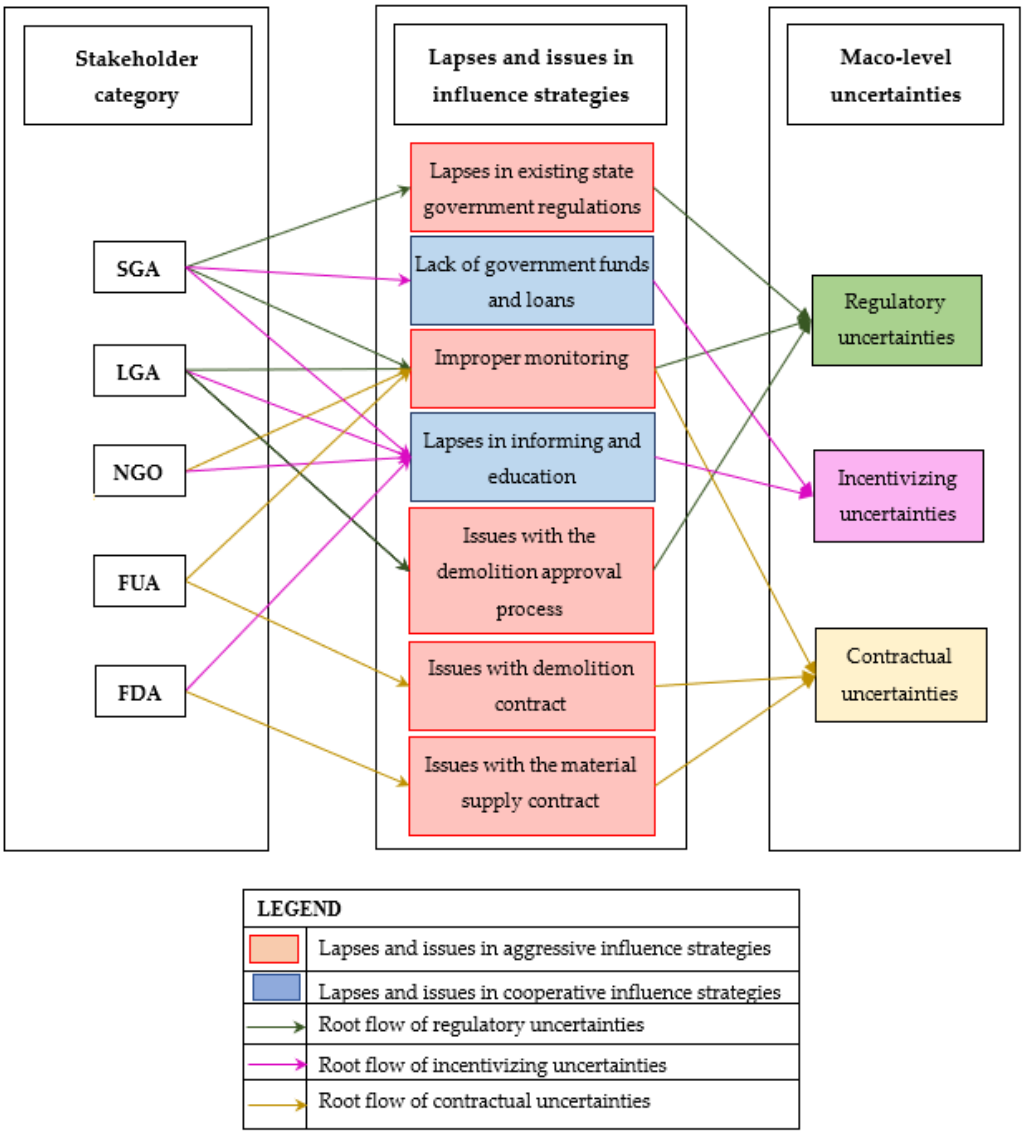

Figure 4. Macro-level uncertainties for quality assurance in the reverse logistics supply chain. SGA–State government agencies; LGA–Local government agencies; NGO–Non-government agencies; FUA–Forward supply chain -upstream actors; FDA–Forward supply chain -downstream actors.

A number of previous studies highlighted that an ineffective regulatory environment is a critical barrier for CDW management in countries such as China [62,94], the United Kingdom [95], and Hong Kong [96]. For instance, Bao et al. [96] criticized the fact that, even if the Hong Kong government has made efforts to regulate and promote CDW management, the existing regulations are still incapable of providing how-to guidelines for the industry. Similarly, the current study established that the existing immature regulatory system in SA has failed to provide useful information for internal stakeholders, creating an

uncertain environment for the RLSC of DW. Although there are regulations that influence CDW management in SA, their overall effectiveness is doubtable. The primary focus of these regulations is not waste management but to protect the environment and ensure workers' health and safety. On the one hand, these regulations have overlapping responsibilities (e.g., asbestos management), and on the other hand, none of them regulates some practices such as source separation. This has made it difficult for internal stakeholders to engage in QA with cohesive and clear legislation. In addition, several government agencies are currently engaged in administering these regulations, which act individually without any collaboration. This observation is common in most industrialized countries, including China [62] and Saudi Arabia [97]. Herein, Yuan [62] reported that CDW management had become a complicated process in China due to the influence of many government departments that do not have inter-department coordination. Given this, the current study affirmed that lapses in the existing state government regulations, issues with the demolition approval process and improper monitoring (demarcated with green arrows in Figure 4) have led to regulatory uncertainties for QA in the RLSC of DW. As explained in previous studies, regulatory uncertainty in the manufacturing industry refers to the decision maker's inability to predict the actions of regulatory agencies and the state of different attributes and elements of policy or regulations employed by them [98–100]. Lopez et al. [100] clarified that regulatory uncertainty stems directly from a policy or regulation, hence from its characteristics, specific rules and measures, the implementation process, and interdependencies with other regulations. However, by expanding this existing view, the current study added a different elucidation to the regulatory uncertainty within the context of the RLSC of DW, based on the arguments in OIPT. Accordingly, the regulatory uncertainties refer to the lack of useful information for internal stakeholders due to the ineffective aggressive influence of government agencies. State and local government agencies that create and enforce regulations in SA are responsible for regulatory uncertainties in the RLSC of DW, as shown in Figure 4.

Incentivizing is defined in literature as providing support or encouragement to motivate a party to undertake a particular job [101]. All the external stakeholders could incentivize; a cooperative strategy to influence the target [18]. The current study found that the external stakeholders in RLSCs could incentivize internal stakeholders through subsidizing, informing and educating. Even if all the external stakeholders could inform and educate, only the government agencies can subsidize. However, lack of incentivizing is a most cited barrier for CDW management in developing and developed countries, including China [62,94], Saudi Arabia [97] and Italy [102]. Correspondingly, the current study found that the external stakeholders in SA are not adequately subsidizing, informing and educating internal stakeholders in the RLSC. For instance, even state government agencies have established different subsidizing schemes for waste management; none is specifically for CDW management. There is no external stakeholder category actively engaged in informing and educating the internal stakeholders about the best practices for QA in RLSCs. In some cases, they do not even know that they are obligated to raise awareness for waste management in the construction industry. Lack of incentivizing is not an issue limited to SA and has also been largely neglected in other jurisdictions (e.g., New South Wales) in Australia [103]. Through incentivizing, Wijewickrama et al. [7] affirmed, the external stakeholders communicate useful information for internal stakeholders in RLSCs. Therefore, in SA, internal stakeholders are devoid of useful information due to a lack of incentivizing, leading to uncertainty. None of the previous studies reported this type of uncertainty; thus, it was conceptualized as 'incentivizing uncertainty' in the current study (demarcated with pink arrows in Figure 4).

The internal stakeholders of the RLSC have contractual relationships with forward supply chain actors. Through contracts, upstream and downstream actors in the forward supply chain inform the internal stakeholders of the useful information required for QA in RLSCs. Conforming with previous studies [19,47], the current study affirms that the upstream and downstream forward supply chain actors in the value chain have different

interests over RLSCs, and this ultimately leads to uncertainties. For instance, since the forward supply chain -upstream actors are not the end-users of re-processed products, they do not have any interest to contribute to the QA in RLSCs. Oschlag-Michael and Datta [104] noted that contractual uncertainty exists in the information technology (IT) sector when a contract is not informative or insufficient. Correspondingly, the current study disclosed that uninformative and lenient demolition and material supply contracts in SA had created contractual uncertainties for QA in RLSCs (demarcated with yellow arrows in Figure 4). Since their contracts do not promote waste management, the forward supply chain actors avoid monitoring and do not even incorporate NGOs to monitor the internal stakeholders' work as the government does in their projects. Therefore, improper monitoring has compounded the contractual uncertainty for QA in RLSCs. The current study's findings corroborate past studies that stressed the builders (i.e., upstream actors) value time and money over waste management, and the end-users (i.e., upstream actors) opt for affordable and virgin products over re-processed products [102,103]. Therefore, the forward supply chain actors do not have an impetus to promote QA in RLSCs, and thus, the presence of contractual uncertainties is permissible.

5.2. Minimizing Macro-Level Uncertainties for QA in the RLSC of DW

Figure 5, as developed, illustrates the mapping between the stakeholders and the sub-measures (depicted as grey boxes) that could take to minimize the macro-level uncertainties for QA in the RLSC of DW. These sub-measures are further consolidated into three main measures, as shown in Figure 5. Accordingly, 'reforming regulatory instruments', 'employing effective incentivizing schemes' and 'active involvement of forward supply chain actors' are the measures to minimize the regulatory, contractual, and incentivizing uncertainties, respectively.

Reforming regulatory instruments is the leading strategy to minimize macro-level uncertainties for QA in RLSCs, especially the regulatory uncertainty. Currently, there are two primary regulations for CDW management in SA administered by two different state government agencies, but they are incomplete and fragmented. In addition, the Development Act led by local government agencies is ambiguous and does not indicate much around DW management. Due to this, the regulatory personnel are not even aware of their scope towards waste management. As a solution for regulatory uncertainty, the state and local government regulations should be systematically reformed as they outline the methods and clauses that should adhere to effective RL implementation in the construction industry. Yuan [62] suggested the same strategy to enhance the effectiveness of CDW management in a Chinese city, Shenzhen. The author further mentioned that the responsibilities of each government agency should be defined as a part of the regulatory reformation. Since multiple government agencies are separately involved in CDW management, this action would also be successful if implemented in SA. Apart from reforming the existing regulations, the current study's findings also suggested developing solitary regulation exclusively for CDW management in SA, with one regulatory body responsible for administering it. Many previous studies also raised the same strategy of establishing a "top-down" regulatory system with one government department to lead the CDW management in China [94,105]. Notably, in pursuit of developing a new regulation, the path will never be as swift and straightforward as expected [96]. Since developing a new regulation requires more resources and strong contributions, the state government would not consider this until all the stakeholders in the construction industry are well-prepared, which is the challenge of any jurisdiction. Therefore, until there is a strong need for new regulation from the industry, reforming the existing regulatory instruments and enhancing their execution will be topical measures to evade regulatory uncertainty for QA in the RLSsC of DW.

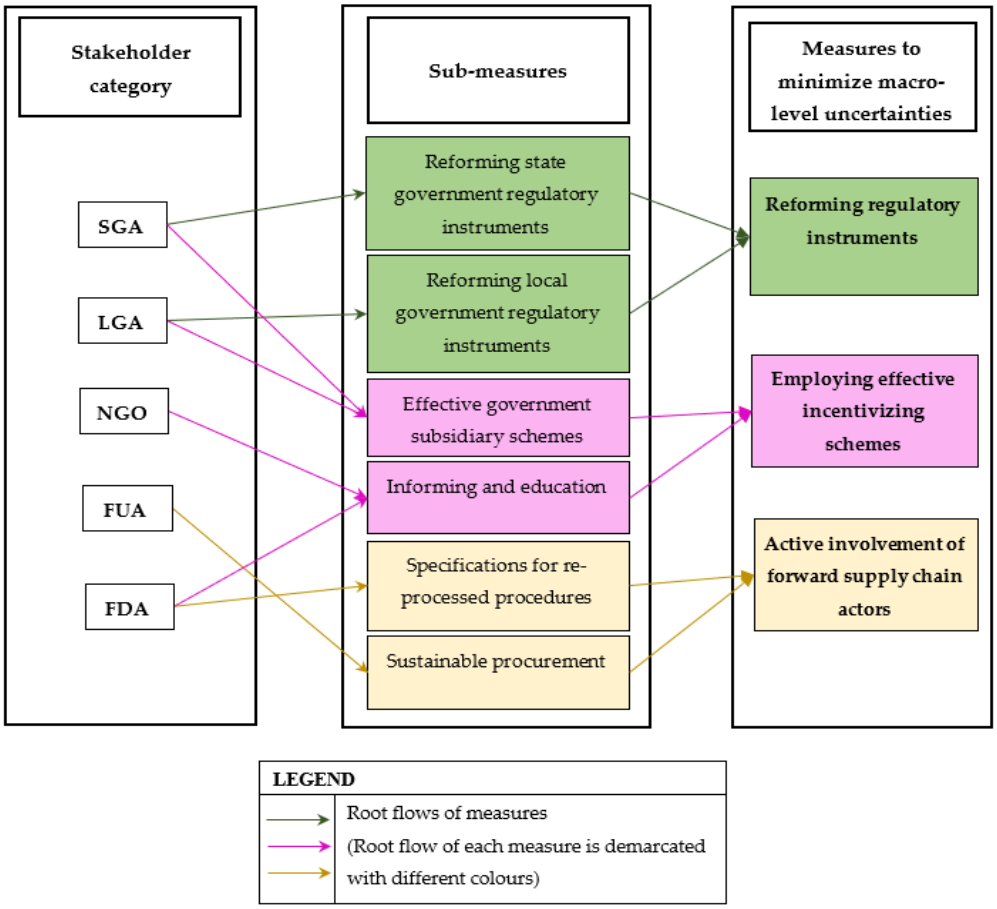

Figure 5. Measures to minimize macro-level uncertainties for quality assurance. SGA–State government agencies. LGA–Local government agencies; NGO–Non-government agencies; FUA–Forward supply chain -upstream actors; FDA–Forward supply chain -downstream actors.

The next strategy is employing effective incentivizing schemes. This strategy is especially aimed to minimize the incentivizing uncertainty for QA in the RLSCs. The state government agencies have to play an important role in this strategy as the regulator and custodian of the RLSC. In SA, most of the grant and loan schemes are available for municipal waste management. Even if there are few schemes for CDW management, they are available only for waste processing companies. Consequently, not many companies are motivated to enter the business, and the existing companies are also running at a lower profit margin. Therefore, appropriate subsidizing schemes are in urgent need to promote RLSC in SA. Both state and local government agencies could act together while implementing these schemes. Huang et al. [94] also highlighted a similar need for China. As solutions, the authors suggested that the Chinese government could increase loan limits, shorten the application period for loans and lower rent for CDW management businesses. The state government agencies should also introduce new technologies for the internal stakeholders to enhance their work efficiency and effectiveness. Shooshtarian et al. [106] pointed out that it is the government's responsibility to introduce innovative technologies for waste management, ranging from simple waste-classifying technologies to sophisticated technologies such as building information modelling (BIM). Other than subsidizing, all the external stakeholders could conduct educational programs and awareness campaigns to improve the knowledge about QA of internal stakeholders in RLSC. Wijewickrama et al. [7] highlighted the fact that informing and education are effective strategies that external stakeholders could employ to provide useful information for internal stakeholders in the RLSC. Many previous studies outlined the active involvement of NGOs in informing and

educating about post-disaster waste management [107] and municipal solid waste management [108–110]. For instance, Karunasena et al. [107] revealed that NGOs share knowledge and experience with industry practitioners when managing post-disaster waste in Sri Lanka. However, none of the previous studies indicates the importance of incorporating NGOs in the RLSC of DW. Given this, the current study found that incorporating NGOs with expertise in waste management to conduct informing and educating sessions would become more successful in the RLSC; however, this would exist if only there is an impetus from government agencies.

The last strategy identified as minimizing macro-level uncertainties is that of active involvement of forward supply chain actors. This strategy is most effective at curtailing the contractual uncertainties experienced by internal stakeholders in the RLSC. The study found that the forward supply chain actors could only influence the internal stakeholders in RLSCs through contracts. Therefore, they should give substantial weight to the QA practices when exerting contractual influence over the RLSC. For instance, as the initiators of the RLSC, the forward supply chain -upstream actors should follow a sustainable procurement process to employ a demolisher for a job. This means that upstream actors should inform the demolishers, through their contracts, that they value the EoLB waste management as much as they are concerned about the time and money. On the other hand, as the end-users, the forward supply chain -downstream actors should initiate developing the specification for re-processed products. Shooshtarian et al. [106] highlighted the importance of technical specifications and standards for re-processed products to enable waste processers to deliver quality output. However, despite efforts to promote the circular economy, the SA still lacks specifications explicitly designed for re-processed products. Given this, the effective involvement of forward supply chain actors and their encouragement to assure process quality is important to minimize the contractual uncertainties in the RLSC. However, as in many previous studies [111,112], the current study also criticized that even if the attitudes of forward supply chain actors for waste management are positive, their behaviour is seeking only to maximize profit. Therefore, it is important to change the behaviours of forward supply chain actors to promote RL by avoiding contractual uncertainties.

The holistic view of minimizing macro-level uncertainties for QA in the RLSC of DW is shown in Figure 6. Herein, Figure 6 re-capitulates the findings of the study: macro-level uncertainties and measures that minimize these uncertainties from the external stakeholders' perspectives. An interesting side of these findings is that the regulatory uncertainties are the root causes that propagate via incentivizing uncertainties to the contractual uncertainties. Many previous studies highlighted that RL is implemented in any industry only based on regulatory enforcement [14,16]. For instance, Rebehy et al. [16] identified that government regulatory influence is the most critical factor for RL implementation of different waste streams in Brazil. Lockery et al. [113] mentioned that even if no strong regulatory strategy exists, government control and monitoring activities prevent illegal dumping of CDW and thereby encourage waste management in the construction industry in Vietnam. In contrast, the current study revealed that the absence of a robust regulatory instrument had become a reason for government agencies in SA to not monitor and incentivize the RL activities in the construction industry. When there is no government intervention, on the one hand, the forward supply chain actors, who are always looking for profit maximization, have no motive to incentivize or contractually influence the QA in RLSCs. Brandão et al. [14] pointed out that, even if there is an intention to influence RL adoption, construction organizations cannot undertake it without inducement from the government. On the other hand, the NGOs, who always ally with the government agencies to influence the target [114], also do not have any impetus to encourage QA in RLSCs. Therefore, even if reforming the regulatory instruments is a direct solution for regulatory uncertainty, it will indirectly minimize the incentivization and, thereby, the contractual uncertainties for QA in RLSCs. In summary, when regulations are strict and robust, all the external stakeholders will be bound to incentivize and contractually support the QA in the RLSC of DW, as shown in Figure 6.

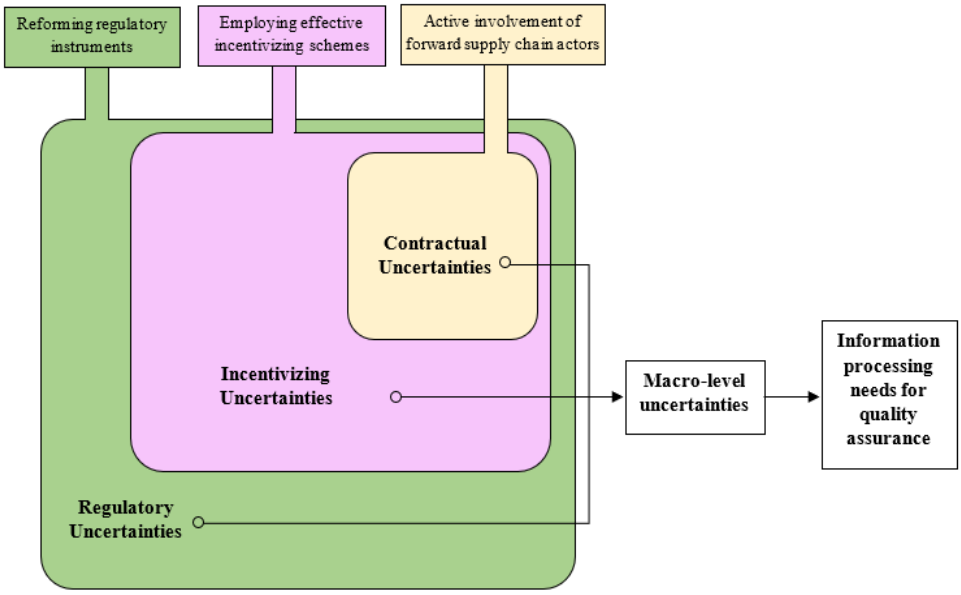

Figure 6. Minimizing macro-level uncertainties for quality assurance in the reverse logistics supply chain of demolition waste.

According to the OIPT by Galbraith [22], the uncertainties are the root causes of IPNs. Correspondingly, as per the current study, the macro-level uncertainties are the root causes of IPNs for QA in RLSC. Even though there are measures that external stakeholders could take to minimize the uncertainties still, the internal stakeholders should be able to withstand them through internally processing information to make effective decisions [26]. Herein, the organizations should undertake mechanisms that build up their IPCs to cope with IPNs and their corresponding macro-level uncertainties. According to the OIPT, this could be achieved by either reducing the information needs to coordinate its activities or increasing its capacity to process more information [22]. Therefore, in the RLSC of DW context, how internal stakeholders could cope with IPNs arising due to the macro-level uncertainties would be an interesting future research area.

6. The Implications of the Study

The current study has a number of theoretical and practical implications that are worth mentioning. However, the study is not deprived of limitations that pave avenues for future research. Therefore, this section presents the theoretical and practical implications of the study, followed by the limitations and future research.

6.1. Implications for the Theory

Many important theoretical implications can be deduced from the results of the current study. The core implication of the study lies in integrating stakeholder theory and OIPT to understand and explain the uncertainties that lead to IPNs via external stakeholders' influence. According to Mkhomazi and Iyamu [65], theories are important to underpin a study, as they advocate the researchers explaining 'how' and 'why' events happen related to the issue under investigation. Accordingly, in the current study, OIPT is used to explain 'how macro-level uncertainties form', while the stakeholder theory explains 'why macro-level uncertainties form'. When looking from the lens of OIPT, the uncertainties form due to a lack of information [22]. In contrast, from the stakeholder theory's standpoint, ineffective external stakeholders' influence strategies fail to provide useful information for an organization [18,19]. After integrating these two theoretical proclamations, the current study put forward the proposition that the ineffective external stakeholders' influences create macro-level uncertainties for QA in the RLSC of DW. Given this, the study added three sources of macro-level uncertainties, which are not hitherto found, to the OIPT literature based on the context of the RLSC of DW. Regulatory and contractual uncertainties

are formed herein due to ineffective aggressive influence strategies, while incentivizing uncertainties are sourced from ineffective cooperative influence strategies of external stakeholders (see Figure 4). Noteworthily, the current study asserted that these macro-level uncertainties are not present discretely, but they do have inter-relationships. The regulatory uncertainty is the root cause for the other two uncertainties, and then the incentivizing uncertainty is a cause for the contractual uncertainty (see Figure 6). According to the OIPT, the organizations should process information through their IPCs to fulfil IPNs caused by uncertainties. However, the current study advanced this understanding and revealed that it would be more effective if the external stakeholders employed appropriate measures to minimize the influence of macro-level uncertainties. Accordingly, the study found three measures that minimize the macro-level uncertainties for QA in the RLSC of DW from the perspective of external stakeholders: reforming regulatory instruments, employing effective incentivizing schemes, and active involvement of forward supply chain actors (see Figure 5). With this, the study proclaims that the macro-level uncertainties could be minimized through measures that external stakeholders can deploy before they essentially become IPNs for internal stakeholders in the RLSC, a new theoretical stance previously not found in the existing literature related to the OIPT.

6.2. Implications for the Practice

Practically, this work informs both external and internal stakeholders of the RLSC about the macro-level uncertainties that could arise from external stakeholders' influence strategies. For instance, Figure 4 reveals the external stakeholder categories responsible for each macro-level uncertainty for QA in the RLSC of DW. Herein, the regulatory uncertainties occurred due to the lapses and issues in aggressive influence strategies of state and local government agencies. Furthermore, as shown in Figure 4, forward supply chain actors and NGOs are responsible for forming contractual uncertainties. Interestingly, the incentivizing uncertainties evolve due to ineffective cooperative strategies of all the external stakeholders except forward supply chain -upstream actors. The study also suggests measures that external stakeholders could undertake to minimize these uncertainties at their source (see Figure 5). Consolidating all these findings, Figure 6 provides a holistic understanding of managing macro-level uncertainties for external and internal stakeholders. Accordingly, the regulatory uncertainties are the most crucial, which also cause the other macro-level uncertainties. Therefore, the study raised the importance of reforming the existing regulations related to CDW management to minimize all the macro-level uncertainties for QA in the RLSC in SA. However, developing a solitary regulation for CDW management is more effective than reforming the current regulations but challenging in the practical context. Employing effective incentivizing schemes would be a solution for incentivizing uncertainties and, thereby, contractual uncertainties. The study also emphasized that, after reforming regulatory instruments and employing effective incentivizing schemes, the contractual uncertainty would still not be minimized if forward supply chain actors had no active involvement in promoting QA in the RLSC of DW.

This study also provided implications for the internal stakeholders in the RLSC. Internal stakeholders need to understand and be aware of the macro-level uncertainties to respond effectively by employing appropriate IPCs. Minimizing the uncertainties for QA in the RLSC of DW eventually produces a quality output augmenting the waste recovery rate in the construction industry. This will be an effective approach for countries such as Australia, that are seeking solutions for waste import bans such as China's 'National Sword' policy.

6.3. Limitations and Future Research

The present study has several limitations that need to be addressed. First, the study results need to be digested considering the limitations inherent in any qualitative study. Qualitative research is about providing a rich and contextualized understanding of an issue, and for this, a small number of respondents are chosen through purposive sampling

strategies. Smith [81] asserted that the rich knowledge and small samples purposefully chosen are unique strengths of qualitative research, even if they are highlighted as limitations in some studies. As explained in Section 3.4, the findings of this study could be generalized into other contexts via transferability and naturalistic generalization. However, even if it is not the purpose of qualitative research, the inability to make statistical generalizations could be highlighted as a limitation of this study. Therefore, future research could develop measurement criteria for each uncertainty and seek to test and possibly refine the current study's findings quantitatively using larger samples. Second, this study is limited to exploring macro-level uncertainties and measures to minimize them from the perspective of external stakeholders. Employing these measures does not guarantee the complete eradication of macro-level uncertainties. Furthermore, the internal stakeholders in a supply chain also encounter micro- and meso-level uncertainties other than macro-level uncertainties [24]. Therefore, exploring IPCs of internal stakeholders, which could confront IPNs arising due to micro-, meso- and macro-level uncertainties, would be an interesting future research area. Third, the context of the study is restricted only to SA with valid justifications. Therefore, future research could apply the findings to other geographical contexts after incorporating the differences between South Australian technical, legal, and socio-economical attributes and those of the alternate context of interest.

7. Conclusions

With an increasing attempt to promote RL in the construction industry, a better understanding of uncertainties that originate from the external environment is becoming increasingly crucial for QA in the RLSC of DW. Nevertheless, there has been no detailed investigation hitherto of the macro-level uncertainties of the RLSC in the construction industry. Given this, identifying and analysing the macro-level uncertainties from the external stakeholders' influences are essential to formulate strategies to minimize their impact at the source before they adversely affect the QA of the supply chain. Taking this into consideration, this study aimed to address the following two research questions: (1) What are the macro-level uncertainties for QA that arise from external stakeholders' influence? and (2) How could these uncertainties be reduced from the external stakeholders' perspective? The study used a qualitative approach involving 21 semi-structured interviews representing five stakeholder categories external to the RLSC of DW.

In response to the first research question, the study established the following three types of macro-level uncertainties for QA in RLSC: (1) regulatory, (2) incentivizing, and (3) contractual uncertainties. Both regulatory and contractual uncertainties origins were due to the ineffective aggressive influences of external stakeholders. In contrast, the incentivizing uncertainties were from the inadequate cooperative influences of external stakeholders. Herein, the regulatory uncertainties were shown to be the root causes that propagate through incentivizing uncertainties to contractual uncertainties. Therefore, the regulatory uncertainties compound the other macro-level uncertainties for QA in the RLSC of DW.

In response to the second research question regarding how these macro-level uncertainties in RLSC could be minimized, the study identified the following three measures: (1) reforming existing regulatory instruments, (2) employing effective incentivizing schemes, and (3) active involvement of forward supply chain actors. The study further proclaimed that, since regulatory uncertainties are the root causes, introducing an effective regulatory instrument and its stringent enactment throughout the state would also evade the other two uncertainties. Noteworthily, rather than reforming, developing a new solitary regulation would be more effective with one government agency responsible for administering. Furthermore, introducing effective incentivizing schemes would not only be a solution for incentivizing uncertainties but would also help avoid the contractual uncertainties. Finally, the active involvement of forward supply chain actors would be an appropriate solution for contractual uncertainties evolving from forward supply chain -upstream and downstream actors.

The results of this study will serve as the starting point for both practitioners and academics to understand the uncertainties due to external stakeholders' influence on QA in the RLSC of DW. This study integrated stakeholder theory and OIPT and paved an avenue for academics to allocate more research efforts to further this field. Furthermore, the external and internal stakeholders can use the findings of this study as a guide to determine the suitable measures to overcome macro-level uncertainties in the RLSC of DW.

Author Contributions: Conceptualization, M.K.C.S.W., N.C., R.R. and J.J.O.; methodology, M.K.C.S.W., N.C., R.R. and J.J.O.; validation, N.C., R.R. and J.J.O.; formal analysis, M.K.C.S.W.; writing—original draft preparation, M.K.C.S.W.; writing—review and editing, N.C., R.R. and J.J.O.; visualization, M.K.C.S.W.; supervision, N.C., R.R. and J.J.O. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data generated or analysed during the study are available from the corresponding author by request.

Acknowledgments: The authors would like to acknowledge the Australian government's financial support through an Australian Government Research Training Program (RTP) Scholarship for Ph.D. studies and support from the University of South Australia.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A Coding and Generating a Description of Themes

Table A1. Coding and generating a description of themes.

Representative Excerpts and Observations	Open Codes	Axial Codes	Selective Codes
"In some scenarios, I'd like to see unified regulation around CDW management who is able to use or who has a capacity to re-use CDW because it can be used inappropriately at times." (Interviewee SGA04)	No solitary regulatory instrument	Lapses in the existing state government regulations	Regulatory uncertainties
"There's not a lot of mandatory requirements for CDW management to South Australia. So even for state as far ahead in terms of waste management, we haven't really put much focus on that, but I think we need to." (Interviewee LGA02)			
"In the demolition industry, no legal instrument administers source separation or dismantling. They have to remove all the asbestos in a certain manner, so that is Safe Work SA; they do that." (Interviewee SGA02)	Not regulating most of the demolishers' work		
"The regulation under EPA only considers the waste once it leaves the site. Because after leaving the site, only EPA consider it as waste. After that, only re-processing can happen and licensing, but if it's processed on-site, it goes from there straight to the quarry and use your rehabilitation, without any further processing, no license, no regulation." (Interviewee SGA01)			
"Since there is no allied regulation, none of the state government agencies has developed standards or guidelines to provide useful information to pursue the demolisher's work." (Interviewee SGA06)			

Table A1. *Cont.*

Representative Excerpts and Observations	Open Codes	Axial Codes	Selective Codes
"The regulation under EPA only considers the waste once it leaves the site. Because after leaving the site, only EPA consider it as waste. After that, only re-processing can happen and licensing, but if it's processed on-site, it goes from there straight to the quarry and use your rehabilitation, without any further processing, no license, no regulation." (Interviewee SGA01)	Not licensing demolishers.		
"No. so there's no provision of the building code that gives scope to our officers to undertake any assessments of that." (Interviewee LGA03)	No provision for demolition in the local government regulations	Issues with the demolition approval process	
"No legislative difference in terms of the steps to be taken in assessing a demolition compared to any other development." (Interviewee LGA02)			
"In that new Act, demolition as such is not a form of development. So, they're talking about having most demolitions not require any approval in the new planning system. In which case, local government agencies would have no statutory responsibility linked to demolition whatsoever." (Interviewee LGA04)			
"There are no firm guidelines in terms of legislation around sustainable destruction. So, this is a gap that needs to be addressed as well." (Interviewee NGA01)			
"The National Construction Code, NCC. It used to be called the building code. So that's what building officers will use when they are making an assessment of a new building, but as part of that demolition process as well. Obviously, it's focused on new buildings and construction, less on the demolition." (Interviewee LGA04)			
"We're going from the development Act to the Planning, Development and Infrastructure (PDI) Act of 2016, the kind of running side by side at the moment, but we are transitioning to the PDI Act." (Interviewee LGA04)	Change of regulations		
"They are talking about the middle of March for the third stage, which is all the Metro areas when new legislation applies to us. So, when we get the application on the 19 March, I think any applications lodged and involves demolition, that doesn't have to apply for approval for demolition, just the construction of whatever they want to do new on the property." (Interviewee LGA01)			
"We're just about to change in regulations probably about six weeks' time to start out by planning design code. So that means that where every council used to have a development plan, we'll actually now be working on one planning design document." (Interviewee LGA02)			
"For the application, the basic assessment is undertaken, and generally, that will be granted consent with conditions. So those conditions generally don't extend to you have to reuse this material in this way, or you have to recycle it." (Interviewee LGA02)	No comprehensive assessment of demolition approval application		
Nothing has been asked about or no condition is specifically related to how DW is going to be managed after demolition. (Reference to the demolition approval application)			
"In most instances, that's effectively an automatic approval, just working through the process." (Interviewee FUA01)			

Table A1. *Cont.*

Representative Excerpts and Observations	Open Codes	Axial Codes	Selective Codes
"We don't look, I must admit in our decision notices, we don't encourage waste management. That's to do with more with regard to new development rather than demolition or repair work. So, unfortunately, we don't focus on it as such." (Interviewee LGA04)			
"We operate a risk-based system for monitoring our licensees. And so, we have a minimum number of site visits we might have to do to a particular risk category of the operator on an annual basis." (Interviewee SGA03)	Improper monitoring of state government agencies	Improper monitoring	
"And so, it's telling you, if there is a license contract that the licensed contractor is not visited often by the EPA to set their low rate score low or low scale or low volume operator. And we may not see them for five years, five-year inspection schedule, but if something wants to happen, although to request something, then I was able to consider." (Interviewee SGA02)			
"We are not monitoring demolishers unless there is a complaint related to noise, dust and litter." (Interviewee SGA05)			
"With demolition, we usually don't go out to do demolition inspections; And the legislation doesn't say we have to do inspections for demolitions." (Interviewee LGA03)	Improper monitoring of local government agencies		
"There's some monitoring, probably less so for the demolition process." (Interviewee LGA04)			

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