

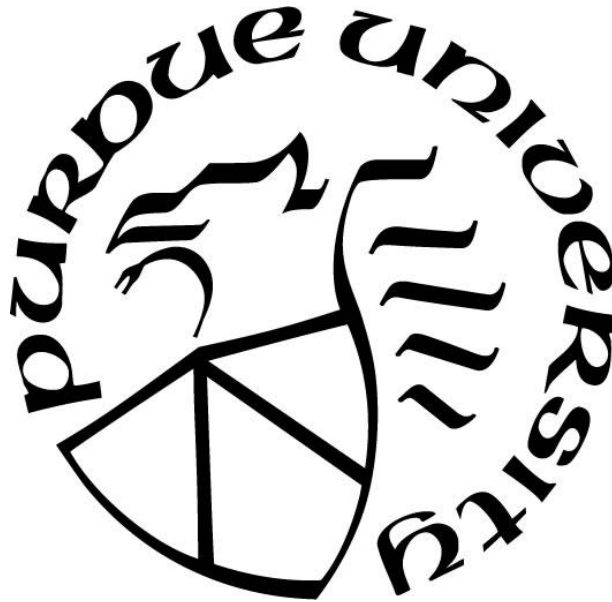
**OPPORTUNITIES FROM DISASTER: THE CASE FOR USING THE
CIRCULAR ECONOMY IN DEBRIS MANAGEMENT**

by
Toy Andrews

A Dissertation

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THE PURDUE UNIVERSITY GRADUATE SCHOOL
STATEMENT OF COMMITTEE APPROVAL

Dr. Randy Rapp, Co-Chair

Purdue Polytechnic Institute, School of Construction Management Technology

Dr. Emad Ewakil, Co-Chair

Purdue Polytechnic Institute, School of Construction Management Technology

Dr. Eric Dietz

Purdue Polytechnic Institute/Purdue Homeland Security Institute, Department of Computer &
Information Technology

Dr. Sam Baroudi

University of Adelaide, Adelaide Business School – Management Discipline

Approved by:

Dr. Kathryn Newton

Dedicated to my mom, my kids, my Navy, and the most patient wife in the world.

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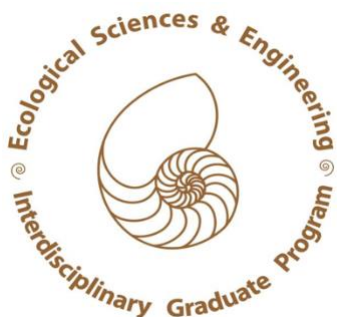


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GLOSSARY

In this study, the researcher worked through an interdisciplinary approach to the complicated problem of sustainable adoption practices by post-disaster cleanup crews. Furthermore, throughout the study, terms will be encountered as familiar with preparedness community and those of the environmentally and economically minded community to enable resource reclamation.

C40 – “A network of the world’s megacities committed to addressing climate change. C40 supports cities to collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change.” (*About C40*, n.d.). A voluntary collective of over the original 40 cities envisioned wherein they compete on the global stage and amongst themselves to meeting and exceeding sustainable targets. The mayors of these cities and by extension, the workings of the city’s governmental reach, commit to and lead their citizenry in adopting these policy guidelines at the actionable level. (*C40*, n.d.).

Capital Expenses – These are typically investment or otherwise upfront costs in the tangible purchases of materials or work performed in the initial construction of a project.

Circular Economy (CE) – Regenerative by design economy in industrial manufacturing (Raworth, 2017). Is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems (What Is the Circular Economy?, n.d.). Operationalized to other businesses as a way to close-the-loop on the logistics of whatever material is being used by the company.

Corporate Social Responsibility (CSR) – The model of businesses to be or become socially responsible in their investment and operational actions. Operationalized as a viewpoint to discuss why sustainability pays off in customer preferences and stockholder interests. In the construction industry, “CSR is literarily perceived as an ambiguous terminology that is lacking in common definition in the industry.” (Xia et al, 2018, p. 350).

Cradle-to-Cradle (C2C) – A model of reviewing a product’s life cycle from raw materials back through until reused as materials for another. Set as a contrast to the typical cradle-to-grave model of materials in life cycle assessments (Braungart & McDonough, 2002). Operationalized and adopted across other production sectors as a standard of ecologically-minded production and can achieve Cradle to Cradle Certified™ as a result.

Leachate – Liquid wastes that seep through the landfill and any precipitation or other water that comes in contact with the waste becoming contaminated. (*Solid Waste Laws and Regulations / Public Private Partnership*, n.d.). Operationalized as the impetus of requiring landfills to have groundwater protecting liners and systems in place to treat any runoff from waste areas.

Leadership in Energy and Environmental Design (LEED) – A globally-recognized, green building rating system. Provides the framework for green building specifications in order to achieve levels of certification (Platinum, Gold, Silver, and Certified) credentialing (What Is LEED?, n.d.).

Resilience – The ability of a system to recover from perturbation; the ability to restore or bounce back after a change due to an outside force (Meadows 2008).

Resource Conservation and Recovery Act (RCRA) – The US law, signed in October of 1976, that governs the disposal of all solid and hazardous waste. Considered the framework of where the Environmental Protection Agency (EPA) works with local, state, and tribal leadership in managing waste streams (US EPA, 2015).

Technical Nutrient – A material or product that is designed to go back into the technical cycle, in the industrial metabolism from which it came (Braungart & McDonough, 2002).

Temporary disposal and storage reduction (TDSR) facilities – Sites created ad hoc either adjacent to immediate pick-up areas for gathering and further sorting. Or, as typically, adjacent to final processing site along a traffic/transportation artery for resource flow management. Also referred to as temporary disaster debris management site (TDDMS).

Triple Bottom Line (TBL) – A concept from 1994 by John Elkington, to include aspects of sustainability, of the bottom line being only economic (profits) as the primary driver, the three lines for profit, people, and planet in order “to measure the financial, social, and environmental performance of the corporation over a period of time (“Triple Bottom Line,” n.d.). Related to and part of the portfolio determination of CSR.

Triple Top Line (TTL) – A 2002 concept from Braungart and McDonough that updated perspective of the TBL to move the accountability of sustainability to the design phase of a company’s manufacturing process using the metrics of economics, ecological, and social values to balance the decisions (Design for the Triple Top Line (2002), n.d.).

LIST OF ABBREVIATIONS

B2B – Business-to-Business
B2C – Business-to-Consumer
B2G – Business-to-Government
BIM – Building Information Modeling
C2C – Cradle-to-Cradle
CAPEX – Capital Expenses
CE – Circular Economy
CSR – Corporate Social Responsibility
EPA – US Environmental Protection Agency
EPR – Extended Producer Responsibility
FEMA – Federal Emergency Management Agency
GIS – Geographic Information System
LEED – Leadership in Energy and Environmental Design
NDA – National Demolition Association
NIMBY – Not in My Backyard
NIMS – National Incident Management System
FOMO – Fear of Missing Out
OMB – Office of Management and Budget
OPEX – Operating Expenses
PACE – Platform for Accelerating the Circular Economy
RCRA – Resource Conservation and Recovery Act
SME – Small and Medium-Sized Enterprises
SMM – Sustainable Materials Management
TBL – Triple Bottom Line
TDSR – Temporary Disposal and Storage Reduction
TTL – Triple Top Line

ABSTRACT

Hurricanes generate a tremendous amount of damage, and the debris volume is on such a scale, most municipal waste management streams cannot accommodate the flux of incoming material. Since getting back to normal operations is a planning imperative, sorting and reclaiming resources gets pushed to “later”. Herein lies the problem that disaster waste management (DWM) has no durable sustainable business model for the team of government regulator and cleanup contractor. The purpose of this interdisciplinary research study was to develop, through grounded theory discovery, best practices and regulations for government planners and cleanup contractors to adopt sustainable resource reclamation as the standard protocol in hurricane prone and by extension, other disaster areas. The first question is what incentives are going to drive cleanup contractors to adopt sustainable resource reclamation practices? Second, if speed is the primary driver to cleanup success, then what support is necessary to facilitate a speedier and more sustainable protocol? Further research looked at how the circular economy (CE) is gaining traction for resource supply professionals everywhere, so application in the DWM arena is the next, logical step in the right direction. The study utilized emergency planning specialists’ interviews, iterative surveys of cleanup contractors, and snapshot analyses of the reclaimed resource market. The end goal of this research was to update the regulatory framework for DWM with applications in the regular, municipal waste management environment.

Keywords: Disaster Waste Management (DWM), Sustainable, Circular Economy, Disaster Recovery, Resource Reclamation, Proactive Resilience

CHAPTER 1. INTRODUCTION

Following a disaster and after all lives have been rescued or bodies have been claimed and/or identified, the next step becomes the expedient debris removal and disposal. This debris has been labeled as a waste and becomes forever lost to the landfill and the impacted communities pay twice in land use and economically. Throughout the study, the researcher engaged both the contracted clean-up businesses and government contracting officials to uncover the drivers of success in order to persuade them to adopt a sustainable resource reclamation regimen as the standard business model as part of the larger Circular Economy (CE). Through sequential interviews and iterative surveys, the researcher used a grounded theory framework for a mixed methods research approach along an area of the Gulf Coast states of Florida and Mississippi, a focused area from the Fourth Region of Federal Emergency Management Agency (FEMA). The literature and procedural analysis showed how contractors and government planners dealt with disaster waste management (DWM) logistics and what economic or procedural factors are precluding the adoption of environmentally and economically sustainable clean-up practices.

Solid Waste Management Legislation

Solid waste, or trash as many people would refer to it, is a part of civilization as far back as people have been gathering together and ridding themselves of what's left, what's not needed anymore, and what's of little to no value for their consumption. It can range from something organically derived in nature, such as an orange or banana peel or the familiar grass clippings, to something as complex and non-organic as the demolition debris pile of an old soccer stadium or a totaled-out Buick. As far as organic or biodegradable materials management, nature does an unassisted, low or no technological, metabolic process to cycle those nutrients and energy back within those biomes. These processes are well understood to decompose and break apart, down to the molecular and elemental levels, the building blocks of a biomass, like a downed tree in the forest. The parts that make up the ecosystem, including all strata of fauna and flora, bound, use, and the return the materials in their own lifecycles and return them to the surrounding area.

For those non-biodegradable systems and materials, like those complex materials that make up an automobile, the process is quite a bit more complicated in a practical and materials cycling

perspective. For practical reasons, materials that are extracted from ore in the form of metals to make a car's frame, are designed for strength and durability. While a bamboo or heavy cardboard frame may be possible, the strength and safety specifications would be lacking. For materials cycling, once a frame is forged into the shape necessary for the function of the car, that ore-derived metal is now in the product as a lifelong sink. To carry the image further of the automobile, at the planned or unplanned end of its useful life, that frame can be extracted or harvested and returned to the supply chain for making the next casting of another car frame. But unlike the frame, the car's seat cushion or carpet that lines the floorboards is now destined for disposal.

Trash or waste has been loosely understood as something not wanted and that is to be disposed of somewhere the collective group, such as a family, village, city, or a county, has deemed suitable for dumping those unwanted materials. In 1965, the US Congress passed the Solid Waste Disposal Act (SWDA), a first in the manner of an environmental law that focused specifically on improving solid waste disposal methods, with the primary goals of reducing waste and protecting both human and environmental health (US EPA, 2015). After only a few years later, the SWDA was amended in 1970 as part of the Resource Recovery Act to put more emphasis on recycling and energy recovery as part of the overall strategy (*Solid Waste Laws and Regulations / Public Private Partnership*, n.d.). It was later that same year when, as part of the Nixon's Reorganization Plan No. 3 of 1970, wherein disparate entities were pooled together to form the Environmental Protection Agency (EPA). This consolidation and creation of the EPA, and National Oceanic and Atmospheric Administration (NOAA), helped to enforce legislation in both the evolving SWDA and its amendment from the Resource Recovery Act (US EPA, n.d.). The EPA saw many growing pains as they absorbed responsibilities that were previously across multiple departments and began taking their enforcement actions seriously in hazardous and solid waste management as it currently stood. In 1976, the Resource Conservation and Recovery Act (RCRA) built upon the earlier changes and codified the EPA's role in establishing regulations to control solid waste disposal (*Solid Waste Laws and Regulations / Public Private Partnership*, n.d.).

RCRA's continued role in solid waste management is felt throughout multiple industries and municipalities, especially when it comes to ones that deal with any hazardous wastes, landfilling of solid wastes, or cleaning up of either of those. Signed into law on October 21, 1976,

it was specifically designed to address the growing volume of both municipal and industrial waste (US EPA, 2015). From **Figure 1** to the right, the legislative changes of solid waste management can be traced through to the present day. Starting with the SWDA in 1965, then after the EPA is officially established in 1970, the RCRA takes shape as the foundational guidance from there on out. In 1984, the Hazardous and Solid Waste Amendments (HSWA) revised the criteria for landfills accepting hazardous waste, treatment protocols for landfill water runoff, and further adoption of a leachate protection system in all new landfills (*Solid Waste Laws and Regulations / Public Private Partnership*, n.d.). The HWSA also made critical changes in the siting of landfills for nearby influencing side-effects and in minimum operational procedures. In 1990, between the HWSA and the next part legislative evolution from Figure 1, the EPA, via Congress, enacted the Pollution Prevention Act, also referred to as the P2 Act. The overall effect of the P2 Act was to emphasize source reduction (US EPA, 2013).

The next major milestone in the evolution involved holding the federal government to account against the states. The Federal Facilities Compliance Act of 1992 (FFCA) waived sovereign immunity and granted the states the ability to sue the Federal government and collect fines and penalties for violations within their state; this turned the EPA, in effect, into an honest broker of arbitration in the form of transparency in reporting and monitoring of sites under the RCRA. As an evolving challenge in waste management, landfills were revisited in the 1996 Land Disposal Program Flexibility Act wherein more specifics on how groundwater needed to be measured and monitored to be in compliance with updates the Clean Water Act of 1972 and decreased the burden to smaller facilities (<20 tons a day) or those in once checked, but overall arid climate conditions. The 1996 Act was seen as a dialing back on a cumbersome to administer and monitor for smaller facilities, but with new technologies of the present day, those allowances of deviation are better tied to actual data at those landfill sites.

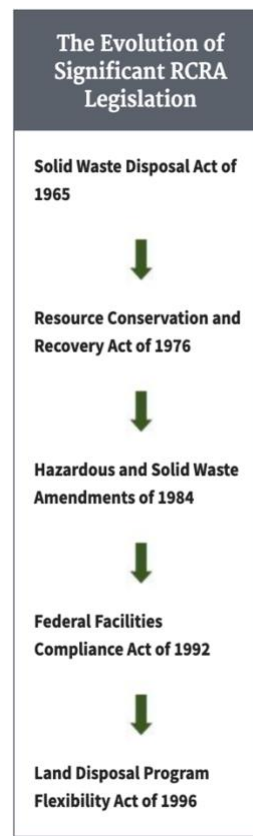


Figure 1. RCRA Through the Years. Derived from History of the RCRA, (US EPA, 2015)

Emergency Management

Throughout the history of the United States, as in other countries around the world, natural disasters have been endured, survived, and recovered from by the population. Many times, those in the path of disaster take not only the physical damages to structures and livelihoods directly, but also endure the costs of rebuilding and recovering themselves. According to the official history of FEMA webpage, the first-time legislated disaster relief, as we know it today, was realized after a devastating fire in the seaport town of Portsmouth, New Hampshire in December 1802, which put a critical strain on this fledgling nation's commerce (History of FEMA | FEMA.Gov, n.d.). From then on, the U.S. Congress, with the power of the purse, responded to events that had federal implications, but it was reactive and monetary in the actions they could do to support recovery. By President Jimmy Carter's Executive Order 12127 of April 1979, the role and scope of emergency management was formally put together with a lead agency, FEMA (History of FEMA | FEMA.Gov, n.d.). Later in the same year, Executive Order 12148 delineated FEMA's dual roles of emergency management and civil defense. After a few years and disasters to flex FEMA's response in 1988, their role was expanded and outlined with an amendment to the Disaster Relief Act of 1974; the new act is known commonly as The Stafford Act. The History of FEMA (n.d.) webpage goes on to say, "The Stafford Act provided clear direction for emergency management and established the current statutory framework for disaster response and recovery through presidential disaster declarations."

While much of the Stafford Act architecture remains today, FEMA itself was moved under the newly created Department of Homeland Security following the terrorist attacks of 9/11, reorganized after Hurricane Katrina's devastation and disorganized recovery of the Gulf Coast, and then streamlined infrastructure processes after Hurricane Sandy's impact to the East Coast (History of FEMA | FEMA.Gov, n.d.). The latest legislative changes came in the Disaster Recovery Reform Act of 2018 that started the mindset shift of looking to the pre-disaster mitigation efforts and in building capability of response partners at all levels. In the emergency management lexicon, when referring to how money is allocated or apportioned after a disaster, managers and legislative representatives call them by the shorthand Stafford funds or Stafford funding. In the latest iteration of the Act's amendments, herein lies the tie-in to the researcher's goals.

Using the latest methods in management processes and after multiple flexes of the emergency management systematically, FEMA built out the administrative and procedural architecture for the National Preparedness Goal of:

“A secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk.” - (National Preparedness Goal | FEMA.Gov, n.d.)

The key enablers to fulfill this goal’s aim involve the National Incident Management System (NIMS) whereby all levels of government are reading from the same playbook and using the same language regarding all aspects of operations before, during, and after a disaster (*National Incident Management System* / FEMA.Gov, n.d.). The US uses the NIMS as the system to allow the National Response Framework (NRF) to scale, flex, and adapt to emergencies (*National Response Framework* / FEMA.Gov, n.d.). More granular details come out of the NRF’s Emergency Support Functions (ESF) by both the area of concern and by delineating, on the national level, who has the cognizant responsibility to champion that ESF, and that function that can be scaled to the local jurisdiction or governmental level. The ESFs listed below show the areas of most concern throughout the operations cycle:

ESF #1: [Transportation](#)

ESF #2: [Communications](#)

ESF #3: [Public Works and Engineering](#)

ESF #4: [Firefighting](#)

ESF #5: [Information and Planning](#)

ESF #6: [Mass Care, Emergency Assistance, Temporary Housing, and Human Services](#)

ESF #7: [Logistics](#)

ESF #8: [Public Health and Medical Services](#)

ESF #9: [Search and Rescue](#)

ESF #10: [Oil and Hazardous Materials Response](#)

ESF #11: [Agriculture and Natural Resources Annex](#)

ESF #12: [Energy](#)

ESF #13: [Public Safety and Security](#)

ESF #14: [Cross-Sector Business and Infrastructure](#)

ESF #15: [External Affairs](#)

With the ESFs in mind, regular exercises of mock scenarios are used to train new personnel and hone the skills of those long involved in the continuum of disaster operations. That continuum consists of those mission areas highlighted in the National Preparedness Goal as prevention, protection, mitigation, response, and recovery. Each mission area focuses on the timeline of an incident’s occurrence and the coverage of each area ensures managers have a framework to go by

in their operations and budgetary discussions, but also allowing realistic training and field exercises by responders, government decision-makers, and the rest of the supporting cast to make an incident less of a long-term impact. These mission areas are further categorized by their functional core capabilities show in **Table 1** from the National Preparedness Goal (2015) guide below:

Table 1: Core Capabilities by Mission Area

| Prevention | Protection | Mitigation | Response | Recovery |
|--------------------------------------|--|---|---|--------------------------------|
| Planning | | | | |
| Public Information and Warning | | | | |
| Operational Coordination | | | | |
| Intelligence and Information Sharing | | Community Resilience | Infrastructure Systems | |
| Interdiction and Disruption | | | Critical Transportation | Economic Recovery |
| Screening, Search, and Detection | | | | |
| Forensics and Attribution | Access Control and Identity Verification | Long-term Vulnerability Reduction | Environmental Response/Health and Safety | Health and Social Services |
| | Cybersecurity | Risk and Disaster Resilience Assessment | Fatality Management Services | Housing |
| | Physical Protective Measures | | Fire Management and Suppression | Natural and Cultural Resources |
| | Risk Management for Protection Programs and Activities | Threats and Hazards Identification | Logistics and Supply Chain Management | |
| | Supply Chain Integrity and Security | | Mass Care Services | |
| | | | Mass Search and Rescue Operations | |
| | | | On-scene Security, Protection, and Law Enforcement | |
| | | | Operational Communications | |
| | | | Public Health, Healthcare, and Emergency Medical Services | |
| | | | Situational Assessment | |

Source: *National Preparedness Goal* / FEMA.Gov, 2015

Circular Economy

Resources are, by virtue of their extraction and use in the economy, a finite-supply material. This is especially true in the realm of barrels of oil pumped out, tons of mineral mined and refined, or acres of land available for productive use. With early adoptions of the concept of industrial ecology, resource constraints were put into an active recovery practice by framing the Earth's systems as the systems on a spacecraft with a very defined, finite set of life-sustaining sources and energy (Boulding, 1966; Fuller, 1969). Continuing through the years and as part of an ever-growing environmental movement, the concept was revisited as part of the codification of the “Reduce, Reuse, Recycle” mantra that shortened up the idea of sustainability to the a consumer-friendly marketing slogan.

Futurists and logisticians, after many years seeing how the consumer was now at the point for what good could be done, began to measure the impacts and see those at the end of a product's life were being responsible for the treatment and return of the product they bought. In 2002, Michael Braungart and William McDonough reframed the whole concept and flipped the emphasis of what to do with something at the end of its life, but instead to think about the product's new life from the design phase in their seminal book *Cradle to Cradle: Remaking the Way We Make Things*. This book inspired many people in industry and academia to work towards way to build up the logistic resilience, work towards a new concept of the Triple Top Line (TTL) instead of a Triple Bottom Line (TBL), and work within the bounds of our natural and industrial process limitations.

One influential leader, Ellen MacArthur, took this concept presented in the Cradle to Cradle book and built a foundation around it to focus on what is referred to as a circular economy (CE). The Foundation's principles of the circular economy are simple and expressed below as:

- Design out waste and pollution,
- Keep products and materials in use,
- Regenerate natural systems. (What Is a Circular Economy?, n.d.)

As further amplification of the CE, an entire movement has become centered around a way to circularize materials across multiple municipalities, regions, state and non-state parties, and allied countries around the world. While the details of execution may be highly technical or cumbersome with getting economies willing to adopt these practices, the Ellen MacArthur Foundation (EMF) has summarized the CE using their now famous “Butterfly Model” as seen in **Figure 2** below:

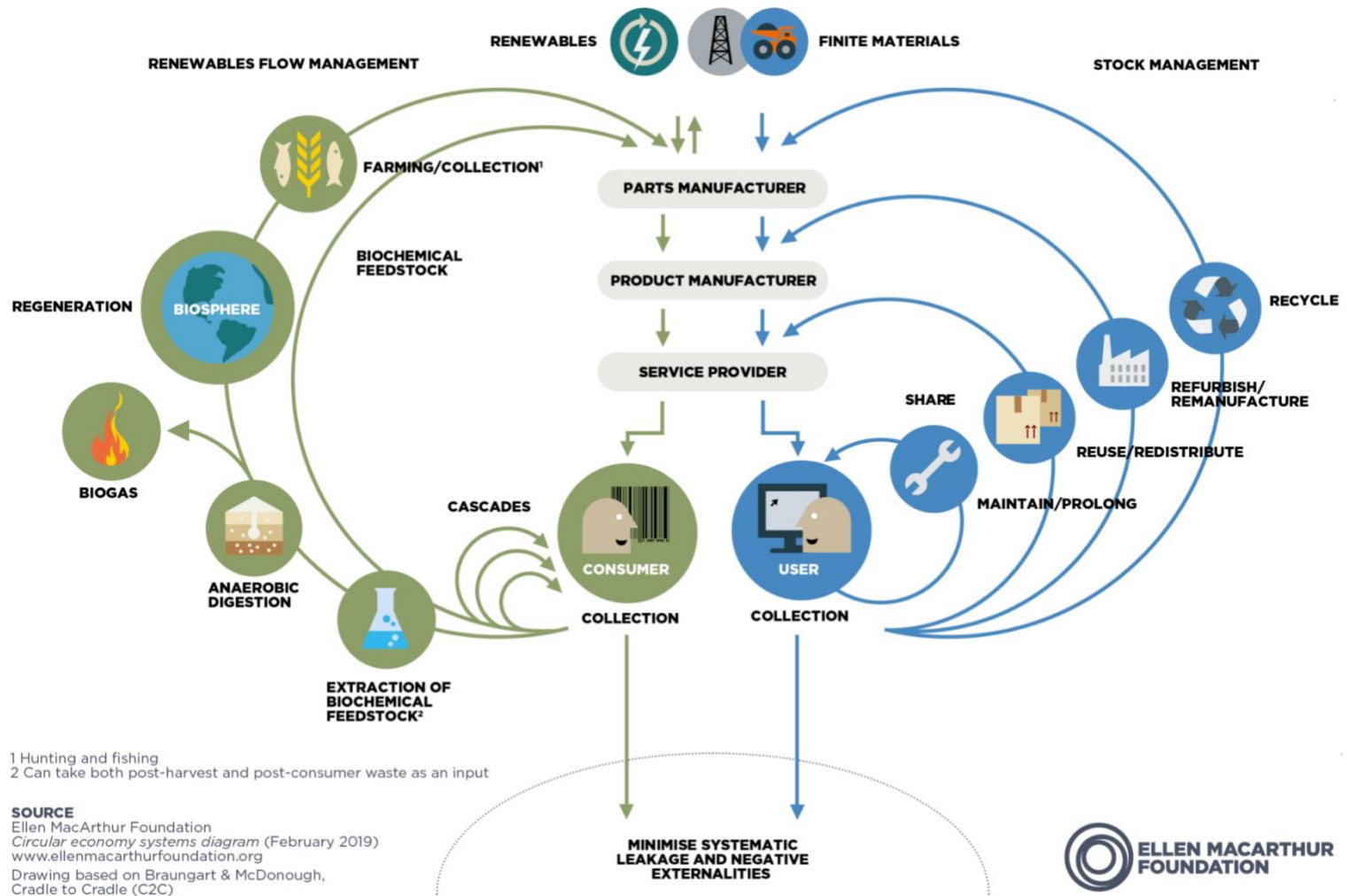


Figure 2: Butterfly Model of the Circular Economy

This summary figure has been instrumental in creating discussions on policy and processes and is being taught in sustainable programs around the world. An animated synopsis of the CE diagram can be watched here as well: <https://youtu.be/EqBivOsNtFg> (Blues Lounge, 2017). In every effort, the diagram and the mindset of the CE is to lower and eventually eliminate the negative externalities of doing business. Braungart and McDonough (2013) followed up their initial book with *The Upcycle: Beyond Sustainability – Designing for Abundance*. One of the key takeaways from their next book was that it is not enough to just be “less bad”, but to instead design out the bad entirely. As many authors and thinkers on the subject have opined in saying, “Waste is a design flaw”, the idea of the CE is only limited by the imagination and willingness of businesses, governments, and citizens around the world to change the way things are and moving to the way they can be.

Problem Statement

Current practice of disaster waste management is to clean up the debris as fast as possible and dispose of the materials by landfilling or incineration. The lost opportunity in this business-as-usual model is that high-risk areas are repeatedly get hit with multiple and ever-strengthening debris-creating events and are losing valuable, viable materials to a landfill. Those landfills are increasingly taking up space for the region to use productively as well as creating a potential for long-lasting effects to the groundwater, air quality, and stability of the landscape.

There are multiple entries in the literature on where a sustainable business model approach to recovery point to indicators of successful applications of known and emerging principles. For instance, the importance of communities caring about the recovery process too by making the actions of preparedness and recovery a function of the community instead of or relying on an outside assistance (Adame & Miller, 2015). Buy-in of the effected population gets things turned around much faster. The same goes with the preparation or proactive mindsets of people to get ready for a disaster. One example is the development and cultivation of self-efficacy beliefs in disaster preparedness through community programs and policies that strengthen the mechanisms of resilience within the community’s operations and psyche for transforming a setback of a disaster into a pathway ahead (Hidayati, 2018). Preparedness is not an accident and quickly recovering areas see the investment of proper planning and preparations firsthand.

After a disaster strikes, the framework itself of how to get life back to normal can be a hinderance to progressing at the rate where modern research and technology knows it can be made more efficient. When policy conflicts from decision makers on sustainable protocols using a quantitative approach for assessing Large Scale Disaster Waste Management (LSDWM) is measured, quickly returning to normal operations does not fully encapsulate the magnitude of the event and costs the regions more in the long run as it ignores the current science and management practices (Habib et al., 2019). By getting the right people to the table, the political arm of a response can be armed with current knowledge and implement flexible responses to not only get things cleaned up, but also getting things back to a normal operating status on a local, regional, and even national level. Another study investigated the issue of properly siting an area for temporary separation sites close to the disaster area by “locating temporary disposal and storage reduction (TDSR) facilities in support of disaster debris cleanup operations.” (Fetter & Rakes, 2012, p. 1). Getting these dangling chads of patchwork policies consolidated, which are now inefficient and scattered, can be taken care of to streamline and improve the flows of debris from an area to follow-on processing sites or nodes.

Therefore, the problem addressed by this study is to discover why contracted DWM clean-up businesses and government contracting officials are not adopting sustainability as a successful business model.

Significance

So why would businesses even entertain the idea of adopting the sustainable measures into their own business models? Money made and resources saved. Asari et al., (2013), created guidelines for separation and treatment of disaster waste after the 2011 Tohoku Earthquake and follow-on cascading disaster resulting in the majority of all debris being successfully processed for reuse/recycling. Savings at scale for anything is a big deal and should be a laudable goal of any industry. Secondly, it makes more money on the retail of a structure when the building has ‘reused’ materials in it as noted in Ibrahim’s (2016) study on a LEED-accredited building. In his study, he investigated the reduction in costs input and the recovery value of those materials by front-loading cost savings by using recycled materials from other demolition sites and showed how much easier it is to get not only LEED accreditation, but also significant savings in recover for the future end of the building’s lifecycle. Make money by saving money in virgin materials and the

Corporate Social Responsibility (CSR) market forces will come through. Quality problems cost everyone in the supply chain time and money. The first instinct of an operator when a part fails for fit or function is to determine how many others show the same condition. The typical next step is to determine the problem and sort for the defect. This may also lead to down time and rework. The scrap associated non-conforming material will also create costs. Problem solving, corrective actions, and administrative costs can add up quickly.

Statement of Purpose

The purpose of this project is to improve strategies for government regulators and businesses to adopt more sustainable resource reclamation practices after hurricane disasters. Business-as-usual involves a contracted clean-up crew arriving at a scene, hauling off debris to a landfill, then getting paid by local and federal governments by the load while those affected by a hurricane are now left with insurance claims and rebuying something new from the market. As the cycle continues, especially in certain hurricane prone areas, the landfill real estate starts to run out and the costs to continue pulling the raw materials for more reconstruction becomes untenable.

Research Questions

Through this research, the following questions were explored:

RQ1. What incentives or disincentives would drive clean-up contractors to adopt sustainable resource reclamation protocols?

RQ2. If speed is the only driver for clean-up, what temporary support and resources would be necessary to facilitate resource reclamation?

While investigating RQ1 and RQ2, the outcomes of this study highlighted trends in the way businesses can make money while the community and region can benefit from a truly localized recovery plan. One hypothesis (H1) the research expected to uncover was that if clean-up contractors adopt the opportunity model from a disaster, then other clean-up processing will be the new business norm, e.g., controlled demolition or construction waste. A sea change in the way to approach a disaster and all the debris generated as an opportunity instead of an economic and environmental hardship can drive other industries to rethink how their trade may apply to any

supply chain. The second hypothesis (H2) the research attempted to validate is whether the reclaimed construction materials market will take up the new surplus resources and cycle the supplies as materials. To fully embrace the circular economy (CE) model, materials and resources are continually in a state of waiting until the next use, so instead of being landfill fodder, a resource born out of debris is still viable as a material for another project.

Once the data of H1 and H2 was collected in the research, their findings were analyzed against RQ1 and RQ2 to make a two-fold addition of deliverables to the practice of disaster waste management (DWM). First, policy modification suggestions for policymakers for the guidelines of cleaning up after a disaster. Second, a new CE-business model for clean-up contractors creating a market demand for the resources they gather.

Assumptions

To proceed, several assumptions were required. The researcher assumed that all reported or estimated costs were real. The researcher also assumed that respondents represent the population of all similar contractors within that demolition sector and their answers are factual. The researcher gained interview access to regulators, business planners, and advocates related to the debris cleanup or sustainably sectors. Finally, it was assumed that all decisions from federal regulators would have associated statutes in the Code of Federal Regulations.

Limitations

The researcher used interviews as one collection tool. Interviews are normally opinion-based and will vary across a population and may not be generalizable to the overall group/population. The cross-sectional nature of the data collected via questionnaires for the current attitudes and policies are subject to variability to include the population's bias regarding recent actions and their own lived experiences. States within the Region IV will also influence motivations and incentives for the contractors and regulators, so each respondent will be categorized into their state for identifying common themes. Finally, the researcher was limited on travel costs, COVID-19 research restrictions (e.g., in-person versus videoconference interviews) and industry impacts, and time constrained to approximately nine months for data collection and analysis before follow-on responsibilities for the researcher put a halt to the study.

Delimitations

The research conducted was only concerned with potential cleanup contractors throughout the National Demolition Association (NDA). The opportunity existed to use all disasters throughout each of FEMA's 10 designated Regions in the United States, but the scope of the data collection would grow too large for this project, so regulator input was focused on Region IV of the Gulf Coast states of Florida, Alabama, and Mississippi. Additionally, the review of resource reclamation will be concerned with disaster waste management (DWM) concerns only, chiefly speed and volume constraints. Municipal waste and recycling programs are outside of the scope of this study, although contribute significantly to the understanding and infrastructure necessary to employ many of the techniques uncovered.

Project Summary

While the coronavirus pandemic that started at the beginning of the researcher's timeline to conduct the on-site tours and interviews with business leaders in the state of Indiana, the points of contact and manner of data collection had to pivot substantially in order to achieve the same levels needed for analysis and to suggest achievable and substantive policy and educational modifications on the way waste is viewed in the demolition industry and the how the opportunities of both everyday operations and emergency debris collection operations can benefit everyone involved.

The researcher realigned priorities early in the summer of 2020 by first seeking Institution Review Board (IRB) approval of the project because of the use of human subjects in the study. After proposal approval and IRB blessing, the researcher reached out and interviewed emergency managers of counties in the Gulf Coast region of Mississippi, Alabama, and Florida. Herein, a semi-structured, over-the-phone interview guided the discussions in the direction of RQ2 and on their knowledge of the CE. After the interviews concluded with those government leaders, the researcher then sought out business leaders for interview to describe their relationship with and implementation of sustainable tenets in their normal operations; the challenge of the coronavirus restrictions toned down the depth and options for hands-on demonstrations of their practices in action.

Initially planned to have in-person interactions through an industry convention show, but after large gatherings and travel for research was cancelled due to the coronavirus protocols, an alliance between the researcher's advisor and the NDA proved fruitful. The partnership allowed for questionnaires to be sent out in two rounds in the fall of 2020 with common questions in each set but added a deviation subset to the second batch for further options of free-text and opinion follow-up answers.

The results of the findings are located herein and were summarized back to the Industrial Committee of the NDA via a video-teleconference on what their members expressed and how they, the NDA, could advocate and educate their associates in capitalizing on the potential opportunity afforded by the growing mindset and trends of the greater economic forces. In addition to the findings of the literature reviewed, the interviews and surveys paint a target-rich environment for businesses, within and surround the demolition industry, to be key leaders in the CE movement at large and provide critical examples to other industries thinking of starting this journey as well.

CHAPTER 2. LITERATURE REVIEW

While no review by a single researcher will be able to capture the totality of the picture facing or intersecting with an issue, the researcher has gone to great lengths to exhaust every avenue and field of study that brings together the seemingly disparate subjects of the circular economy, disaster operations, and the construction and demolition industry into alignment. As the fields grow in their own silos of knowledge, the growing interest in interdisciplinary studies shines light on previously overlooked networks and new points-of-view to combine fields and synthesize truly remarkable outcomes in processes, materials, or overall approaches to the many challenges in both academia and practical application.

Methodology of the Review

The problem as perceived by the researcher is the real and perceived difficulties in adopting a steady-state, sustainable disaster waste management (DWM) protocol as part of the disaster response operations process. Pilot-programs have been floated and minimally tested in the past to increase the level of recycling, but after a hurricane event and the sheer volume of debris is seemingly overwhelming, the regulations are more often waived in the demand to expediency. If the regulation becomes expectant enough for the cleanup contractors and FEMA to agree upon, then waivers would not be the normal for every event. Therefore, the threads for a literature review focused on those barriers to have unswerving standards that are both rigidly enforce while being resiliently agile to flex other options through the exploration of policy exemplars, materials management successes, and how to spread the message in every phase of disaster operations. Ideas for how to overcome logistical challenges of disaster reclaimed resources centered around materials market analysis, best practices, and emerging technologies along with novel applications in the marketplace. Methodologies by which to conduct the research, such as interview and survey best practice implementation, were also be cultivated from the literature. Recent, as defined by 2000-2020, results were be selected for by filter with earlier material reviewed on a case-by-case basis.

As the screening and selection process for how to chart a path forward, the researcher presumed the status of how operations are perceived by everyday citizens and how things are

generally understood by those working the disaster response. Using **Figure 3** below, the researcher connected ideas of how a structure's end of life is treated in either planned or unplanned circumstances:

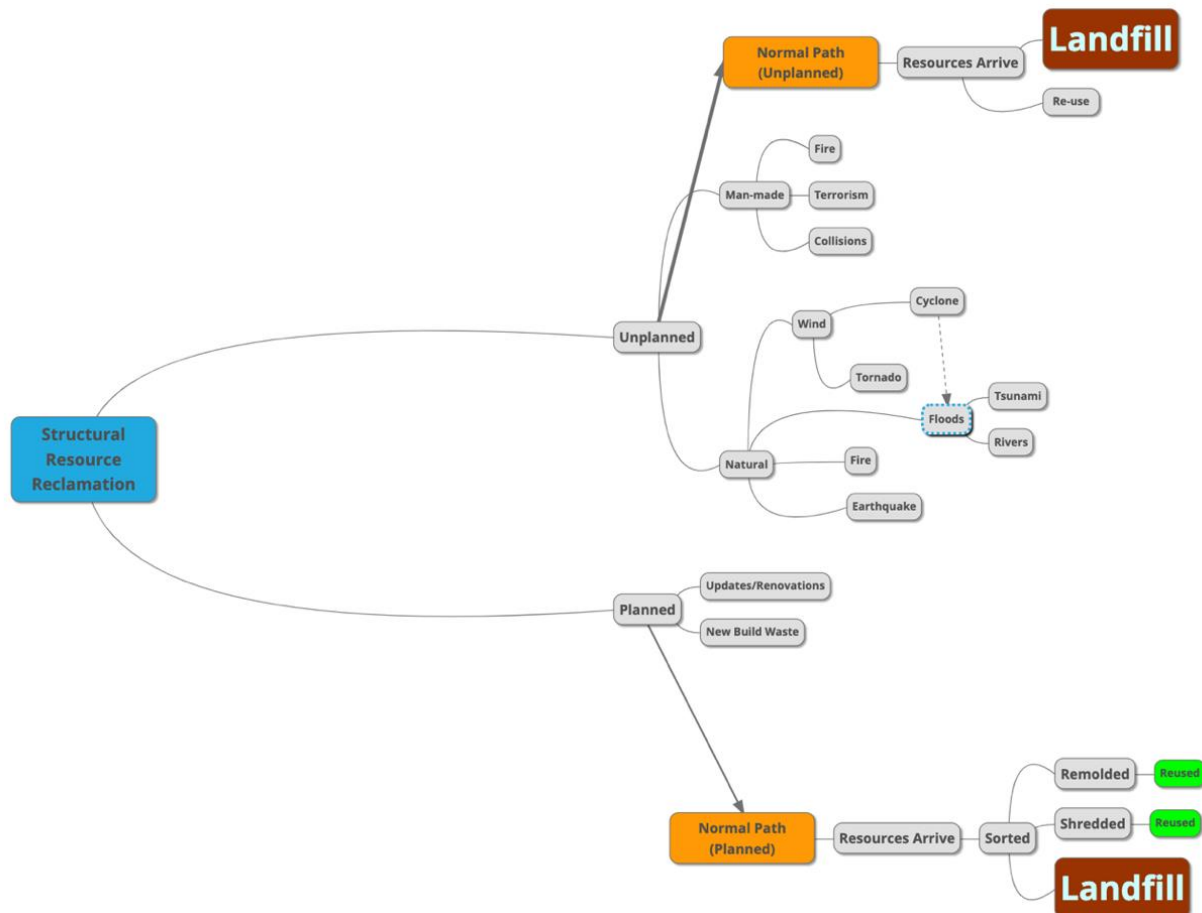


Figure 3: Mindmap of Approach

Focusing in on the unplanned resource problem, the researcher began to uncover threads of best-practices and examples of applying the management technique of disaster waste management (DWM). While it is a network of logistical challenges and funding streams that cross with a patchwork of federal, state, and local municipality-derived regulations, the researcher was able to model the interconnectedness as depicted in **Figure 4** below:

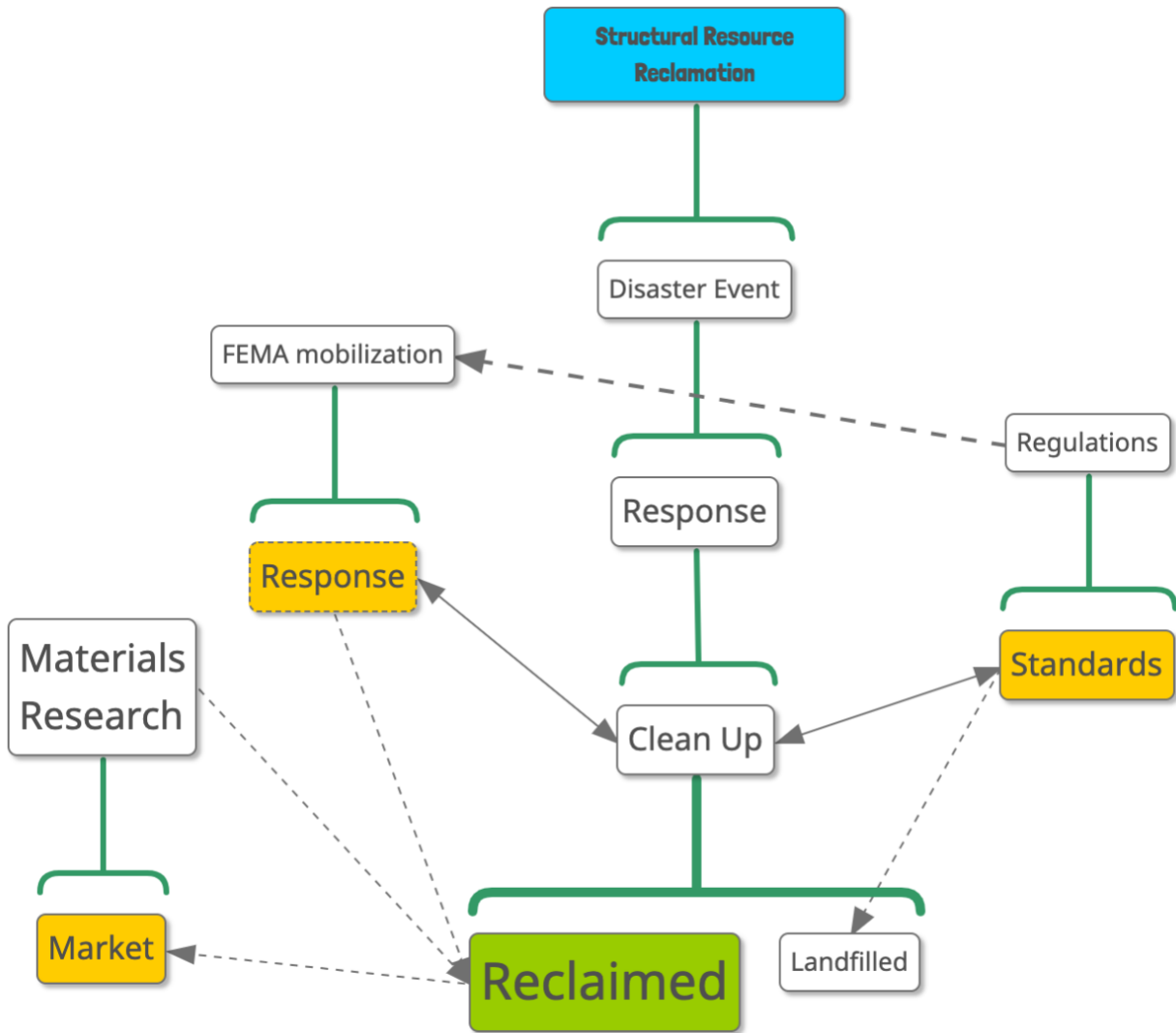


Figure 4: Organizational Networking of the Research Plan

The research plan started to materialize as the areas of emphasis from **Figure 4** highlighted where the largest drivers of adoption and action in the industry resided in the literature and in practice. Not everything pulled from the academic, governmental policy, and industrial practices related specifically to the areas of “response, market, or standards”, but those centers of gravity made the research organize in a way that is practical for the research team and the industry points of contact for further investigation.

Going through Purdue's libraries of databases to research, Google Scholar, ProQuest, and Scopus were the ones the researcher returned to repeatedly, with the best results from Scopus.

Within Scopus, the selected primary database, the search strategy started off broad and narrowed along the lines of the following search terms in **Table 2**.

Table 2: Scopus Search Terms and Rates of Useful Hits

| Boolean Search Terms | Number of Hits | Useful Hits |
|---|----------------|-------------|
| Sustainable AND Disaster | 5,205 | 8 |
| Recycling AND Disaster | 336 | 5 |
| “Disaster Debris” AND Recycling | 13 | 7 |
| Green AND Disaster | 1,320 | 0 |
| Sustainable AND Recovery AND Disaster | 506 | 2 |
| Disaster AND Landfills | 143 | 3 |
| Green AND Chip AND Sustainable | 115 | 0 |
| Disaster AND Debris | 2,624 | 0 |
| Disaster AND Debris AND “United States” | 119 | 1 |
| Debris AND Incentives | 81 | 4 |
| Debris AND Communication | 1,309 | 0 |
| Debris AND Recycling | 847 | 2 |
| Debris AND Recycling AND Incentives | 8 | 2 |
| Disaster AND Communication AND Debris | 119 | 2 |
| Totals | 12,745 | 36 |

Note. The searches were stacked and sorted by number of citations and then screened for up to the top 50.

In addition to these Boolean searches, the researcher successfully used a snowballing of reviews and articles found within each of the articles themselves. Many of the articles added to the literature review collection were attained this way to get a grasp on the status of the research thus far and what is missing in the author’s own findings. Scopus was extremely helpful in the ability to combine the search sets to serve as double, triple, and further filters to clear out unrelated topics of interest to the researcher.

The searches and snowballed articles of content had the logic construct as shown in **Figure 5** below and the Venn Diagram of **Figure 6** below with major themes overlapping on what is necessary for both the research questions proposed but helped to identify the emergence of lacks within the literature as well. One of the most successful strategies has been to put together the Boolean string terms in the search for the triangulated area on what balanced approach to the new wave of sustainability in the disaster waste management (DWM) field. Being able to weed through construction and demolition (C&D) studies that number in the hundreds, the narrowing of the multi-filter settings made building the literature review more productive.



Figure 5: Search Logic for Literature Review within Databases

Figure 5 above successfully illustrates the researcher's methods for finding the examples of how the CE and cleanup of C&D, although sometimes only tangentially related to DWM, were applied, and now thrive in their own regional or national markets.

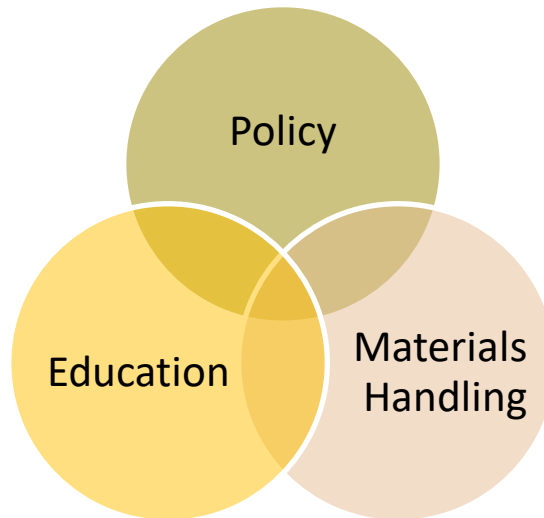


Figure 6: Categorical Breakdown of Literature Reviewed

The Venn Diagram of Figure 6 shows the commonality of how those success stories from Figure 5 presented themselves in the literature. The main themes of Policy, Education, and Material Handling drove the framework for the rest of the researcher’s study construction. In the study proposal to the NDA, they too were in agreement to the most likely candidates for looking into were these three main themes.

The researcher also used non-academia searches within the U.S. Government Accountability Office (GAO) reports and the Federal Emergency Management Agency (FEMA) planning manuals with regularity throughout the review. The GAO’s database of reports is conducive to finding the shortfalls through suggested actions to FEMA as well as any supporting agencies within the government. It was especially helpful in finding the latest actions taken or not taken by federal agencies after their findings. In the FEMA handbooks and manuals, the guidance was searchable and pointed to many other agencies’ roles in supporting functions as well as regulations pertaining to the researcher’s planned study.

Findings Relevant to the Problem & Purpose

Concept 1: Policymakers – Those controlling the rules.

In the United States and throughout the Federal Emergency Management Agency’s (FEMA) stated mission of, “Helping people before, during, and after disasters.”, they work through multiple agencies at the federal level such as the Environmental Protection Agency (EPA), the Department

of Homeland Security (DHS), and the Centers for Disease Control (CDC), to streamline policies and procedures to move on past a devastating event (“Home | FEMA.gov,” n.d.). One approach that has shown to get more ‘buy-in’ from the locals is to get their involvement throughout the process instead of handing over the entire recovery to an outside agency, normally FEMA (Hidayati, 2018). Hidayati further discusses, through a sense of owning the disaster, the those hit will learn to thrive in the renewal and new opportunities.

In the case of a disaster, an impromptu and regulatory-waived landfill is hastily constructed, and materials of all types are dumped in. This puts the EPA in a bind to hold up their duties for instance in the Emergency Planning and Community Right-to-Know Act (EPCRA) where they need to know the status of and report to the local community any dangers that may be near them, but with a quick landfill, that’s shaky at best (US EPA, 2013). The U.S. Government Accountability Office (GAO) also found instances of mismanaged or ill-tracked contracts and continued ignoring of independent committees’ recommendations (Office, 2019a, 2019b, 2019c).

Concept 2: Materials Handling – What to do with the resources reclaimed.

In the reclaim market, the construction industry and the niche clientele goals of going ‘retro’ or ‘classic’ style are easy to identify with lighting and plumbing fixtures, furniture reuse, and even the wiring itself can be sold off as scrap. In those cases, there still tends to be a downcycle of stops before the material still ends up in a landfill. The studies have already been in practice a few years and as a case study from Italy showed after an earthquake, the furnishings are not the only part of a disaster or rapid deconstruction of a building or neighborhood that can be recycled back into the material stream (Blengini, 2009). The engineering progress in Life Cycle Assessment (LCA) of materials is now taking on whole systems, including complex building structures, to be able to pre-identify their makeup and, if/when disaster strikes, the inventory is already complete for the next iteration of that building’s function.

One study took the look at the circular economy (CE) through the eyes of the construction industry and helped in developing scalar values of importance from surveys on the roles associated with perceived impact of implementing a CE model on their worksites (Núñez-Cacho et al., 2018). While not conclusive, their findings pointed to the business imperative of survival and the CE is the way this can be achieved for not only construction, but also applied to the disaster debris realm as the researcher intends.

Concept 3: Education – Knowing what to do for the process and the market.

The naysayers of Braungart and McDonough point to the Pollyanna ideals of their principles, but practitioners around the world are already onboard and the process is proving to be beneficial all around. For instance, after the triple disaster of the 2011 Tohoku Earthquake and Tsunami in Japan, that cascaded a serious disaster at a nuclear power plant at Fukushima, the government worked with scientists to create a manual to reuse and recycle all the co-mingled debris, even the radioactive materials, for safe handling and to ensure they do not take up precious land space for vast landfills (Asari et al., 2013). Getting the public involved and aware not only builds the mental resilience necessary to recover from a disaster (Hidayati, 2018), but also allows the areas vitalization to be realized through its flexibility and strength in the pre, during, and post disaster phases. In the materials market, the push to evolve the practices into the CE are growing across sectors with some companies already specializing in training and bringing the CE to an interested company or sector (Circle Economy - Practical, Scalable Implementation of the Circular Economy, n.d.).

Findings Relevant to the Significance

When policy conflicts from decision makers on implementing sustainable protocols using a quantitative approach for assessing Large Scale Disaster Waste Management (LSDWM) is measured, quickly returning to normal operations does not fully encapsulate the magnitude of the event and costs the regions more in the long run and ignores the current science and management practices (Habib et al., 2019). By getting the right people to the table, the political arm of a response can be armed with current knowledge and implement flexible responses to not only get things cleaned up, but also getting things back to a normal operating status on a local, regional, and even national level. Another study looked into the issue of properly siting an area for temporary separation sites close to the disaster area by “locating temporary disposal and storage reduction (TDSR) facilities in support of disaster debris cleanup operations.” (Fetter & Rakes, 2012, p. 1). Getting these dangling chads, that are now inefficient and scattered, can be taken care of can streamline and improve the flows of debris from an affected area to a follow-on processing site and be taken back up into the industrial, agricultural, and construction industries.

So why would businesses even entertain the idea of adopting the sustainable measures into their own business models? Money made and resources saved. Asari et al., (2013), created

guidelines as part of a manual-building project for separation and treatment of disaster waste after the 2011 Tohoku Earthquake and follow-on cascading disaster resulting in a majority of all debris being successfully processed for reuse/recycling. Resources are not going to get any cheaper to pull out of the ground. Secondly, it makes more money on the retail of a structure when the building has ‘reused’ materials in it as noted in Ibrahim’s (2016) study on a LEED-accredited building. In his study, he looked into the reduction in costs input and the recovery value of those materials by front-loading cost savings by using recycled materials from other demolition sites and showed how much easier it is to get not only LEED accreditation, but also significant savings in recover for the future end of the building’s lifecycle. Make money by saving money in virgin materials and the Corporate Social Responsibility (CSR) market forces will come through.

Findings Relevant to the Methodology of Cited Studies & Proposed Methodology

The methodologies used in previous work helped the researcher incorporate similar approaches to the sustainable DWM problem. In one doctoral dissertation, the entire enterprise of DWM was considered with a systems approach by case studies of five prominent disasters and widely varying degrees of debris recycling (Brown, 2012). Her work was comprehensive regarding those five instances and applicable to the follow-on work she has done since and in generating ideas for other researchers to investigate for implantation of a better DWM model. Her later work collaborated with another author to reinvestigate her earlier case studies and focus on just the recycling piece (Brown & Milke, 2016). Together, they were able to conduct a multi-hazard, multi-context, embedded, multi-case analysis of qualitative data on the study’s topic and analyze the findings for surfacing trends. One way to approach the many aspects of DWM is what Ekanem (2011) detailed in his master’s thesis on the viability of recycling construction and demolition (C&D) on a regional scale. His meso-focus on the recycling market availability provided a novel analysis of what was perceived versus what was actually being seen in the data for return on investment (ROI).

A few authors dove into the realm of attitudes toward the subject of changing the protocols in waste management, particularly and analogously in C&D debris disposal. The construction industry was canvassed for the likely uptake and understanding of the potential in investing into the circular economy (CE) by ways of measuring the revenues generated and the costs lowered in the construction (Núñez-Cacho et al., 2018). Other authors attempted to test the waters of the

palatability of the circular economy on how things are done in their realms. In a short piece, one set of authors tried to appeal to the virtuous nature of truly embracing the CE and coming to terms with the fact that its adoption will lead to less than the current concept of materialism available for use (Schröder et al., 2019). Another finding was able to successfully canvas attitudes toward landfill placement or apprehension using the Not In My Backyard (NIMBY) approach to where a new one should go (Simsek et al., 2014). In each of these attitude measuring findings, the analysis came to a reasonable conclusion of what is a tenable, even if unpleasant, solution. Their combined approaches, along with the systems approaches to find the trends in the data to then present to the end users to urge changes in the known protocols.

Review of the Literature Summary

Further research is needed to bring together these three disparate points of getting the policy right, making sure the capacity and means are there, and getting buy-in at every level to see that it is better than good for the environment, it just makes good, economic sense. Through collecting data on motivations and attitudes towards adopting more aggressive targets and continued review of the literature, the researcher found out what business-minded and government-regulatory levers may need pressure applied to get more sustainable results. The researcher also investigated through the literature and regulations as to why speed is valued so high above all other factors in cleanup that tends to leave those affected, those that must stay and rebuild, a multi-layer stressor that they now feel powerless to overcome. By getting the right mix of regulation for protection and buy-in (Adame & Miller, 2015), disasters will no longer be erasures, but instead new starting points. As the study pushed ahead, the never-ending literature review was paused and incorporated into the study's report. The researcher continually reached out directly to and engaged with points of contact relayed by the committee to polish the searches to better understand the study and create new leads for further research in related studies.

CHAPTER 3. METHODOLOGY

Introduction

Hurricane debris overwhelms municipal waste management systems in place and, due in parts to the sheer volume of it created and the expediency by which it is expected to be cleared and supposed to be disposed of, the disaster waste management (DWM) community of contractors and regulators put sustainability last in priority of importance. The problem addressed by this study was a lack of understanding in the research on the sustainable business model adoption attitudes in the DWM arena by the clean-up contractors themselves and the government regulators that let the contracts for them. The purpose of this interdisciplinary research was to develop best practices for government regulators and businesses to adopt sustainable resource reclamation practices after a hurricane as a successful business model with growing applications in other disasters and non-emergent scenarios. Throughout the study, the research remained committed to the following two questions: What incentives or disincentives would drive clean-up contractors to adopt sustainable resource reclamation protocols? And secondly, if speed is the only driver for clean-up, what temporary support and resources would be necessary to facilitate resource reclamation? By analyzing the clean-up contractor and federal regulatory interaction, the researcher provided data supported updated policy recommendations to the contracting procedures and guidelines.

Research Approach

In this mixed-methods business model and policy development research, the researcher used a twofold approach. First, a grounded theory approach using current guidelines and semi-structured interviews with practitioners to address the current and proposed sets of policy modifications for a greater adoption of resource reclamation as the default objective in DWM. The second approach that will apply moreover to the business model of the research involved a survey research strategy to both uncover trends in best practices with regards to the disaster materials reclaimed and to gain insight into the motivations of the post-disaster clean-up contractors. As noted by Ibrahim (2016) and Eichholtz, Kok, and Quigley (2010), some of these contractors may not be aware of the business potential that lies within these reclaimed materials.

For the interviews, their insights assisted in developing a proposed business strategy framework and focus the researcher to the current practice of enforcing and executing the guidelines. On the collected data from the clean-up contractors, a series of surveys measured the status of the current state of contracting with regulators and test proposed efficiencies, attitudes in adoption the new practice, and business opportunities for their work.

Population & Sample

For the data collection, the researcher used a combined convenience and purposive sampling method to interview Gulf Coast area, county emergency managers to stay within the FEMA Region IV scope. For successful businesses and groups that were advocating for or implementing sustainable practices, only two groups were available for non-directive interviews. For the contractor survey canvassing, the researcher utilized a stratified random sampling with data collected in the form of digital (Qualtrics) surveys that were sent out to businesses most likely to be pre-contracted and used by county managers to clean up after a disaster via the National Demolition Association (*Qualtrics XM - Experience Management Software*, 2020).

Description of the Population

Based on the researcher's personal experiences of the region, the county emergency managers were chosen by both their familiarity to the researcher and based on their known or perceived experience in DWM. The bounds of the 3-state region were from the coastal counties of the Florida Panhandle (Gulf, Bay, Walton, Okaloosa, Santa Rosa, and Escambia), across Alabama's coastal counties of Mobile and Baldwin, and the coastal Mississippi counties of Jackson, Harrison, and Hancock. For the successful business or group canvassing, the researcher used a snowball sampling of network connections throughout the state of Indiana for in-person (later restricted to digital or video interviews for COVID-19 research protocols). Regarding the businesses for survey participation, the researcher used a stratified random sampling of businesses most likely called upon for disaster cleanup.

Sample Size

For the county emergency managers, only four were available to take the semi-structured phone interviews (See Appendix C) with the researcher. Concerning the successful collection of businesses or groups already engaged in fully embracing sustainable models, the researcher was able to find participation from two within the state of Indiana to conduct non-directive interviews; a proximal choice to meet for in-person interviews for the researcher that was overridden by COVID-19 protection protocols. Through the access of the NDA, the two rounds of surveys were able to successfully get 89 respondents with $n = 52$ in the first round and $n = 37$ in the second iteration.

Variables

The researcher investigated the motivations of both businesses and regulators to bypass sustainable resource reclamation practices after a hurricane or any other disaster and attempted to analyze each independent variable for the study. The attitudes for monetary incentives were analyzed as well as the interactions with the regulatory framework for cleanup contracts. Other variables, including the moderating variable of a viable market for reclaimed resources were briefly considered as well as the mediating variable of hurricane frequency were examined. The influence of each moderating and mediating variable upon the relationship of the independent and dependent variables is explained in Sekaran and Bougie's (2016) Figure 5.7 and on page 80 of the same book and summarized with the following flowchart:

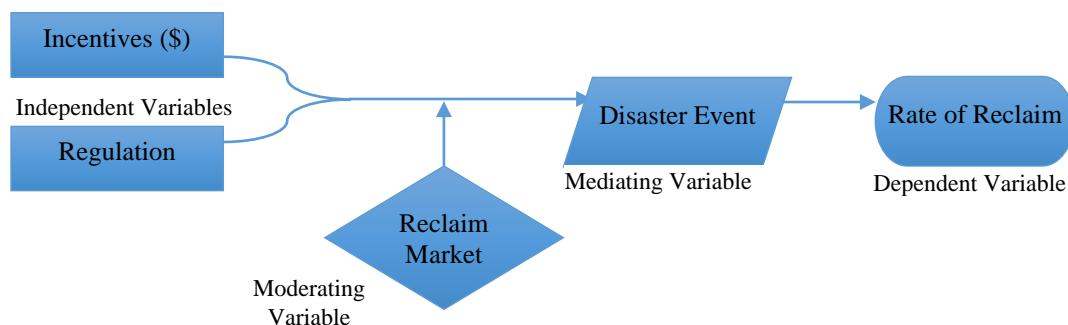


Figure 7: Flowchart of independent variables evaluated in each round of surveys

Interview Design & Administration

The interview was designed to be semi-structured for discussion starting points along the same topics for each emergency manager. While the researcher originally intended on interviewing FEMA Region IV operational planners and data analysts, the practice of handling emergency management at the lowest levels afforded FEMA to rid themselves of the day-to-day implementations of these policies and focus on the national and regional coordination roles. Therefore, the researcher shifted the focus of the interviews to two groups of people. The first group interviewed was the county emergency managers, situated along FEMA Region IV's area of responsibility and along a hurricane-prone swath of Gulf Coast counties. The second group involved organizations that are successfully using a sustainable business model in their waste management practices that have the potential for scalability.

Interview Design

In both groups, the researcher worked to uncover the factors that drove the management to the actions they take in their daily functions. In the case of the emergency managers, the goal was to reveal what were seen as hurdles to sustainable practice adoption in contract letting for cleanup. Many of the researcher's questions (See Appendix C) focused on awareness of CE practices and what insights could be gained from their management opinions and best practices. For the successful organizational interviews, these were non-directive in nature and aimed to uncover the best practices and any challenges they initially faced when implementing these goals and further how they are championing the growth of the movement by expanding their spheres of influence.

Interview Administration

For the county emergency managers, requests for and coordination for over-the-phone interviews was done over email. The calls to each of the four available covered the eleven questions (See Appendix C) plus any ancillary chatting on the topic with the aim of keeping the calls to 30 minutes or less. In each case, consent was obtained, and their anonymity assured for the research report in accordance with the IRB protocol (See Appendix E).

For the organizational interviews, the goal was to meet with these local groups and meet in-person to not only discuss the research topic but also see the implementation of their operations

for sustainability. Following the COVID-19 research protection protocol, the researcher had to pivot to purely distant or remote interactions with any subjects. With the limits of the availability, two organizations were available and conducted a phone interview and a videoconferencing interview respectively. Consent to interview and permission to use their organization's names were obtained verbally.

Survey Design & Administration

Using the university-accessible survey software Qualtrics, the researcher was able to combine the interview answers and topics from the literature into questionnaires (See Appendix A) that were sent out in two waves (*Qualtrics XM - Experience Management Software*, 2020). In the first wave, a baseline of questions were used to include topics on the research as well as required demographic metrics. In the second wave, the baseline questions were asked plus a deviation of subjective answer options with free text sections for measuring attitudes and opinions.

Survey Design

In coordination with the university's Statistical Consulting Service (SCS), the questions were reviewed for measurability and analysis capability. The intent of each survey was to make it as convenient to respondents as possible by limiting the time estimated to complete it to 3-5 minutes for the first wave and up to 10 minutes for the deviation set of the second wave. Due to the expected longer time on the second set of surveys, a \$20 digital gift card was offered as an incentive to complete it.

Survey Administration

After coordinating with the NDA, via their Industrial Committee and as part of an ongoing relationship of the organization with the university's research, access to the members was gained. An introductory email was sent out from within their membership communications to access the surveys via an anonymous link. Both survey waves had consent go-ahead statements and assurances of anonymity (See Appendix A). For the first wave, 52 respondents completed the survey over the three-week availability window. In the second wave for the longer survey, 37 respondents answered back over a four-week availability window.

Reliability & Validity

Reliability of the testing instrument for the survey was screened through both the university's Statistical Consulting Service (SCS) and test runs of the survey as a whole and piecemeal were tried out successfully on members of the NDA Industrial Committee and with other graduate students alongside the researcher and found it to be useful on gaining insights and free of survey logic errors. Qualtrics surveys are readily accessible, and it allows graphical analysis of the data collected and have a reputation of being a go-to for research in academia and marketing analysts (*Qualtrics XM - Experience Management Software*, 2020). Interviews, by the nature of the respondents' subjectivity being measured, are only as reliable as they are consistent in asking the same questions as the researcher did in the semi-structured ones to the county emergency managers.

By interpreting the Qualtrics survey data based on the interview-derived questions, the measurement of the attitudes of the cleanup contractors, typically a demolition industry contractor, was found to be a valid process for measuring these aspects of the industry. The overall validity of the study, both survey and interview questions, was further confirmed with reviews conducted by the researcher's committee and by the NDA Industrial Committee.

Summary

Since the main goal was to get industry opinions, gain insight to the perceived state of enforcement challenges, and then develop recommendations for policy and contracting changes, the grounded-theory method for building upon the previous step's outcomes fits the function perfectly. The literature brought out trends and developed the interview questions. These questions to the interviewees grew into relevant survey questions to the demolition industry practitioners. Combined, the answers at each stage created a picture of where emphasis in moving forward needs to be applied for policy, education, and materials management reform recommendations.

CHAPTER 4. RESULTS

The following sections include the outputs from interview questions collected from four Gulf Coast region, county emergency managers, a brief note on the two interviews with the successful organizations that will be followed up in Chapter 5, and a breakdown of the survey data of the 89 respondents.

Data Analysis

As part of this grounded theory study construction, the build-up of each step carried forward into the next as the new findings presented themselves. For the interviews with the county emergency managers, the common themes in the answers and the interpretations of their attitudes were compared and used for the foundation of the questions posed in the rounds of survey administration. In the case of the two interviews with winning organizations at the corporate and state levels, the inspirational models of how to apply the principles of a sustainable management practice often lends itself to mimicry in the easiest sense, and overall business paradigm shifting in the more intricate and deliberate ways of doing business. With the multi-staged surveys, the respondents were given baseline questions and opportunities to comment or describe their opinions on the overall climate of the industry and the willingness it (from their own perspectives) has to move to the CE.

Emergency Manager Interview Analysis

The interview process for the county emergency managers landed on four willing and able respondents to answer questions (See Appendix C) from researcher using the semi-structured model. Each of the four participants were briefed on the policy to maintain their anonymity and consent was obtained as the first question. The following is a breakdown of each respondent, labeled Emergency Manager (EM) 1 through 4:

EM1: After having served as EM of this county for over two years, the pathway to EM was in disconnected county jobs and then into the emergency sector of county operations. EM1 does recycle at home via an opt-in pathway but is unable to at work on a regular basis. EM1 had not

ever heard of the CE and knows the recommendation for dumping waivers comes via their own office and the Public Works departments. EM1's department closely coordinates with a grants section of the county offices for recovery funding and works with the engineering department for debris removal and landfill specifications or any necessary deviations. EM1 also takes part in an annual debris management exercise and have started bringing in the county's GIS team to take part in the planning and exercises. Outside of safety and speed, transportation routes being restored and life services back to normal are the priorities after a disaster. When asked about an ideal or hypothetical debris management program that is more sustainable, no answer could be given; it was the first time EM1 had ever thought about it. Time – 21 minutes 40 seconds.

EM2: Upon exiting military service, EM2 started working for the county's EM department for around three years after a brief internship. EM2 does recycle at home via a compulsory program within the city and is available for service throughout the county too, although it is less available at work. EM2 had not ever heard of the CE and is aware of waivers but is limited in the number of landfills available, so tends to cross county lines if capacity is approached. EM2 believes the response organization is mainly tied to the scale of the disaster and the impact on the beach regarding tourist economic impacts. EM2 had not heard of any programs for situational awareness or resource routing support. After safety and speed, opening of the roads and other transit routes, as well as tourist-support infrastructure are the priorities. EM2 would support a more sustainable debris management program but has serious doubts the costs will ever allow it. Time – 25 minutes 37 seconds.

EM3: After years in the private engineering sector, EM3 had been serving as the EM for approximately a year. EM3 recycles at home and at work through compulsory curbside and office service. EM3 had not ever heard of the CE and is sure the way to a waiver is dependent upon the type of debris being sorted and if there is a potential for further sorting after collection. EM3 believes their county has good cross-coordination and is very familiar with the county's GIS department to get debris estimates and other functions that help via human relations and financing departments in the vetting and letting of contracts. After safety and speed, right-of-way routes and then other major transportation arterials and collaterals back online are the major priorities. EM3 had proposed plans for a sustainable debris management program involving

county-located metal sorting facilities, a wood pellet plant, and a network of chippers and grinders to get the vegetative debris handled. Time – 46 minutes.

EM4: Having served for over eight years at the EM, EM4 had worked in the health sector before coming over to the emergency management section of the county. EM4 recycles at home via an opt-in curbside service but does not have access to recycling service at work within their own department; other departments do have it. EM4 had not ever heard of the CE and readily grants waivers on all except white goods in the debris stream. EM4's county coordinates well with the operations and GIS departments and actively works on software improvements and trials. After safety and speed, rights-of-way, disaster functions, and critical facilities are the restoral priorities. When asked about an ideal or hypothetical debris management program that is more sustainable, no answer could be given; it was the first time EM4 had ever thought about it. Time – 20 minutes.

Successful Organization Interview Analysis

Following the interviews with the emergency manager practitioners, the researcher was able to get two successful organizations to provide perspective and business model insight into their own sustainable operations as a ready-reference point to other industries. Both organizations were eager to participate in the study and consented to their organization's identification and access to any follow-up work that may help the study in the CE.

Subaru of Indiana Automotive, Inc. (SIA): As a regional and industry exemplar to having the role of sustainability being a central tenet of their operation, SIA has the noteworthy accomplishment of being a zero-landfill facility since 2004. This is not just in their car manufacturing line, but down to their insistence on the maximum-allowable recycled content in their materials, on-site composting from employee cafeteria food waste and the surrounding campus vegetative materials, and a rigorous reuse plan in all their shipping practices, such as continually cycling back and forth the shipping polystyrene with parts suppliers. They take deliberate steps to identify and continually innovate their processes with groups such as their Byproducts Management Group, specifically assigned to find recycling or reuse avenues for all the shipping crates, packaging, and typically hard-to-recycle products, like their tons paint sludge

that is sent to a processor that treats and reuses it as a base for another product. Their business model for sustainability also includes an in-depth vetting and later-on auditing process for the vendors to select the ones that are aligned with their zero-waste goals. As a campus of operations, they manage eight stormwater ponds, provide acres of prairie habitat for a variety of species, and continue to influence their neighbors to follow in their footsteps (Subaru Environment, n.d.).

Indiana Recycling Coalition (IRC): In the semi-structured interview session with the VP of the IRC, the coalition's reasons for existing to connect sustainable targets with actionable processes and policies throughout the state were made clear (Indiana Recycling Coalition - Home, n.d.). As a non-profit coalition, there are many networks of networks of businesses and their associated industries, but as a repository of expertise and center of advocacy, they push for legislative changes to the processes that can make the sustainable goals possible by actively pursuing the connections necessary. The VP, a member of a design firm herself, described how the experience in her company has been brought forward for C&D projects to make it part of doing business to think about the main customer's long and short-term goals on the use of a building material exchange and is introducing it to the wider coalition audience as a model to follow where commercially-viable products are warehoused and shopped from in a secondhand for business concept (Why SchottXchange?, n.d.). In addition to the successful concepts brought on through the design lens, IRC is also working to educate their coalition membership on the successful economic and environmental movements around the industry of renovations. There is a new emphasis in the CE in the recent years and they are currently working through ways to meet the standards of a the Green Building Initiative (GBI) (Green Building Initiative : Home Page, n.d.). While similar to the LEED process, the GBI one allows and accounts for existing structures and how to retrofit or renovate them to meet the new standards in both sustainability and energy efficiency.

Survey Analysis

Over the course of two collection rounds, 89 respondents from the NDA membership answered the call to voluntarily provide insight into the attitudes surrounding their industry's adoption of sustainable practices. Their responses to Likert scale ratings, rankings, and open

answer opinion and concerns were gathered and analyzed using the Qualtrics-Experience Management software (*Qualtrics XM - Experience Management Software*, 2020). For the first round, 52 respondents provided their answers over a 3-week survey availability window with only one, a potential 53rd participant, having an incomplete and summarily scrubbed off the collection entry. In the second round, 37 participants completed the same baseline questions as the first wave and then went into greater detail on some of the particulars of upcoming legislative and economic frameworks. By design, the second one was going to be longer to complete and more subjective in the opinions of the respondents (See Appendix B), therefore an incentive of a \$20 digital gift card was offered over another 3-week opportunity window. There were no anomalies or incomplete survey starts in the second round to report.

Results

The results of the study conducted in cooperation with Gulf Coast county emergency managers, successful, sustainably-minded organizations of the Midwest, and the NDA are herein this section and allow for thematic trends to be visualized and focus the interviews for articulated interpretations of the responses. The limits of the study, both in physical-distancing requirements due to COVID-19 restrictions and willingness of the respondents to answer the surveys are noted, but the level of response is still sufficient to see how the attitudes are trending and provide direction on where to focus follow-on studies.

Interview Results

In comparing the interviews of the four emergency managers and the two sustainably minded organizations, the researcher was able to identify common themes and insights that, when taken one-by-one, do not seem to influence regular operations, but when viewed through a systems-wide approach, uncover truths hidden in silos of information or operational procedure. The breakdown of the trends will follow the same organizing structure as the researcher's literature review framework highlights of policy, education, and materials handling as the major indicators found with any additional insights noted separately.

Policy: The county emergency managers relied heavily on both precedent for what has worked for them in the past to get reimbursed by FEMA and what actions get their respective counties back to pre-disaster operations the quickest. Waivers for sorting requirements and easing of environmental mitigation measures were uniform across the counties if the speed of returning to normal were going to be impacted. Coordination across other county offices was important for tabletop exercises and actual response to events, but the emphasis was always focused on opening rights-of-way and returning to normal operations as quickly as possible. Each EM noted the lack of clear guidance county or state leadership for what needs to happen to the debris once it is moved out of the affected area and off to the landfill other than to make it happen quickly.

The SIA and IRC spokespersons had the common complaint about standardization across the industries that they interact with. Some of the business operations were chalked up to best practices noted, but without a uniform expectation based on either an outside standard or industry-agreed rule, the overwhelming administrative burden and practical application makes their narrow lane ambitions become sidelined. Alone, these organizations are doing well for their advocacy and day-to-day implementation of their goals, so part of their mission now is to demand the same business rule adoptions they use.

Education: In the governmental offices for each of the county EMs, awareness of other processes and ideas were extremely limited or non-existent. This is especially true regarding the lack of awareness of what the CE is and how it relates to disaster operations or the greater application in the local economies. Partnerships with software and research institutions for efficiency improvements in processes and were unheard of with the exception minimal interactions with the growing field application of GIS to the emergency management office operations. On the other hand, SIA and the IRC were well-versed and actively demonstrating within their own organizations and with which they do business on how to squeeze the efficiencies in every process or acquisition in terms of equally weighted priorities of economic and environmental goals.

Materials Handling: County EMs have very real concerns, after the rescues and endangering situations with damaged structures are stabilized, to get their counties back to operation, especially those in the coastal region that relies so heavily upon tourist dollars to keep the local

economy moving. The next step after the area is rendered safe by crews involves the monumental task of moving the debris to a landfill. In most cases, a TDSR or diversion of resources stop is bypassed to meet the pressures of the speedy return to normal. In each of their answers, the EMs did not see how the connection of resources in debris could be recovered for local economic or manufacturing source materials. For SIA, they regularly revisit their processes and vendors to realize the newest sustainable, both economically and environmentally, practices at their manufacturing and assembly plant. For the IRC, their role as a voice of expertise and advocacy champions businesses like SIA in their growing network of enterprises across the state of Indiana.

Survey Results

The primary research goal of the study, measuring the attitudes and willingness of the practicing demolition industry leaders and members to adopt more sustainable operations, was accomplished through the NDA's access and support to find out if this area should be explored even more in their membership ranks. The following results illustrate the findings and were briefed to the NDA Industrial Committee (See Appendix D) for both awareness and to identify key pressure points they, as a national organization, can emphasize in their members, in their lobbying efforts for legislative changes, and overall paradigm shifting strategies to embrace the changing tide of following more sustainable practices across every industry. The results briefed were a shortened version of what follows in this section using the Strengths, Weaknesses, Opportunities, and Threats (SWOT) strategic analysis framework for digestible and actionable areas for the NDA to investigate further, focus training on, or adopt as a membership renewal parameter to remain at the forefront of demolition innovation in the greater economy.

Strengths

The identified strengths from the respondents' combined to find a few noteworthy trends that demand further research and emphasis for the NDA and any partnering academic or industrial firm looking to emphasize and grow the returns while expanding the business TBL and zeroing in on the TTL. As seen below in **Figure 8**, a large representative group of state responses, 31 out of a possible 51 including D.C., was gathered:

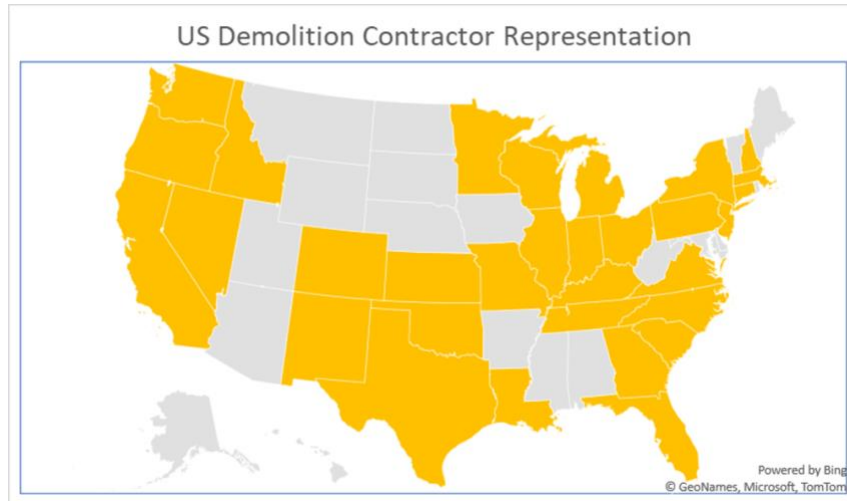


Figure 8: State Representation of Demolition Survey Respondents

From these representative respondents, over 86% of those surveyed already engage in recycling on a personal level as seen here in **Figure 9**:

Personal Life Recycling

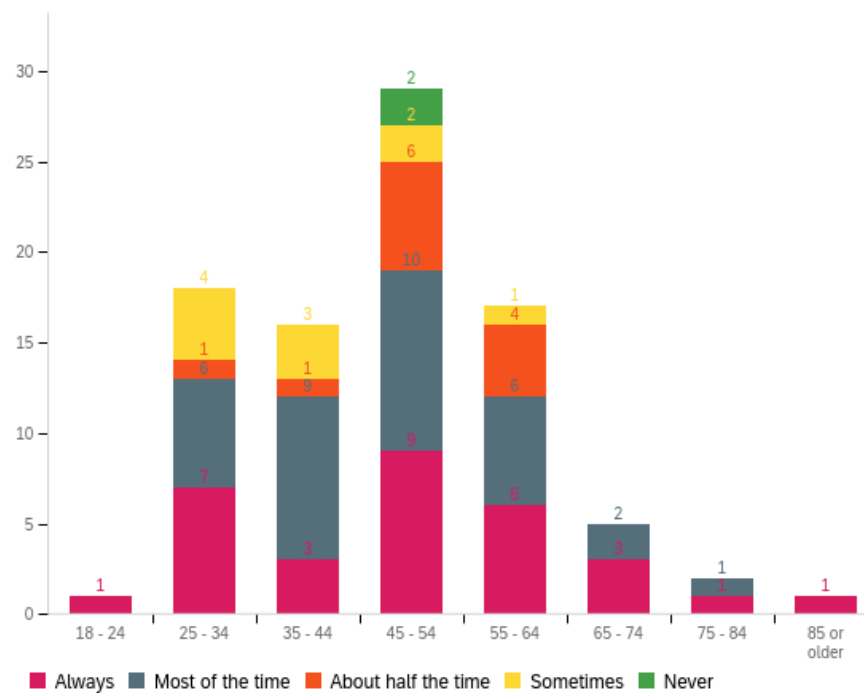


Figure 9: Numbers of Personal Recycling by Age Groups

The rates of recycling in the demographics above show positive potential for the businesses to foster growth in making the conversion of personal actions manifest in their own professional lives with the materials they demolish and collect as a part of normal operations. While emphasis is in positive territory for personal actions of members, **Figure 10** below shows where the overlap in at-home recycling translates to a demolition business's bottom line with the use of salvage revenues:

Company Salvage Revenue

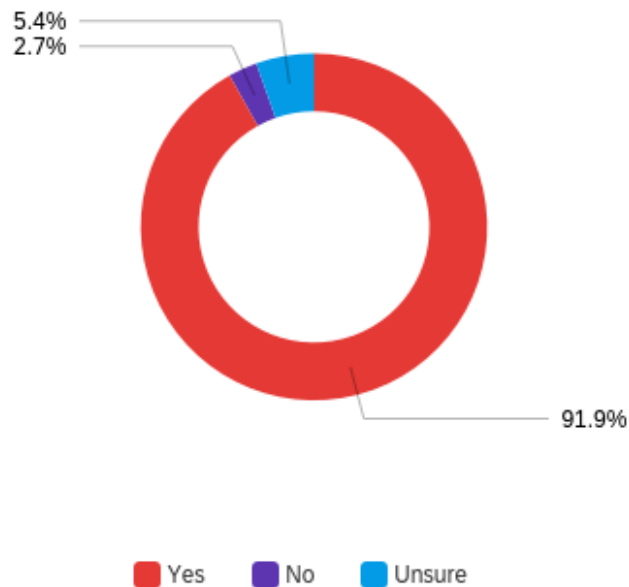


Figure 10: Respondent Confirmation of Salvage for Profits

It is known throughout most of the demolition industry that some firms, their operating budget can only be made whole with the profits attained through salvage sales revenue. For the remaining 8.1% of respondents unsure or not participating in the salvage market, the overwhelming majority of the industry has already made the strong case for including it in the income. calculus.

Weaknesses

In any industry, those closest to the problem, as seen from the outside, may not recognize the issue exists in the first place. By partnering with the researcher, the NDA and their members are able to get an objective assessment of the state of things and to point out not only items or topics to focus restorative plans, but also to clearly provide the organization with a certain degree of concern within those areas. As with most demolition businesses already onboard with salvaging revenue, **Figure 11** below continues to bridge the link of unrealized potential analyzing what is done now for “business as usual”, but instead on what partnering with a secondary market user could do for their business:

Secondary Market Partner

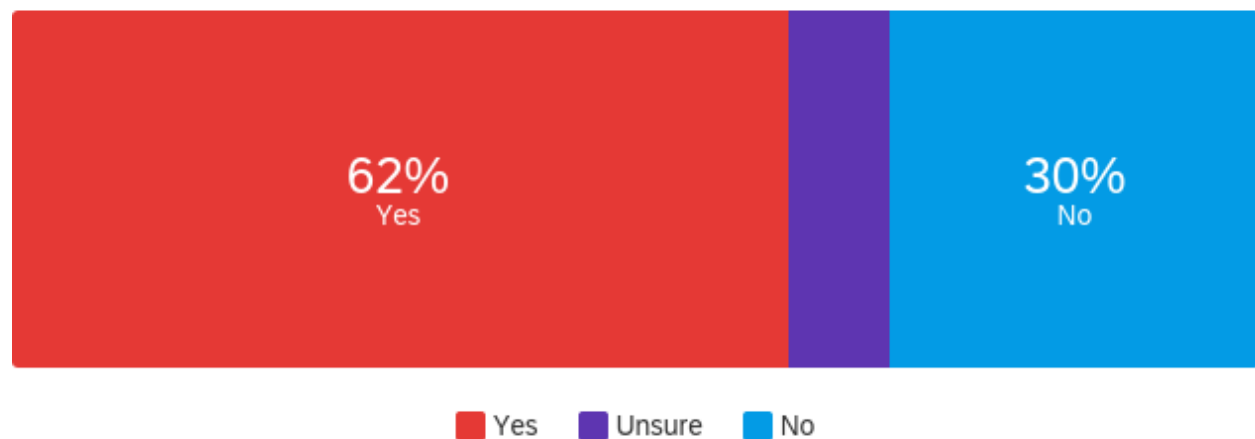


Figure 11: Measurement of Businesses Partnering with a Secondary User of Materials

While not familiar with every business, follow-on markets in secondary or even tertiary avenues require partnerships and market exchanges for a valuable resource. There is no sound business reason for nearly 40% of respondent companies to be missing out on a proven track. For example, a soil amendments retailer using reclaimed gypsum from deconstruction projects to keep the resource in a value chain cycle, even if it shifts from the technical to the biological cycle from **Figure 2**. Some of the other weaknesses identified were in the subjective attitude measurements of respondents by asking what where the most common obstacles to adopting sustainable practices and the most common answers are highlighted in the word cloud below of **Figure 12** pointing to an overall feeling of doubt in the how a new business paradigm would be applied to the demolition industry evenly and objectively:



Figure 12: Obstacles Beyond the Standard Survey Question Rank-Choice

This doubt in the viability of a new business shift is indicative of a few other related, but not causal reasons the researcher was able to find in the demographic data of the respondents. First, the gender breakdown of the 89 surveyed showed that nearly 89% of respondents were male and the most representative were those over the age of 45 as illustrated in **Figure 13** below:

Age by Gender

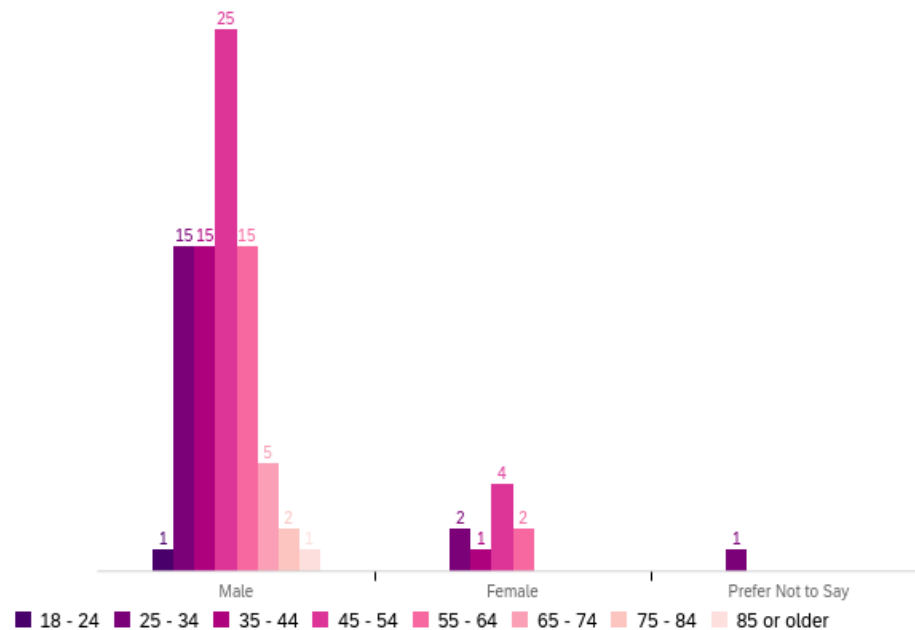


Figure 13: Age Breakdown by Gender of Respondents

As the late Supreme Court Justice and women's advocate champion is quoted:

Women belong in all places where decisions are being made.

— Ruth Bader Ginsberg

This lack of gender and age diversity for the decision makers is keeping the industry locked in a rigid and somewhat difficult course from which to change over to. The same is true when the demographic aspect of racial representation was measured in the respondent group as shown in **Figure 14** below:

Racial Breakdown

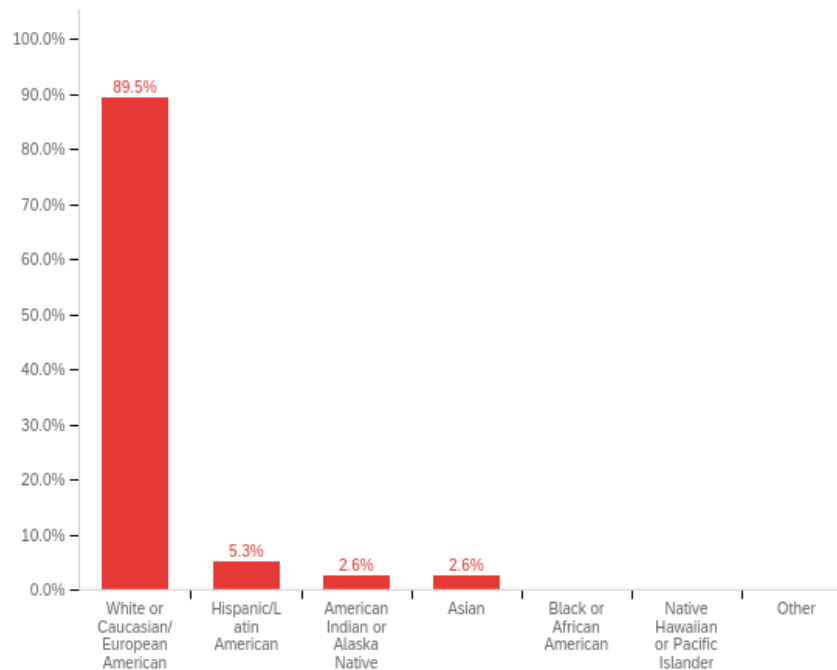


Figure 14: Respondent Demographic Breakdown by Race/Ethnicity

While those responding to the survey may have been self-selective or the minority groups were under participating, the trend from this study shows that group homogeneity can stifle innovation and resist changes to any market shifts that do not align with previous experience in the field.

Opportunities

The brightest rays of sunshine from the study came in the questions that point to the opportunities at the intersectionality of the demolition industry and the CE. In the first instance, over 54% have at least an entry level or better understanding of the concepts and ideas of the CE as shown in **Figure 15** below:

Familiarity of the Circular Economy Concept

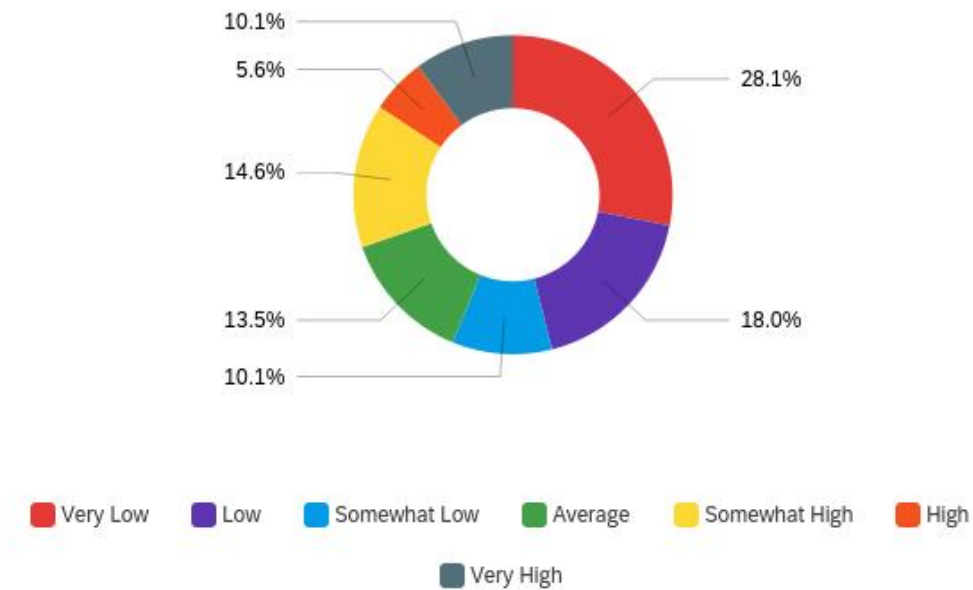


Figure 15: Awareness Levels of the Circular Economy

Although knowledge of a concept is useful, taking those steps necessary to implement it fully are more consequential. The respondents were asked on a list of drivers, derived from the interviews and literature, which two reasons would be the most likely reasoning behind their companies adopted more sustainable practices in the day-to-day and contingency contract operations. Their responses, as shown in **Figure 16** below, point to actionable areas the NDA and each regional or state-level manager can work to find solutions to implementing the CE in the demolition realm:

2 Most Likely Reasons to Adopt Sustainability

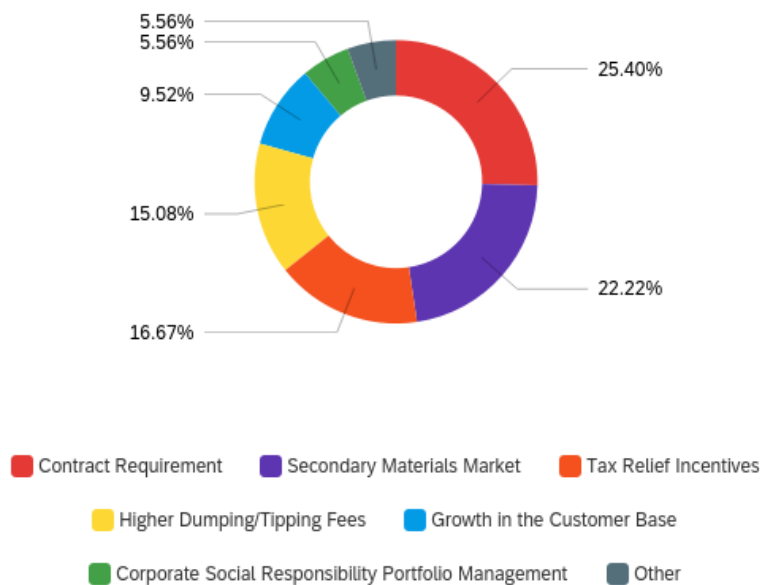


Figure 16: Leverage Areas Identified to Achieve the CE

The areas to leverage above clearly identify where effort needs to be applied and other questions in the survey point towards further attitudes that show a positive trend in willingness to get onboard with the CE’s sustainable practices. When asked about the respondents’ attitudes towards profitability, their answers are illustrated with **Figure 17** below:

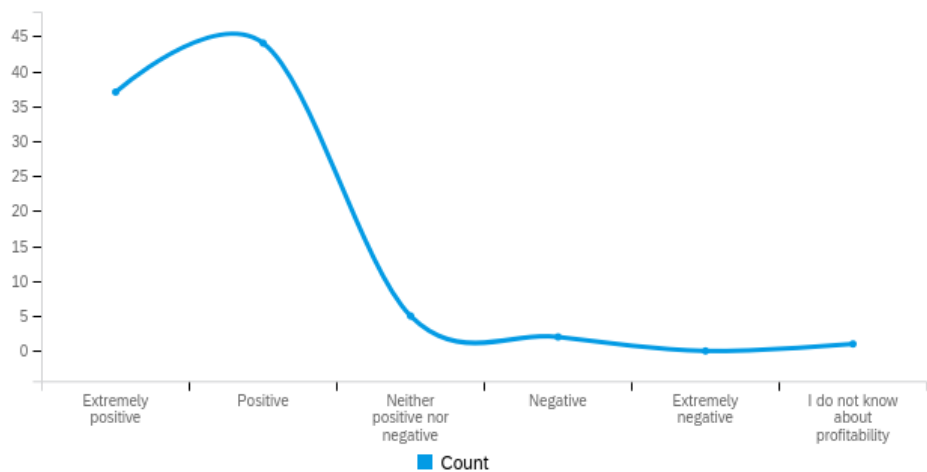


Figure 17: Thoughts on "Profitability"

And it logically follows that a successful business would tend to positively favor profits as a main goal for their operations. The next question in the same format asked about their attitudes about sustainability as shown below in **Figure 18**:

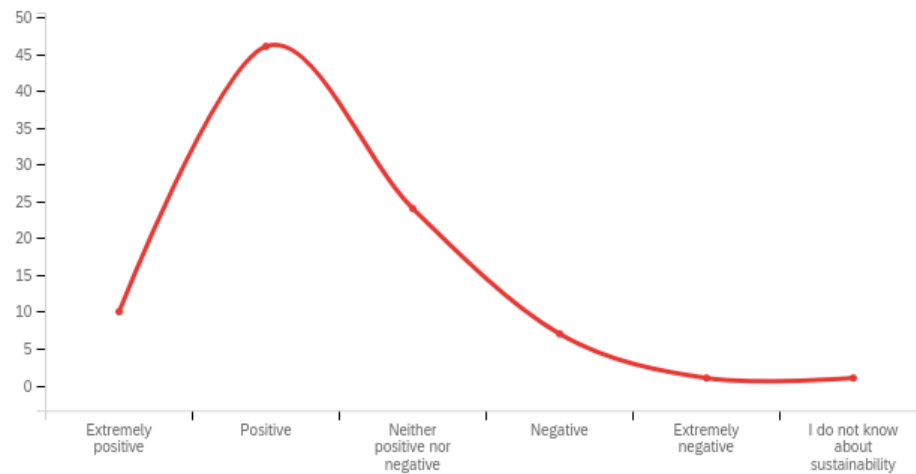


Figure 18: Thoughts on "Sustainability"

A watered-down term for some as greenwashing a subject or area has become fashionable or the new craze, but the respondents still had a majority favorable opinion of it. Another question in both opinion-based and awareness measuring is on the similarly growing concept of extended producer responsibility (EPR) with those responses shown in **Figure 19** below:

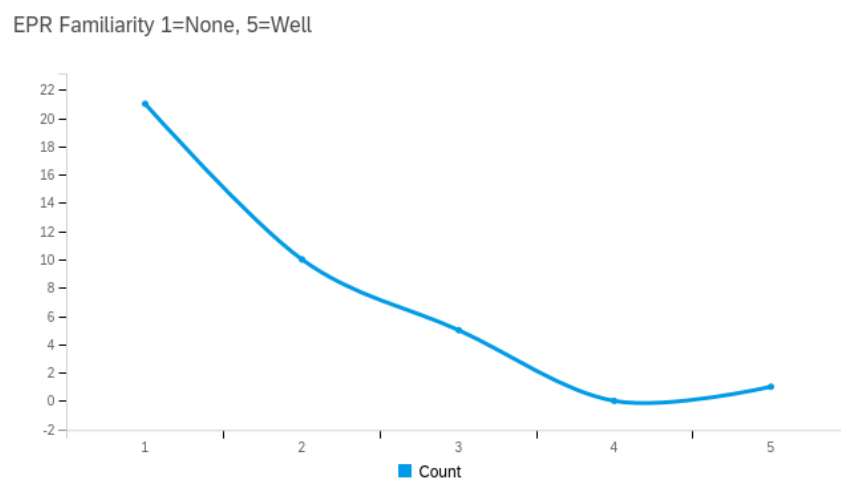


Figure 19: Familiarity with Extended Producer Responsibility

Even though demolition industry practitioners may not be producers, the opportunity to educate and then capitalize on the unique position they play in implementing EPR as a part of the CE are limited only by a business forecaster's imagination.

Threats

In an organization, the threats to success are typically given the most oxygen to “fix” by supervisors and management. As part of this study, the researcher asked respondents to rank, from one to five, the most to least obstructive barriers to adopting a more sustainable practice in their own businesses. In addition to the free-text options as seen in **Figure 12**, the ones delineated in the survey from the literature and interview data points were ranked as shown below in **Figure 20**:

Most to Least Obstructive Obstacles to Adopt Sustainable Practices

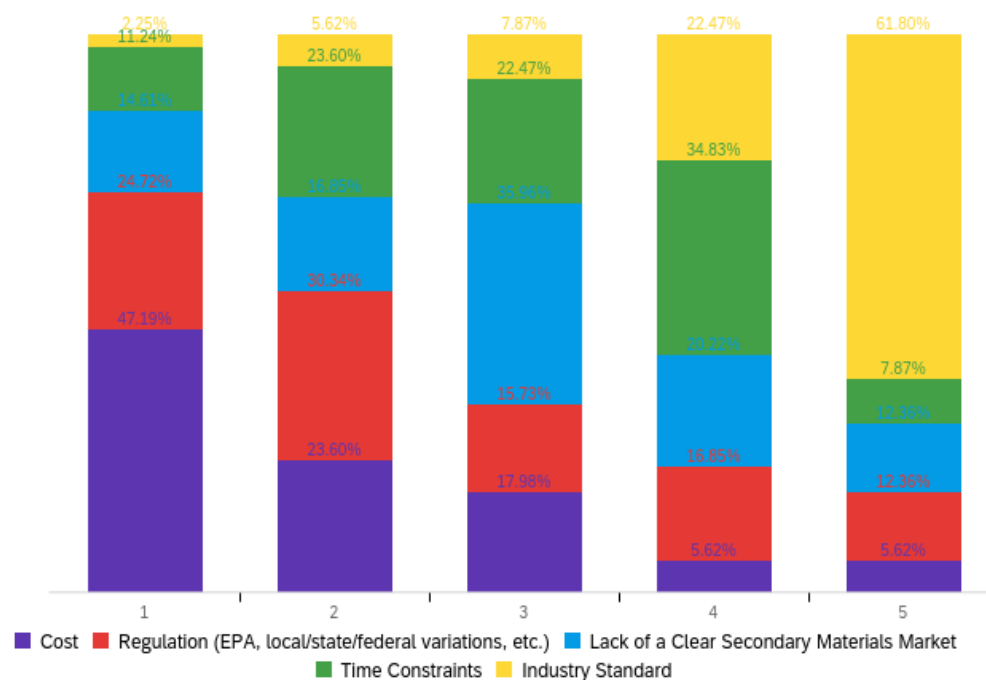


Figure 20: Ranking of the Hurdles to CE Adoption

With the defined set of hurdles as noted above, businesses alone and NDA as a collective can make their voices heard to address these issues if CE is the way ahead for the demolition

industry. And although most respondents were ready to report what they had seen in the past, but when asked about their opinions of how difficult implementing the EPA’s newest National Recycling Goal of “50 by 30” (US EPA, 2020), the trends in age and difficulty cross paths at the middle-career mark as illustrated in Figure 21 below:

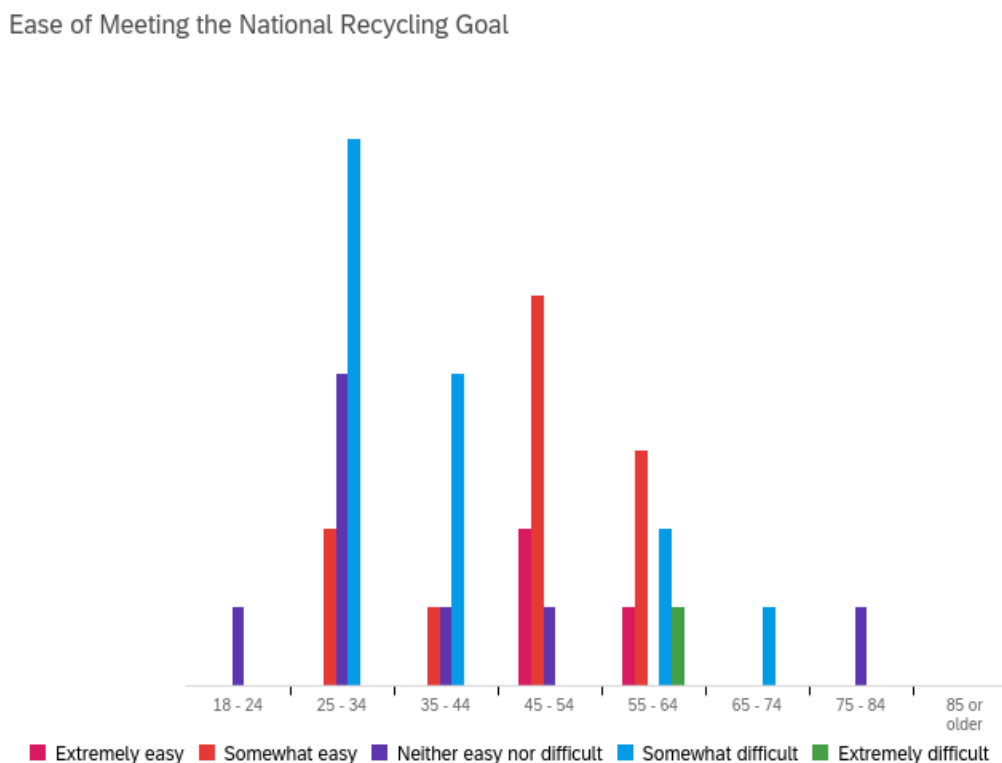


Figure 21: Ease of Meeting "50 by 30" Goal Grouped by Age

On any change to business practices, proposed or legislated, those in the industry and a part of the institutional inertia will have the probably the greatest challenges of changing stride mid-career and pivoting to the new paradigm.

Summary

In the interviews, even a transient understanding of the CE and understanding options of what to do for increasing the sustainable actions of a process, an associated organization, or an entire system of resource-cycling were eye-opening, and respondents were willing, if not eager, to see where the new CE might take their operations. The SWOT analysis given to the NDA

Industrial Committee (See Appendix D) gave those in the meeting and minutes to the rest of the NDA a look into how they can influence and apply resources to the association, for each of the member companies, to get in front of the CE wave and be on the leading edge, not just reacting to it. The survey data and interview highlights given to the Industrial Committee are not meant to be prescriptive or limiting in nature but do show where improvements across the industry can allow those within and supporting the demolition and overall C&D areas can dictate how practices are regulated from inside the association instead of a new law, a new contract requirement, or a multi-modal event force it upon them. Consultation for how to set up the CE successfully will come from the bottom up, not the top down.

CHAPTER 5. CONCLUSIONS & DISCUSSIONS

Introduction

Using the guiderails of policy, education, and materials handling, the researcher was able to apply a grounded theory construction to a mixed-method study using qualitative data from interviews to inform and build the quantitative tool of the survey for trend and confounding analyses. Even though no study is foolproof, the research questions were continually applied to every step of the data collection and measured against the literature and business practices around the demolition industry.

Discussions

Throughout the study, emergency management and business interviewees, demolition industry survey takers, and finally the NDA Industrial Committee were aware of the distance between where their typical debris management techniques are versus where the trends in consumer goods waste are headed. The nascent adoption of the fast-growing Circular Economy (CE) model or the recognizable take-back options in the form of an Extended Producer Responsibility (EPR) framework for materials and businesses created anchor points and directional indicators for those in the demolition industry and to the larger C&D arena. While any paradigm shifting to a new line of business or operational procedure can be tough, the international catalog of examples, both good and bad, uniquely position points in the materials recovery chain and reuse network to rapidly adopt the new procedures, new methodologies, and new business model workings and lead the entire C&D sector into the future. The following discussion section will be outlined around the U.S. military's five paragraph order, acronymically known as "SMEAC", for providing the Situation, Mission, Execution, Administration and Logistics, and Command and Signal aspects of a military operation.

Situation

The C&D industry uses material and equipment intensive processes to bring us, the consumers and users of their services, a durable structure to do our living and our business. When a demolition event, disaster or planned, occurs, those materials retain value, even if it may

not be in that structure anymore. By taking up valuable land area with leachate inducing debris into a landfill, the whole process is wasting away resources that were in circulation. New techniques in adopting the Circular Economy are growing in the US for the manufacturing sectors that need a steady supply of input materials, raw/virgin or otherwise, to shorten their supply chains, gain the market advantage, and further enhance their sustainable portfolios. This opportunity to capitalize on the supply need and a resource, formally known as waste, oversupply are ripe with potential for transforming how materials flow within a local, regional, and even national economy. With recent developments in the global economy like the National Sword policy in China and the newly adopted Basel Convention, the materials-focused recovery and circularized economy is set to pivot internally for national resilience within our own borders (*Basel Convention Home Page*, n.d.; *What Is the National Sword?* - *Center for EcoTechnology*, n.d.).

In the survey results shown in Figures 11 through 21, each illustration points to shifts already underway or willing to shift from the demolition contractors. Knowledge gaps on the part of these businesses are a function of cost reduction as the only imperative and a lack of exposure to the concepts brought out in the survey and interview questioning. By addressing these issues on how to make a profit by a wholesale revaluation of the resources and educating the industry on the trends and practices to better address regional material shortfalls, the demolition industry is uniquely positioned in the value chain for creating a huge impact on day-to-day operations. Moreover, a collective demolition industry standard adoption will shape the way legislative changes are made and championed for approval and enforcement.

Mission

As soon as possible, the demolition industry will aggressively seek out and adopt ways to keep building materials in use at a capacity anticipated for a large-scale disaster whereby the volume of debris resources coming in will exceed normal operational parameters. Within each FEMA region, EPA and equivalent economic zones, akin to Opportunity Zones (*Opportunity Zones - Home / Opportunityzones.Hud.Gov*, n.d.), are able to serve as focal points for economic activity and materials hubs. The rapid adoption of circular principles to the C&D arena will allow for greater flexibility in material operations, shorter logistics lines, and an overall resilient flow of resources insulated from international shortages or disruptions to access.

Execution

Shifting momentum on any operation, especially ones that have been done a certain way for decades with minimal improvements to the procedures. There are no prescriptive absolutes in adopting a whole new paradigm in debris management, but the following steps, when implemented, will not only change the way disaster waste management is regulated, but it will also completely rethink and reset how demolition debris is treated in everyday operations.

1. Educate your business. C&D recycling is starting to take hold in the US and is only going to grow. Online and in-person learning is addressing the base knowledge shortfall in the CE and the associated material logistics relationships.
2. Ask around for what works. There is no monopoly on good ideas, so do not hesitate to find a successful program or set of processes that will make the CE fit a particular application.
3. Partner with others in the industry. A single enterprise or small group of interested and willing businesses is not going to change an entire industry if some members are going to continue with operations as usual. Work through the network, such as through the NDA, to demand more guidance and advice on moving forward with adopting a CE mindset in resource recovery.
4. Talk to regulators. Instead of the call for contracts for pre-letting, actively engage with and demonstrate to county managers, public works engineers, and landfill management to show what new avenues for the resources recovered can do for the area. Some of them have only dealt with or heard of the impact that recycling can have, but many have not seen or heard of what the CE is or what it can do for a local economy and resource availability.
5. Network with action groups. Action on an industry and regional or national scale takes coalitions and groups striving toward the same goals. Groups like Circular Cities, C40, and Race to Zero all have programs for education and advocacy needed to help change policy or grow the workforce with skillsets pertinent to the CE.
6. Always keep learning. Practices, procedures, and innovations along the way create efficiencies and opportunities to gain market advantage while also doing good in the CSR management functions. Just like networking with action groups, partnering with research institutions and universities to help field test and pilot new techniques will advance the industry to become leaders in C&D and the overall economy as a model to follow.

Administration and Logistics

As part of the application process, a two-way approach to getting the CE into normal and emergency debris operations, a network of partnerships will be required. Demolition businesses, following a common standard, will need to self-police and push the industry to innovate collection, separation, and redistribution processes. Manufacturers will coordinate with resource harvesting companies like those in the demolition industry, to source their materials to include in the next production line. Local economic zone managers and legislators will be required to set up materials market exchanges and enforcement schemes, as designed by the industries involved themselves, to circulate materials within a region and trade with adjacent regions when an oversupply (disasters) or shortage (high demand) requires more movements.

Command and Signal

Even though private businesses are typically not going to have a vertical structure of command in the same sense as the military, an agreed-upon standard set of procedures and expectations for members within the network can be ratified into industry standards. With a bottom-up model, the businesses doing the demolition and debris removal operations are able to dictate their standards up the chain of expectations. Additionally, standards can be influenced by requiring organizations like the Institute for Scrap Recycling Industries (ISRI), as an advocate, to objectively determine and require standards for the entirety of the demolition industry (*Institute of Scrap Recycling Industries - ISRI*, n.d.). With ISRI's support, their position as a third-party representative will influence the way contracts are let and the parameters they include. Once the US codifies the National Recycling Goal of "50 by 30", ISRI and NDA with all the members' support, will be able to lead from a position of knowledge and ambition. While sustainability is a real goal for the CE adoption and an admirable goal in and of itself, the cogent implications of business profits and future earnings is cause enough to put the effort into getting it fully implemented throughout the industry.

Conclusions

The C&D industry is a practical and, as much as possible, cost conscious mover in every aspect of city, regional, and national responses to a declared disaster. The demolition sector

renders damaged structures to recoverable resource rubble piles that all-too-often end up in a low-cost landfill option scenario. With the rise of the Circular Economy making its way across from European and Asian markets, the US has a vested interest in taking the lessons of those earlier adopters and improving them in the ways only American innovation drives can do. The hardest part of making the switch is the institutional inertia throughout the demolition businesses and disaster operations operators to adopt the new techniques that are at worst foreign to them and, as the case for most early-adoption techniques, more expensive in the near-term.

The secondary and tertiary implications of the CE being used as a resource network extractor in structures are only starting to be noted in the manufacturing sector, so making the case for the larger volumes and harder-to-get new/virgin materials to shift over is where the industry needs to go if operations into the company's future are expected. Policy changes based on the latest research and best practices around the world make for leading instead of trying to catch up. Continuous innovations in manufacturing and remanufacturing research and technology are already coming online across the waste management industry, so adopting them into the C&D ecosystem is a perfect application of the principles of the CE. Education in the processes and business model innovations will be the key enabler across the spectrum of operations for both government regulators, like the emergency managers, and the demolition business planner and operator.

Suggestions for Future Research

While this research covered many aspects of the intersections between the nascent circular economy and the demolition industry, the limitations of scope and time caused the researcher to narrow the field to only a portion of the broader implications of the applicability of the research and the results. To further the study and the field of creating a more sustainable and circular economy within the whole of the construction and demolition industry, the researcher recommends the following pathways:

1. Follow-up with the NDA surveys to explore or uncover hidden motivations for contractors to adopt the practice into the field. This would specifically be part of a case-study if, within the NDA's larger membership, a handful of small and medium-sized enterprises (SME) ventured a pilot of fully embracing the circular concept in their debris cleanup procedures.

2. Analyze the secondary use markets for both supply concerns and demand trends among new and renovation construction projects. This may be hyperlocal (same location), city, state, or within regions as broken up by the FEMA Regions but as a combined delineation with the EPA and other offices for coordination.
3. Carry out lateral analyses of disassociated fields and how their intersections with the construction and demolition industry could benefit from adopting the circular economy in local and regional market models. This is especially prudent once the feedstocks from one process in the economy become integral to multiple operations across the landscape of any manufacturing practice.

Summary

There is no monopoly on a best-practice on disaster debris management, only innovations of practices born out of lessons learned across the gambit of scenarios, materials handling and processing breakthroughs, and a continued hunger to get better and find out more. This is especially true in the demolition industry that is ripe to evolve and improve with the society's changing demands for the new mindsets as demonstrated in the Circular Economy principles. The US population's tolerance has and will continue to wane for allowing outmoded practices of debris management when better ones exist for healthier soils, clean water sources, and the overall environmental neutrality or positivity. Even if it were not a case of environmental degradation, the costs associated with throwing resources into a landfill with tipping fees, land purchasing costs, site monitoring and maintenance, and the potential costs associated with clean-up fines are all items to take into the calculus of continuing with business as usual. In the case of disaster waste management, the bulk and speed pressures do not have to dictate a sound approach to turning a disaster into an area's new starting point of growth and progress. Mottainai!

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APPENDIX A. SURVEY QUESTIONNAIRES

Each round of surveys was administered through and analyzed using the Qualtrics ® software, Version October 2020-March 2021 of Qualtrics. Copyright © 2021 Qualtrics. Qualtrics and all other Qualtrics product or service names are registered trademarks or trademarks of Qualtrics, Provo, UT, USA. <https://www.qualtrics.com>. The first-round questions contain all the core questions that were repeated into the second round. The second-round questions build upon the core questions and deviate to collect data more directly with some of the most recent environmental and sustainability guidance.

Survey Questions: Round 1

Consent

Welcome to the Sustainable Debris Resource Recovery Research Study!

As Part 1 of the study, we are interested in understanding the policy opinions surrounding barriers to sustainability in disaster waste debris via the demolition industry. Please be assured that your responses will be kept completely confidential.

The study should take you around 5-7 to complete. If you complete both Part 1 and Part 2 of the study, you will be eligible to receive a \$5 Amazon gift card for your participation. Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Dr. Randy Rapp at rrapp@purdue.edu and the primary POC for the study, PhD Candidate, Toy Andrews at andrew93@purdue.edu.

By clicking the button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

Please note that this survey will be best displayed on a mobile device but can easily be displayed on your laptop or desktop computer.

I consent, begin the study

INTRO Thank you for your time in furthering the study of sustainability surrounding disaster waste management (DWM). Please answer the questions below to the best of your knowledge and use estimates if you are unsure of the exact number or value.

1. When did you start with the Construction and/or Demolition industry? Year (yyyy)

2. When did you start with your current employer? Year (yyyy)

3. Has your company ever been contracted for pre- or post-disaster clean-up?

Yes ,No ,Unsure

Skip To: 5 If... Has your company ever been contracted for pre- or post-disaster clean-up? = No

4. How long had your company been involved in demolition debris (natural or planned) removal before their first contract?

< 1 year, 1 - 3 years, 4 - 7 years, > 7 years, Unsure, Not Applicable

5. How large is your organization regarding employees that work in the field? Small = under 10, Medium = 10 to 50, Large = more than 50

Small, Medium, Large

6. How large is your organization's management (i.e. contracting specialists, planners, engineers) that are 'off-site' for the majority of a debris removal operation?

Small = under 10, Medium = 10 to 50, Large = more than 50

Small, Medium, Large

7. What is your current opinion of the term "sustainability"?

Extremely positive, Positive, Neither positive nor negative, Negative, Extremely negative, I do not know about sustainability

8. What is your current opinion of the term "profitability"?

Extremely positive, Positive, Neither positive nor negative, Negative, Extremely negative, I do not know about profitability

9. Please rank, with 1 being the most obstructive to 5 being the least obstructive, on what you think are the largest obstacles for your business to adopt sustainable practices?

_____ Regulation (EPA, local/state/federal variations, etc.)

_____ Cost

_____ Lack of a Clear Secondary Materials Market

_____ Time Constraints

_____ Industry Standard

10. Was there an obstacle you think should be included in the ranking above?

No, Yes

Skip To: 12 If... Was there an obstacle you think should be included in the ranking above? = No

11. What other obstacle would you include and where would you rank it? ____Free text answer____

12. What do you think would most likely cause your company to choose more sustainable practices?

Select 2. Contract Requirements, Secondary Materials Market, Growth in the Customer Base, Corporate Social Responsibility Portfolio Management, Higher Dumping/Tipping Fees, Tax Relief Incentives, Other_____

13. On a scale of 1 to 7, with 1 being "none whatsoever" and 7 being "extremely familiar", how familiar are you with the term "Circular Economy"?

1, 2, 3, 4, 5, 6, 7

14. Do you recycle in your personal life (at home, while traveling, etc.)?

Always, Most of the time, About half the time, Sometimes, Never

15. Marital Status

Married, Widowed, Divorced, Separated, Never married

16. Number of Children

0, 1, 2, 3, 4+

17. Highest Education Completed

Less than High School, High School Graduate, Trade School Certificate(s), Some College, 2 year Degree, 4 year Degree, Professional Degree, Doctorate

18. Annual Income

\$30,000 - \$49,999, \$50,000 - \$69,999, \$70,000 - \$89,999, \$90,000 - \$119,999, \$120,000 - \$149,999, \$150,000 - \$200,000, More than \$200,000

19. Age

18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85 or older

20. Which best describes your gender?

Male, Female, Prefer Not to Say

21. In which state do you currently reside?

50 states (individual choices), D.C., and Puerto Rico, I do not reside in the United States

22. Survey feedback/comments/questions for anything that were unclear, misspelled, or anything else to help the research. If nothing, please type "None".

Survey Questions: Round 2

Consent

Welcome to the Sustainable Debris Resource Recovery Research Study!

As Part 2 of the study, we are interested in understanding the incentive mechanisms and motivations of sustainability in disaster waste debris via the demolition industry. Please be assured that your responses will be kept completely confidential.

The study should take you around 10 minutes to complete. For the first 150 respondents, you will be eligible to receive a \$20 Amazon gift card for your participation. Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Dr. Randy Rapp at rrapp@purdue.edu or the primary study POC, PhD Candidate, Toy Andrews at andrew93@purdue.edu. By clicking the button below, you acknowledge that your participation in the study is voluntary, you are 18 years of age, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason.

Please note that this survey will be best displayed on a mobile device, but can easily be displayed on your tablet, laptop, or desktop computer.

I consent, begin the study

CORE QUESTIONS – Same as Survey 1

1. Where does your organization do business? Select all that apply.

Exclusively within the USA, North America (Canada, USA, Mexico), Internationally, Only within One state (___Listed___), Regionally

2. Has your company ever partnered with another to provide materials for creating/producing another finished product (e.g. the way tire brands partnering with tire shops to recover used tires for reselling in the playground padding industry)?

Yes, No, Unsure

3. Have you ever heard of the term 'Extended Producer Responsibility'?

Yes, No

4. Using the slider scale, how familiar are you with Extended Producer Responsibility (EPR)?

1 = heard of it, 5 = been involved/fully understand it

1, 2, 3, 4, 5

5. As part of the EPA's new National Framework on recycling, they organize under the three strategic objectives of:

- Reduce contamination in the recycling stream
- Increase processing efficiency
- Improve markets

What role do you think the construction and demolition industry can play in achieving one or more of these objectives? Free text answers.

6. From the EPA, the new National Recycling Goal is to increase the national recycling rate to 50 percent by 2030. This goal will help EPA, stakeholders, and the public see how the United States is managing materials more sustainably. It will help governments to make necessary changes to collection and sorting systems and help industry determine the supply of available materials and make investment decisions.

How easy do you believe it will be to meet the new National Recycling Goal by 2030?

Extremely easy, Somewhat easy, Neither easy nor difficult, Somewhat difficult, Extremely difficult

Skip To: 8 If...How easy do you believe it will be to meet the new National Recycling Goal by 2030? = Extremely easy

Skip To: 8 If...How easy do you believe it will be to meet the new National Recycling Goal by 2030? = Somewhat easy

7. Why do you think it will be difficult to meet the new National Recycling Goal?

8. Have you ever sold scrap in your personal life (e.g. aluminum cans, copper piping, etc.)?

Yes, No

9. Does your company make or recoup money from reclaiming or scrapping materials?

Yes, No, Unsure

10. On an average demolition job, what percentage of materials are recycled before final disposal? Percentages must total 100.

_____ On-site Recycled, _____ Off-site Recycled, _____ Not Recycled

11. Choose one or more races that you consider yourself to be:

White or Caucasian/European American, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, Hispanic/Latin American, Other_____

12. If you're in the first 150 respondents, you qualify for a \$20 Amazon gift card. Please provide your email address below to send the digital card to: _____email address_____

* Note: 37 respondents of Survey 2 qualified for the gift cards and 32 total, after follow-up confirmation emails to decline or accept, where awarded for survey responses. *

APPENDIX B. AGGREGATED SURVEY RESULTS

Common Core Questions (n = 89)

1. When did you start with the Construction and/or Demolition industry? Year (yyyy)

| | | | | | |
|----------|----------|----------|----------|----------|----------|
| 1. 1990 | 16. 2017 | 31. 1983 | 46. 1995 | 61. 2000 | 76. 1985 |
| 2. 1985 | 17. 1986 | 32. 1960 | 47. 1997 | 62. 1977 | 77. 2001 |
| 3. 2005 | 18. 1970 | 33. 1996 | 48. 1998 | 63. 2012 | 78. 1972 |
| 4. 1985 | 19. 2019 | 34. 1961 | 49. 1985 | 64. 1990 | 79. 2000 |
| 5. 1992 | 20. 2008 | 35. 2012 | 50. 1975 | 65. 2010 | 80. 1994 |
| 6. 1965 | 21. 1980 | 36. 2000 | 51. 1993 | 66. 1945 | 81. 2009 |
| 7. 1993 | 22. 1990 | 37. 1992 | 52. 1985 | 67. 2017 | 82. 2005 |
| 8. 2018 | 23. 2010 | 38. 2013 | 53. 2001 | 68. 2016 | 83. 1990 |
| 9. 1976 | 24. 1996 | 39. 2003 | 54. 1983 | 69. 2015 | 84. 2016 |
| 10. 1996 | 25. 1985 | 40. 2007 | 55. 1999 | 70. 2010 | 85. 2015 |
| 11. 1996 | 26. 2009 | 41. 1971 | 56. 1990 | 71. 2005 | 86. 2018 |
| 12. 1987 | 27. 2014 | 42. 1976 | 57. 2008 | 72. 2017 | 87. 1996 |
| 13. 1999 | 28. 1996 | 43. 2017 | 58. 1985 | 73. 2020 | 88. 1990 |
| 14. 2015 | 29. 2012 | 44. 1985 | 59. 2017 | 74. 1993 | 89. 1968 |
| 15. 1985 | 30. 1990 | 45. 1995 | 60. 1993 | 75. 2006 | |

2. When did you start with your current employer? Year (yyyy)

| | | | | | |
|----------|----------|----------|----------|----------|----------|
| 1. 2019 | 15. 1985 | 29. 2012 | 43. 2016 | 57. 2008 | 71. 2017 |
| 2. - | 16. - | 30. 1990 | 44. 2018 | 58. 1985 | 72. 2017 |
| 3. 2018 | 17. 2001 | 31. - | 45. 1995 | 59. 2017 | 73. 2020 |
| 4. - | 18. - | 32. - | 46. 2016 | 60. 2013 | 74. 1993 |
| 5. 1992 | 19. - | 33. 1996 | 47. - | 61. 2000 | 75. 2006 |
| 6. - | 20. 1999 | 34. 1965 | 48. 2008 | 62. 1994 | 76. 2018 |
| 7. - | 21. 2013 | 35. 2012 | 49. 1985 | 63. 2012 | 77. 2001 |
| 8. 2018 | 22. 2002 | 36. - | 50. - | 64. 2002 | 78. 1972 |
| 9. 2017 | 23. 2010 | 37. 2018 | 51. 2014 | 65. 2016 | 79. 2000 |
| 10. 1996 | 24. 2017 | 38. 2013 | 52. 2001 | 66. 1986 | 80. 1995 |
| 11. 1998 | 25. 1985 | 39. - | 53. 2009 | 67. 2017 | 81. 2009 |
| 12. 2005 | 26. 2017 | 40. 2007 | 54. 1983 | 68. 2017 | 82. 2005 |
| 13. - | 27. 2014 | 41. - | 55. 2018 | 69. 2016 | 83. 2020 |
| 14. 2015 | 28. 1996 | 42. - | 56. 2011 | 70. 2010 | 84. 2016 |

85. 2018

86. 2018

87. 1996

88. 2008

89. 1992

3. Has your company ever been contracted for pre- or post-disaster cleanup?

| | | | | | |
|-----------|------------|---------|---------|------------|------------|
| 1. Unsure | 16. Unsure | 31. Yes | 46. Yes | 61. Yes | 76. Unsure |
| 2. Yes | 17. Yes | 32. Yes | 47. Yes | 62. Yes | 77. Yes |
| 3. No | 18. Yes | 33. No | 48. Yes | 63. Yes | 78. Yes |
| 4. Yes | 19. No | 34. Yes | 49. No | 64. Yes | 79. Yes |
| 5. Yes | 20. Yes | 35. Yes | 50. Yes | 65. No | 80. No |
| 6. Yes | 21. Yes | 36. No | 51. No | 66. Yes | 81. Unsure |
| 7. Yes | 22. Yes | 37. No | 52. Yes | 67. Unsure | 82. Yes |
| 8. Unsure | 23. Yes | 38. Yes | 53. Yes | 68. Yes | 83. Yes |
| 9. Yes | 24. No | 39. Yes | 54. Yes | 69. Yes | 84. Yes |
| 10. Yes | 25. Yes | 40. Yes | 55. No | 70. Yes | 85. Yes |
| 11. Yes | 26. Yes | 41. Yes | 56. Yes | 71. Yes | 86. No |
| 12. Yes | 27. Yes | 42. Yes | 57. Yes | 72. Unsure | 87. Yes |
| 13. No | 28. No | 43. Yes | 58. Yes | 73. Unsure | 88. No |
| 14. No | 29. Yes | 44. Yes | 59. Yes | 74. Yes | 89. Yes |
| 15. Yes | 30. Yes | 45. Yes | 60. Yes | 75. No | |

4. How long had your company been involved in demolition debris (natural or planned) removal before their first contract?

| | | | | |
|--------------|---------------|---------------|---------------|---------------|
| 1. 7 years | 16. < 1 year | 31. 7 years | 46. 7 years | 61. 7 years |
| 2. < 1 year | 17. 4-7 years | 32. < 1 year | 47. 7 years | 62. 7 years |
| 3. - | 18. 7 years | 33. - | 48. 1-3 years | 63. 7 years |
| 4. 7 years | 19. - | 34. 4-7 years | 49. - | 64. < 1 year |
| 5. 4-7 years | 20. 7 years | 35. 7 years | 50. 7 years | 65. - |
| 6. 7 years | 21. 7 years | 36. - | 51. - | 66. < 1 year |
| 7. 7 years | 22. < 1 year | 37. - | 52. 7 years | 67. < 1 year |
| 8. 4-7 years | 23. 7 years | 38. 4-7 years | 53. 7 years | 68. 7 years |
| 9. 1-3 years | 24. - | 39. 1-3 years | 54. 7 years | 69. 1-3 years |
| 10. 7 years | 25. 1-3 years | 40. < 1 year | 55. - | 70. 4-7 years |
| 11. < 1 year | 26. 7 years | 41. 7 years | 56. 7 years | 71. 7 years |
| 12. 7 years | 27. 1-3 years | 42. 7 years | 57. 1-3 years | 72. 1-3 years |
| 13. - | 28. - | 43. 7 years | 58. 7 years | 73. < 1 year |
| 14. - | 29. 7 years | 44. < 1 year | 59. 7 years | 74. 7 years |
| 15. 7 years | 30. 7 years | 45. 7 years | 60. 7 years | 75. - |

| | | | | |
|--------------|---------------|-------------|---------------|---------------|
| 76. < 1 year | 79. < 1 year | 82. 7 years | 85. 1-3 years | 88. - |
| 77. 7 years | 80. - | 83. 7 years | 86. - | 89. 1-3 years |
| 78. < 1 year | 81. 1-3 years | 84. 7 years | 87. 7 years | |

5. Field Work Employee Size Small = < 10, Medium = 10-50, Large = > 50

| | | | | | |
|------------|------------|------------|------------|------------|------------|
| 1. Large | 16. Medium | 31. Large | 46. Medium | 61. Medium | 76. Medium |
| 2. Large | 17. Large | 32. Large | 47. Large | 62. Large | 77. Large |
| 3. Medium | 18. Large | 33. Large | 48. Medium | 63. Large | 78. Medium |
| 4. Large | 19. Small | 34. Medium | 49. Large | 64. Medium | 79. Large |
| 5. Medium | 20. Large | 35. Large | 50. Large | 65. Large | 80. Large |
| 6. Large | 21. Large | 36. Medium | 51. Large | 66. Medium | 81. Large |
| 7. Large | 22. Medium | 37. Large | 52. Large | 67. Large | 82. Large |
| 8. Large | 23. Large | 38. Medium | 53. Large | 68. Large | 83. Large |
| 9. Large | 24. Medium | 39. Large | 54. Large | 69. Medium | 84. Large |
| 10. Large | 25. Large | 40. Small | 55. Small | 70. Medium | 85. Large |
| 11. Small | 26. Large | 41. Large | 56. Medium | 71. Large | 86. Small |
| 12. Large | 27. Medium | 42. Large | 57. Large | 72. Large | 87. Large |
| 13. Medium | 28. Medium | 43. Medium | 58. Medium | 73. Large | 88. Medium |
| 14. Medium | 29. Large | 44. Medium | 59. Large | 74. Large | 89. Large |
| 15. Medium | 30. Medium | 45. Large | 60. Medium | 75. Large | |

6. How large is your organization's management (i.e. contracting specialists, planners, engineers) that are 'off-site' for the majority of a debris removal operation?

Small = < 10, Medium = 10-50, Large = > 50

| | | | | | |
|------------|------------|------------|------------|------------|------------|
| 1. Medium | 14. Medium | 27. Small | 40. Small | 53. Large | 66. Small |
| 2. Small | 15. Small | 28. Small | 41. Small | 54. Medium | 67. Medium |
| 3. Small | 16. Small | 29. Medium | 42. Medium | 55. Small | 68. Medium |
| 4. Small | 17. Medium | 30. Small | 43. Small | 56. Small | 69. Small |
| 5. Small | 18. Medium | 31. Medium | 44. Medium | 57. Large | 70. Small |
| 6. Small | 19. Small | 32. Large | 45. Medium | 58. Medium | 71. Medium |
| 7. Medium | 20. Medium | 33. Medium | 46. Small | 59. Medium | 72. Medium |
| 8. Medium | 21. Large | 34. Small | 47. Large | 60. Small | 73. Medium |
| 9. Medium | 22. Small | 35. Large | 48. Small | 61. Medium | 74. Medium |
| 10. Medium | 23. Large | 36. Small | 49. Medium | 62. Large | 75. Large |
| 11. Small | 24. Small | 37. Large | 50. Medium | 63. Medium | 76. Small |
| 12. Medium | 25. Large | 38. Small | 51. Small | 64. Medium | 77. Medium |
| 13. Medium | 26. Medium | 39. Small | 52. Medium | 65. Medium | 78. Medium |

| | | | | | |
|------------|------------|-----------|------------|-----------|-----------|
| 79. Small | 81. Medium | 83. Small | 85. Medium | 87. Large | 89. Large |
| 80. Medium | 82. Medium | 84. Large | 86. Large | 88. Small | |

7. How do you view the term "sustainability"?

- | | | | |
|--------------------------------------|--------------------------------------|--------------------------------------|--|
| 1. Positive | 21. Neither positive nor negative | 45. Neither positive nor negative | 68. Positive |
| 2. Neither positive nor negative | 22. Positive | 46. Neither positive nor negative | 69. Neither positive nor negative |
| 3. Neither positive nor negative | 23. Positive | 47. Neither positive nor negative | 70. Positive |
| 4. Negative | 24. Extremely positive | 48. Negative | 71. Positive |
| 5. Neither positive nor negative | 25. Neither positive nor negative | 49. Positive | 72. Positive |
| 6. Neither positive nor negative | 26. Extremely positive | 50. Negative | 73. Positive |
| 7. Neither positive nor negative | 27. Positive | 51. Positive | 74. Neither positive nor negative |
| 8. Positive | 28. Extremely negative | 52. Neither positive nor negative | 75. Extremely positive |
| 9. Neither positive nor negative | 29. Positive | 53. Positive | 76. Extremely positive |
| 10. Neither positive nor negative | 30. Positive | 54. Positive | 77. Positive |
| 11. Negative | 31. Positive | 55. Neither positive nor negative | 78. Neither positive nor negative |
| 12. Positive | 32. Positive | 56. Positive | 79. Positive |
| 13. Neither positive nor negative | 33. Extremely positive | 57. Positive | 80. Neither positive nor negative |
| 14. Positive | 34. Neither positive nor negative | 58. Neither positive nor negative | 81. Positive |
| 15. Neither positive nor negative | 35. Positive | 59. Extremely positive | 82. Positive |
| 16. Positive | 36. Negative | 60. Positive | 83. Positive |
| 17. Positive | 37. Negative | 61. Extremely positive | 84. Positive |
| 18. Positive | 38. Positive | 62. Positive | 85. Positive |
| 19. Neither positive nor negative | 39. Positive | 63. Positive | 86. Positive |
| 20. Extremely positive | 40. Positive | 64. Positive | 87. Extremely positive |
| | 41. Negative | 65. Positive | 88. Positive |
| | 42. Neither positive nor negative | 66. Positive | 89. I do not know about sustainability |
| | 43. Positive | 67. Extremely positive | |
| | 44. Positive | | |

8. How do you view the term "profitability"?

- | | | | |
|-----------------------------------|-----------------------------------|------------------------|---------------------------------------|
| 1. Extremely positive | 23. Positive | 46. Positive | 67. Extremely positive |
| 2. Positive | 24. Extremely positive | 47. Positive | 68. Positive |
| 3. Extremely positive | 25. Positive | 48. Positive | 69. Positive |
| 4. Negative | 26. Positive | 49. Extremely positive | 70. Positive |
| 5. Neither positive nor negative | 27. Extremely positive | 50. Negative | 71. Extremely positive |
| 6. Positive | 28. Extremely positive | 51. Extremely positive | 72. Positive |
| 7. Positive | 29. Extremely positive | 52. Extremely positive | 73. Positive |
| 8. Positive | 30. Positive | 53. Positive | 74. Positive |
| 9. Positive | 31. Extremely positive | 54. Extremely positive | 75. Extremely positive |
| 10. Extremely positive | 32. Positive | 55. Extremely positive | 76. Extremely positive |
| 11. Neither positive nor negative | 33. Positive | 56. Positive | 77. Extremely positive |
| 12. Positive | 34. Positive | 57. Positive | 78. Positive |
| 13. Neither positive nor negative | 35. Positive | 58. Extremely positive | 79. Extremely positive |
| 14. Positive | 36. Extremely positive | 59. Positive | 80. Extremely positive |
| 15. Neither positive nor negative | 37. Positive | 60. Extremely positive | 81. I do not know about profitability |
| 16. Positive | 38. Positive | 61. Extremely positive | 82. Positive |
| 17. Extremely positive | 39. Positive | 62. Positive | 83. Positive |
| 18. Extremely positive | 40. Extremely positive | 63. Extremely positive | 84. Positive |
| 19. Positive | 41. Extremely positive | 64. Extremely positive | 85. Positive |
| 20. Extremely positive | 42. Positive | 65. Extremely positive | 86. Positive |
| 21. Extremely positive | 43. Extremely positive | 66. Extremely positive | 87. Extremely positive |
| 22. Positive | 44. Positive | | 88. Positive |
| | 45. Neither positive nor negative | | 89. Extremely positive |

9. Please rank, with 1 being the most obstructive to 5 being the least obstructive, on what you think are the largest obstacles for your business to adopt sustainable practices?

a. _____ Regulation (EPA, local/state/federal variations, etc.)

b. _____ Cost

c. _____ Lack of a Clear Secondary Materials Market

d. _____ Time Constraints

e. _____ Industry Standard

| | | | | | | | | | | | |
|-----|---|---|-----|---|---|-----|---|---|-----|---|---|
| 1. | 3 | 1 | 11. | 1 | 3 | 21. | 1 | 3 | 31. | 5 | 1 |
| | | 2 | | | 4 | | | 2 | | | 3 |
| | | 4 | | | 2 | | | 4 | | | 2 |
| | | 5 | | | 5 | | | 5 | | | 4 |
| 2. | 3 | 1 | 12. | 1 | 2 | 22. | 5 | 3 | 32. | 1 | 2 |
| | | 5 | | | 3 | | | 1 | | | 3 |
| | | 2 | | | 4 | | | 2 | | | 4 |
| | | 4 | | | 5 | | | 4 | | | 5 |
| 3. | 5 | 2 | 13. | 2 | 1 | 23. | 2 | 3 | 33. | 3 | 2 |
| | | 1 | | | 4 | | | 4 | | | 5 |
| | | 3 | | | 3 | | | 1 | | | 4 |
| | | 4 | | | 5 | | | 5 | | | 1 |
| 4. | 2 | 1 | 14. | 2 | 1 | 24. | 4 | 2 | 34. | 1 | 2 |
| | | 4 | | | 3 | | | 3 | | | 3 |
| | | 3 | | | 4 | | | 1 | | | 4 |
| | | 5 | | | 5 | | | 5 | | | 5 |
| 5. | 2 | 1 | 15. | 1 | 2 | 25. | 2 | 3 | 35. | 3 | 2 |
| | | 5 | | | 4 | | | 1 | | | 4 |
| | | 3 | | | 3 | | | 4 | | | 1 |
| | | 4 | | | 5 | | | 5 | | | 5 |
| 6. | 1 | 2 | 16. | 4 | 1 | 26. | 4 | 1 | 36. | 1 | 2 |
| | | 3 | | | 2 | | | 2 | | | 3 |
| | | 4 | | | 3 | | | 5 | | | 4 |
| | | 5 | | | 5 | | | 3 | | | 5 |
| 7. | 4 | 1 | 17. | 2 | 1 | 27. | 2 | 1 | 37. | 4 | 1 |
| | | 2 | | | 5 | | | 3 | | | 2 |
| | | 3 | | | 3 | | | 4 | | | 3 |
| | | 5 | | | 4 | | | 5 | | | 5 |
| 8. | 2 | 1 | 18. | 1 | 3 | 28. | 3 | 1 | 38. | 3 | 2 |
| | | 3 | | | 5 | | | 4 | | | 4 |
| | | 5 | | | 4 | | | 2 | | | 1 |
| | | 4 | | | 2 | | | 5 | | | 5 |
| 9. | 1 | 3 | 19. | 1 | 2 | 29. | 3 | 1 | 39. | 3 | 2 |
| | | 5 | | | 4 | | | 2 | | | 4 |
| | | 4 | | | 5 | | | 4 | | | 1 |
| | | 2 | | | 3 | | | 5 | | | 5 |
| 10. | 4 | 5 | 20. | 2 | 5 | 30. | 2 | 1 | 40. | 2 | 4 |
| | | 2 | | | 1 | | | 4 | | | 1 |
| | | 1 | | | 4 | | | 3 | | | 3 |
| | | 3 | | | 3 | | | 5 | | | 5 |

| | | | | | | |
|-------|---|-------|---|-------|---|---|
| 41. 1 | 2 | | 2 | 66. 2 | 1 | 3 |
| | 3 | | 5 | | 3 | 4 |
| | 4 | 54. 4 | 1 | | 4 | 1 |
| | 5 | | 3 | | 5 | 4 |
| 42. 2 | 1 | | 2 | 67. 2 | 1 | 2 |
| | 3 | | 5 | | 5 | 3 |
| | 4 | 55. 1 | 2 | | 3 | 1 |
| | 5 | | 3 | | 4 | 5 |
| 43. 2 | 1 | | 4 | 68. 1 | 5 | 2 |
| | 3 | | 5 | | 3 | 4 |
| | 4 | 56. 2 | 3 | | 2 | 1 |
| | 5 | | 1 | | 4 | 3 |
| 44. 3 | 1 | | 5 | 69. 5 | 3 | 4 |
| | 5 | | 4 | | 2 | 5 |
| | 2 | 57. 5 | 1 | | 4 | 1 |
| | 4 | | 3 | | 1 | 3 |
| 45. 4 | 3 | | 2 | 70. 2 | 1 | 4 |
| | 1 | | 4 | | 5 | 5 |
| | 2 | 58. 2 | 3 | | 4 | 1 |
| | 5 | | 4 | | 3 | 4 |
| 46. 1 | 3 | | 1 | 71. 4 | 1 | 3 |
| | 2 | | 5 | | 3 | 5 |
| | 4 | 59. 5 | 1 | | 2 | 5 |
| | 5 | | 3 | | 5 | 3 |
| 47. 4 | 1 | | 4 | 72. 3 | 4 | 1 |
| | 3 | | 2 | | 2 | 4 |
| | 2 | 60. 4 | 3 | | 1 | 1 |
| | 5 | | 2 | | 5 | 2 |
| 48. 2 | 1 | | 1 | 73. 3 | 2 | 3 |
| | 4 | | 5 | | 1 | 5 |
| | 3 | 61. 4 | 3 | | 4 | 4 |
| | 5 | | 1 | | 5 | 3 |
| 49. 2 | 3 | | 2 | 74. 1 | 4 | 2 |
| | 1 | | 5 | | 3 | 5 |
| | 5 | 62. 5 | 2 | | 5 | 1 |
| | 4 | | 1 | | 2 | 4 |
| 50. 1 | 2 | | 4 | 75. 2 | 1 | 3 |
| | 3 | | 3 | | 3 | 5 |
| | 4 | 63. 5 | 1 | | 4 | 4 |
| | 5 | | 2 | | 5 | 3 |
| 51. 1 | 2 | | 3 | 76. 3 | 1 | 5 |
| | 4 | | 4 | | 5 | 2 |
| | 3 | 64. 5 | 1 | | 2 | 2 |
| | 5 | | 3 | | 4 | 1 |
| 52. 3 | 2 | | 2 | 77. 5 | 1 | 3 |
| | 1 | | 4 | | 3 | 5 |
| | 4 | 65. 4 | 1 | | 2 | |
| | 5 | | 3 | | 4 | |
| 53. 1 | 3 | | 2 | 78. 1 | 5 | |
| | 4 | | 5 | | 2 | |

10. Was there an obstacle you think should be included in the ranking above?

- | | | | | | |
|-------|-------|--------|--------|---------|--------|
| 1. No | 3. No | 5. No | 7. No | 9. No | 11. No |
| 2. No | 4. No | 6. Yes | 8. Yes | 10. Yes | 12. No |

| | | | | | |
|---------|---------|---------|---------|--------|---------|
| 13. No | 26. No | 39. Yes | 52. No | 65. No | 78. Yes |
| 14. Yes | 27. No | 40. No | 53. No | 66. No | 79. No |
| 15. No | 28. Yes | 41. Yes | 54. Yes | 67. No | 80. No |
| 16. No | 29. No | 42. No | 55. No | 68. No | 81. No |
| 17. No | 30. No | 43. No | 56. No | 69. No | 82. No |
| 18. No | 31. No | 44. No | 57. No | 70. No | 83. Yes |
| 19. No | 32. No | 45. No | 58. No | 71. No | 84. No |
| 20. No | 33. Yes | 46. Yes | 59. Yes | 72. No | 85. Yes |
| 21. No | 34. No | 47. Yes | 60. No | 73. No | 86. No |
| 22. No | 35. No | 48. Yes | 61. Yes | 74. No | 87. No |
| 23. No | 36. No | 49. No | 62. Yes | 75. No | 88. No |
| 24. No | 37. No | 50. No | 63. No | 76. No | 89. Yes |
| 25. No | 38. No | 51. No | 64. No | 77. No | |

11. What other obstacle would you include? (listed from exceptions of 'yes' answer to above)

6. ownership issues

8. safety

10. My state does not understand demolition practices, the market, or possible solutions, and gives grants to startups with little capability, rather than working with existing companies like mine, to achieve its goals.

14. lack of internal mechanisms

28. Local government

33. Competition not following the same work practices

39. Qualified Labor, Operators

41. Democrats

46. Safety in handling

47. competition – all bidders are not environmentally responsible

48. Availability of recyclers or vendors to take materials for recycling

54. New construction and energy designs are making it so that structures being built today are difficult to recycle. No thought at design for end of usefulness.

59. Internal Historical Knowledge ("teaching old dogs, new tricks")

61. Indirect Environmental Impacts

62. Education

78. Cost

83. Bureaucracy

85. Education

89. Funding to develop markets for Recycled materials

12. What do you think would most likely cause your company to choose more sustainable practices? Select 2.

- Contract Requirements
- Growth Potential in the Customer Base
- Secondary Materials Market Revenue

- Corporate Social Responsibility
 - Portfolio Management
 - Higher Dumping/Tipping Fees
 - Tax Relief Incentives
 - Government Regulation
 - Other
1. Contract Requirement, Secondary Materials Market
 2. Growth in the Customer Base, Tax Relief Incentives
 3. Contract Requirement, Other
 4. Contract Requirement, Secondary Materials Market
 5. Contract Requirement, Secondary Materials Market
 6. Secondary Materials Market, Corporate Social Responsibility Portfolio Management
 7. Contract Requirement, Higher Dumping/Tipping Fees
 8. Contract Requirement, Tax Relief Incentives
 9. Contract Requirement, Secondary Materials Market
 10. Secondary Materials Market, Growth in the Customer Base
 11. Higher Dumping/Tipping Fees, Other
 12. Secondary Materials Market, Growth in the Customer Base
 13. Growth in the Customer Base, Tax Relief Incentives
 14. Secondary Materials Market, Corporate Social Responsibility Portfolio Management
 15. Secondary Materials Market, Higher Dumping/Tipping Fees
 16. Contract Requirement, Higher Dumping/Tipping Fees
 17. Contract Requirement, Secondary Materials Market
 18. Contract Requirement, Growth in the Customer Base
 19. Secondary Materials Market, Growth in the Customer Base
 20. Contract Requirement, Secondary Materials Market
 21. Contract Requirement, Secondary Materials Market
 22. Secondary Materials Market, Higher Dumping/Tipping Fees
 23. Contract Requirement, Secondary Materials Market
 24. Contract Requirement, Tax Relief Incentives
 25. Secondary Materials Market, Higher Dumping/Tipping Fees
 26. Contract Requirement, Other
 27. Contract Requirement, Higher Dumping/Tipping Fees
 28. Tax Relief Incentives, Other
 29. Secondary Materials Market, Tax Relief Incentives
 30. Contract Requirement, Higher Dumping/Tipping Fees
 31. Contract Requirement, Secondary Materials Market
 32. Contract Requirement, Growth in the Customer Base
 33. Contract Requirement, Tax Relief Incentives
 34. Contract Requirement, Growth in the Customer Base
 35. Secondary Materials Market, Growth in the Customer Base
 36. Contract Requirement, Secondary Materials Market
 37. Contract Requirement, Secondary Materials Market
 38. Contract Requirement, Higher Dumping/Tipping Fees
 39. Contract Requirement, Higher Dumping/Tipping Fees
 40. Secondary Materials Market, Tax Relief Incentives
 41. Secondary Materials Market, Tax Relief Incentives
 42. Secondary Materials Market, Higher Dumping/Tipping Fees
 43. Growth in the Customer Base, Tax Relief Incentives
 44. Contract Requirement, Higher Dumping/Tipping Fees
 45. Contract Requirement, Secondary Materials Market
 46. Contract Requirement, Other
 47. Contract Requirement, Secondary Materials Market
 48. Contract Requirement, Secondary Materials Market
 49. Contract Requirement, Growth in the Customer Base
 50. Contract Requirement, Higher Dumping/Tipping Fees
 51. Growth in the Customer Base, Corporate Social Responsibility Portfolio Management

- | | | |
|--|---|--|
| 52. Secondary Materials Market, Tax Relief Incentives | 64. Secondary Materials Market Revenue, Higher Dumping/Tipping Fees | 77. Secondary Materials Market Revenue, Tax Relief Incentives |
| 53. Corporate Social Responsibility Portfolio Management, Government Regulation | 65. Secondary Materials Market Revenue, Growth Potential in the Customer Base | 78. Contract Requirements, Secondary Materials Market Revenue |
| 54. Secondary Materials Market Revenue, Growth Potential in the Customer Base | 66. Secondary Materials Market Revenue, Growth Potential in the Customer Base | 79. Contract Requirements, Higher Dumping/Tipping Fees |
| 55. Secondary Materials Market Revenue, Tax Relief Incentives | 67. Contract Requirements, Higher Dumping/Tipping Fees | 80. Contract Requirements, Other |
| 56. Secondary Materials Market Revenue, Tax Relief Incentives | 68. Secondary Materials Market Revenue, Corporate Social Responsibility Portfolio Management | 81. Growth Potential in the Customer Base, Tax Relief Incentives |
| 57. Contract Requirements, Growth Potential in the Customer Base | 69. Contract Requirements, Higher Dumping/Tipping Fees | 82. Tax Relief Incentives, Government Regulation |
| 58. Secondary Materials Market Revenue, Higher Dumping/Tipping Fees | 70. Secondary Materials Market Revenue, Growth Potential in the Customer Base | 83. Contract Requirements, Other |
| 59. Contract Requirements, Secondary Materials Market Revenue | 71. Contract Requirements, Growth Potential in the Customer Base | 84. Corporate Social Responsibility Portfolio Management, Tax Relief Incentives |
| 60. Secondary Materials Market Revenue, Tax Relief Incentives | 72. Secondary Materials Market Revenue, Growth Potential in the Customer Base | 85. Contract Requirements, Secondary Materials Market Revenue |
| 61. Secondary Materials Market Revenue, Growth Potential in the Customer Base | 73. Secondary Materials Market Revenue, Government Regulation | 86. Secondary Materials Market Revenue, Government Regulation |
| 62. Contract Requirements, Higher Dumping/Tipping Fees | 74. Contract Requirements, Secondary Materials Market Revenue | 87. Growth Potential in the Customer Base, Corporate Social Responsibility Portfolio Management |
| 63. Secondary Materials Market Revenue, Growth Potential in the Customer Base | 75. Contract Requirements, Tax Relief Incentives | 88. Contract Requirements, Government Regulation |
| | 76. Contract Requirements, Tax Relief Incentives | 89. Secondary Materials Market Revenue, Tax Relief Incentives |

12a. 'Other' selections from above (listed from exceptions of 'Other' answer to above)

3. Regulatory Requirement

11. Many of the "sustainable practices" that are advertised by local competitors are merely gimmicks to fool the public.
 26. regulations regarding emissions
 28. Schedule relief

46. Change in OSHA recordable status of minor injuries
 80. Cost savings
 83. Profitability

13. How familiar are you with the term "Circular Economy"? 1 = none whatsoever and 7 = extremely familiar

| | | | | | |
|-------|-------|-------|-------|-------|-------|
| 1. 7 | 16. 5 | 31. 5 | 46. 6 | 61. 3 | 76. 1 |
| 2. 1 | 17. 1 | 32. 1 | 47. 5 | 62. 7 | 77. 1 |
| 3. 2 | 18. 1 | 33. 3 | 48. 4 | 63. 5 | 78. 1 |
| 4. 6 | 19. 5 | 34. 1 | 49. 7 | 64. 6 | 79. 1 |
| 5. 3 | 20. 6 | 35. 6 | 50. 4 | 65. 1 | 80. 1 |
| 6. 1 | 21. 1 | 36. 1 | 51. 5 | 66. 1 | 81. 1 |
| 7. 1 | 22. 3 | 37. 7 | 52. 1 | 67. 5 | 82. 2 |
| 8. 5 | 23. 4 | 38. 3 | 53. 2 | 68. 2 | 83. 2 |
| 9. 2 | 24. 1 | 39. 4 | 54. 5 | 69. 2 | 84. 4 |
| 10. 2 | 25. 7 | 40. 4 | 55. 4 | 70. 2 | 85. 5 |
| 11. 7 | 26. 2 | 41. 1 | 56. 4 | 71. 3 | 86. 1 |
| 12. 5 | 27. 2 | 42. 1 | 57. 3 | 72. 1 | 87. 7 |
| 13. 2 | 28. 2 | 43. 2 | 58. 2 | 73. 5 | 88. 1 |
| 14. 4 | 29. 4 | 44. 7 | 59. 3 | 74. 1 | |
| 15. 3 | 30. 7 | 45. 4 | 60. 4 | 75. 5 | |

14. Do you recycle in your personal life (at home, while traveling, etc.)?

| | | | |
|------------------------|-------------------------|-------------------------|-------------------------|
| 1. Sometimes | 11. Most of the time | 21. Always | 31. Most of the time |
| 2. Most of the time | 12. Most of the time | 22. Most of the time | 32. Always |
| 3. Most of the time | 13. Sometimes | 23. Always | 33. Sometimes |
| 4. Most of the time | 14. Most of the time | 24. Most of the time | 34. Most of the time |
| 5. Always | 15. About half the time | 25. About half the time | 35. Most of the time |
| 6. Most of the time | 16. Most of the time | 26. Always | 36. Most of the time |
| 7. Always | 17. Always | 27. Most of the time | 37. Most of the time |
| 8. Sometimes | 18. Most of the time | 28. Never | 38. Most of the time |
| 9. About half the time | 19. Most of the time | 29. Always | 39. Sometimes |
| 10. Most of the time | 20. Always | 30. About half the time | 40. About half the time |

| | | | |
|-------------------------|-------------------------|----------------------|-------------------------|
| 41. Always | 54. About half the time | 67. Most of the time | 80. About half the time |
| 42. Always | 55. Most of the time | 68. Always | 81. Sometimes |
| 43. Always | 56. About half the time | 69. Always | 82. Sometimes |
| 44. Always | 57. Most of the time | 70. Always | 83. Always |
| 45. About half the time | 58. Never | 71. Most of the time | 84. Sometimes |
| 46. Most of the time | 59. Most of the time | 72. Most of the time | 85. About half the time |
| 47. Most of the time | 60. Always | 73. Sometimes | 86. About half the time |
| 48. Sometimes | 61. Always | 74. Most of the time | 87. Always |
| 49. Always | 62. Always | 75. Always | 88. Most of the time |
| 50. Always | 63. Always | 76. Always | 89. Always |
| 51. Always | 64. Most of the time | 77. Always | |
| 52. Most of the time | 65. About half the time | 78. Most of the time | |
| 53. Always | 66. Most of the time | 79. Always | |

15. Marital Status

| | | | | |
|---------------|--------------|--------------|-------------|--------------|
| 1. Married | 21. Divorced | 41. Married | 60. Married | 76. Divorced |
| 2. Married | 22. Married | 42. Married | 61. Married | 77. Divorced |
| 3. Married | 23. Married | 43. Divorced | 62. Married | 78. Married |
| 4. Married | 24. Divorced | 44. Divorced | 63. Married | 79. Married |
| 5. Married | 25. Married | 45. Married | 64. Married | 80. Never |
| 6. Married | 26. Never | 46. Married | 65. Married | married |
| 7. Married | married | 47. Married | 66. Married | 81. Married |
| 8. Married | 27. Married | 48. Married | 67. Never | 82. Married |
| 9. Married | 28. Married | 49. Married | married | 83. Married |
| 10. Married | 29. Married | 50. Married | 68. Never | 84. Married |
| 11. Married | 30. Married | 51. Married | married | 85. Married |
| 12. Married | 31. Married | 52. Married | 69. Married | 86. Never |
| 13. Separated | 32. Married | 53. Married | 70. Married | married |
| 14. Never | 33. Married | 54. Married | 71. Never | 87. Married |
| married | 34. Married | 55. Married | married | 88. Married |
| 15. Married | 35. Married | 56. Married | 72. Married | 89. Married |
| 16. Married | 36. Married | 57. Never | 73. Never | |
| 17. Married | 37. Divorced | married | married | |
| 18. Divorced | 38. Married | 58. Married | 74. Married | |
| 19. Divorced | 39. Married | 59. Never | 75. Never | |
| 20. Married | 40. Married | married | married | |

16. Number of Children

| | | | | | |
|--------|-------|--------|--------|--------|-------|
| 1. 2 | 16. 1 | 31. 2 | 46. 0 | 61. 0 | 76. 2 |
| 2. 3 | 17. 3 | 32. 4+ | 47. 3 | 62. 3 | 77. 2 |
| 3. 4+ | 18. 2 | 33. 2 | 48. 2 | 63. 0 | 78. 2 |
| 4. 2 | 19. 2 | 34. 2 | 49. 0 | 64. 1 | 79. 3 |
| 5. 4+ | 20. 3 | 35. 2 | 50. 2 | 65. 4+ | 80. 0 |
| 6. 2 | 21. 3 | 36. 2 | 51. 4+ | 66. 2 | 81. 2 |
| 7. 3 | 22. 2 | 37. 2 | 52. 4+ | 67. 0 | 82. 1 |
| 8. 3 | 23. 1 | 38. 0 | 53. 3 | 68. 0 | 83. 2 |
| 9. 1 | 24. 2 | 39. 2 | 54. 2 | 69. 1 | 84. 3 |
| 10. 3 | 25. 2 | 40. 1 | 55. 2 | 70. 3 | 85. 0 |
| 11. 4+ | 26. 0 | 41. 4+ | 56. 2 | 71. 0 | 86. 1 |
| 12. 4+ | 27. 2 | 42. 2 | 57. 0 | 72. 0 | 87. 2 |
| 13. 1 | 28. 3 | 43. 0 | 58. 2 | 73. 0 | 88. 2 |
| 14. 0 | 29. 0 | 44. 2 | 59. 0 | 74. 3 | 89. 2 |
| 15. 2 | 30. 3 | 45. 0 | 60. 0 | 75. 0 | |

17. Highest Education Completed

| | | |
|--|---|---|
| 1. 4 year Degree | 17. High School Graduate | 35. 4 year Degree |
| 2. High School Graduate, Some College | 18. 4 year Degree | 36. 4 year Degree |
| 3. Professional Degree | 19. High School Graduate | 37. 4 year Degree |
| 4. Some College | 20. 4 year Degree | 38. 4 year Degree |
| 5. Trade School Certificate(s) | 21. 4 year Degree | 39. 4 year Degree |
| 6. High School Graduate | 22. Professional Degree | 40. Professional Degree |
| 7. 4 year Degree | 23. 4 year Degree | 41. High School Graduate,2 year Degree |
| 8. Some College | 24. Professional Degree | 42. 4 year Degree |
| 9. 2 year Degree | 25. 4 year Degree | 43. 4 year Degree |
| 10. 4 year Degree | 26. 4 year Degree | 44. 4 year Degree |
| 11. Professional Degree | 27. 4 year Degree | 45. Some College |
| 12. 4 year Degree | 28. 4 year Degree | 46. Some College |
| 13. Some College | 29. 4 year Degree | 47. 4 year Degree |
| 14. Professional Degree | 30. High School Graduate | 48. 4 year Degree |
| 15. High School Graduate, Trade School Certificate(s) | 31. Trade School Certificate(s) | 49. Professional Degree |
| 16. Trade School Certificate(s),4 year Degree | 32. 4 year Degree, Professional Degree | 50. Trade School Certificate(s) |
| | 33. 4 year Degree | 51. 4 year Degree |
| | 34. Some College | 52. 4 year Degree |

| | | |
|---|--|---|
| 53. 4 year Degree, Professional Degree | 64. 4 year Degree, Professional Degree | 77. Some College |
| 54. Trade School Certificate(s) | 65. Professional Degree | 78. High School Graduate |
| 55. Trade School Certificate(s),4 year Degree | 66. 4 year Degree | 79. High School Graduate |
| 56. Some College | 67. Professional Degree | 80. 2 year Degree |
| 57. Some College | 68. 4 year Degree, Professional Degree | 81. 4 year Degree |
| 58. Trade School Certificate(s) | 69. 4 year Degree | 82. Some College |
| 59. 4 year Degree | 70. 4 year Degree | 83. 4 year Degree |
| 60. 4 year Degree | 71. 2 year Degree | 84. 4 year Degree |
| 61. 4 year Degree | 72. 4 year Degree | 85. Some College |
| 62. High School Graduate, Some College | 73. Professional Degree | 86. Trade School Certificate(s),2 year Degree |
| 63. 4 year Degree | 74. 4 year Degree | 87. Some College |
| | 75. 4 year Degree | 88. 4 year Degree |
| | 76. 4 year Degree | 89. Some College |

18. Annual Income

| | | | |
|--------------------------|---------------------------|---------------------------|---------------------------|
| 1. \$150,000 - \$200,000 | 14. More than \$200,000 | 27. More than \$200,000 | 38. \$150,000 - \$200,000 |
| 2. \$150,000 - \$200,000 | 15. More than \$200,000 | 28. \$150,000 - \$200,000 | 39. More than \$200,000 |
| 3. \$150,000 - \$200,000 | 16. \$30,000 - \$49,999 | 29. \$150,000 - \$200,000 | 40. \$50,000 - \$69,999 |
| 4. \$120,000 - \$149,999 | 17. More than \$200,000 | 30. More than \$200,000 | 41. More than \$200,000 |
| 5. \$150,000 - \$200,000 | 18. \$90,000 - \$119,999 | 31. More than \$200,000 | 42. \$120,000 - \$149,999 |
| 6. \$90,000 - \$119,999 | 19. - | 32. More than \$200,000 | 43. \$70,000 - \$89,999 |
| 7. \$70,000 - \$89,999 | 20. \$150,000 - \$200,000 | 33. More than \$200,000 | 44. \$120,000 - \$149,999 |
| 8. \$70,000 - \$89,999 | 21. More than \$200,000 | 34. - | 45. More than \$200,000 |
| 9. \$120,000 - \$149,999 | 22. More than \$200,000 | 35. \$120,000 - \$149,999 | 46. \$120,000 - \$149,999 |
| 10. More than \$200,000 | 23. \$150,000 - \$200,000 | 36. \$70,000 - \$89,999 | 47. More than \$200,000 |
| 11. - | 24. \$90,000 - \$119,999 | 37. \$120,000 - \$149,999 | 48. More than \$200,000 |
| 12. More than \$200,000 | 25. More than \$200,000 | | 49. - |
| 13. \$90,000 - \$119,999 | 26. \$90,000 - \$119,999 | | |

| | | | |
|---------------------------|---------------------------|---------------------------|---------------------------|
| 50. \$70,000 - \$89,999 | 59. \$70,000 - \$89,999 | 69. \$120,000 - \$149,999 | 80. \$90,000 - \$119,999 |
| 51. More than \$200,000 | 60. \$70,000 - \$89,999 | 70. \$90,000 - \$119,999 | 81. \$70,000 - \$89,999 |
| 52. More than \$200,000 | 61. \$120,000 - \$149,999 | 71. \$120,000 - \$149,999 | 82. More than \$200,000 |
| 53. \$90,000 - \$119,999 | 62. More than \$200,000 | 72. \$70,000 - \$89,999 | 83. More than \$200,000 |
| 54. More than \$200,000 | 63. \$150,000 - \$200,000 | 73. \$90,000 - \$119,999 | 84. \$70,000 - \$89,999 |
| 55. \$120,000 - \$149,999 | 64. \$150,000 - \$200,000 | 74. \$90,000 - \$119,999 | 85. \$70,000 - \$89,999 |
| 56. \$120,000 - \$149,999 | 65. \$70,000 - \$89,999 | 75. \$150,000 - \$200,000 | 86. \$50,000 - \$69,999 |
| 57. \$70,000 - \$89,999 | 66. \$150,000 - \$200,000 | 76. \$90,000 - \$119,999 | 87. \$150,000 - \$200,000 |
| 58. More than \$200,000 | 67. \$50,000 - \$69,999 | 77. \$70,000 - \$89,999 | 88. \$150,000 - \$200,000 |
| | 68. \$50,000 - \$69,999 | 78. \$90,000 - \$119,999 | 89. \$150,000 - \$200,000 |
| | | 79. More than \$200,000 | |

19. Age

| | | | | |
|-------------|-------------|-------------|-------------|-------------|
| 1. 55 - 64 | 19. 45 - 54 | 37. 55 - 64 | 55. 35 - 44 | 73. 25 - 34 |
| 2. 55 - 64 | 20. 45 - 54 | 38. 25 - 34 | 56. 45 - 54 | 74. 55 - 64 |
| 3. 35 - 44 | 21. 65 - 74 | 39. 35 - 44 | 57. 25 - 34 | 75. 35 - 44 |
| 4. 45 - 54 | 22. 45 - 54 | 40. 45 - 54 | 58. 45 - 54 | 76. 45 - 54 |
| 5. 45 - 54 | 23. 25 - 34 | 41. 65 - 74 | 59. 25 - 34 | 77. 45 - 54 |
| 6. 65 - 74 | 24. 45 - 54 | 42. 55 - 64 | 60. 25 - 34 | 78. 65 - 74 |
| 7. 55 - 64 | 25. 55 - 64 | 43. 45 - 54 | 61. 25 - 34 | 79. 45 - 54 |
| 8. 45 - 54 | 26. 25 - 34 | 44. 45 - 54 | 62. 55 - 64 | 80. 45 - 54 |
| 9. 55 - 64 | 27. 35 - 44 | 45. 45 - 54 | 63. 25 - 34 | 81. 25 - 34 |
| 10. 35 - 44 | 28. 45 - 54 | 46. 35 - 44 | 64. 45 - 54 | 82. 25 - 34 |
| 11. 45 - 54 | 29. 25 - 34 | 47. 45 - 54 | 65. 55 - 64 | 83. 55 - 64 |
| 12. 45 - 54 | 30. 45 - 54 | 48. 45 - 54 | 66. 55 - 64 | 84. 25 - 34 |
| 13. 35 - 44 | 31. 55 - 64 | 49. 65 - 74 | 67. 25 - 34 | 85. 25 - 34 |
| 14. 25 - 34 | 32. 85+ | 50. 45 - 54 | 68. 18 - 24 | 86. 35 - 44 |
| 15. 45 - 54 | 33. 35 - 44 | 51. 45 - 54 | 69. 35 - 44 | 87. 55 - 64 |
| 16. 35 - 44 | 34. 75 - 84 | 52. 55 - 64 | 70. 25 - 34 | 88. 45 - 54 |
| 17. 55 - 64 | 35. 35 - 44 | 53. 35 - 44 | 71. 35 - 44 | 89. 75 - 84 |
| 18. 35 - 44 | 36. 45 - 54 | 54. 55 - 64 | 72. 25 - 34 | |

20. Gender

| | | | | |
|-----------|------------|------------|------------|----------------|
| 1. Male | 19. Male | 37. Male | 55. Male | 73. Male |
| 2. Male | 20. Male | 38. Male | 56. Male | 74. Female |
| 3. Male | 21. Male | 39. Male | 57. Male | 75. Male |
| 4. Male | 22. Male | 40. Female | 58. Male | 76. Male |
| 5. Male | 23. Male | 41. Male | 59. Male | 77. Female |
| 6. Male | 24. Female | 42. Male | 60. Male | 78. Male |
| 7. Female | 25. Male | 43. Male | 61. Female | 79. Male |
| 8. Male | 26. Male | 44. Male | 62. Male | 80. Male |
| 9. Male | 27. Male | 45. Male | 63. Male | 81. Prefer Not |
| 10. Male | 28. Female | 46. Male | 64. Male | to Say |
| 11. Male | 29. Male | 47. Male | 65. Male | 82. Male |
| 12. Male | 30. Male | 48. Male | 66. Male | 83. Male |
| 13. Male | 31. Male | 49. Male | 67. Female | 84. Male |
| 14. Male | 32. Male | 50. Male | 68. Male | 85. Male |
| 15. Male | 33. Male | 51. Male | 69. Female | 86. Male |
| 16. Male | 34. Male | 52. Male | 70. Male | 87. Male |
| 17. Male | 35. Male | 53. Male | 71. Male | 88. Male |
| 18. Male | 36. Male | 54. Male | 72. Male | 89. Male |

21. 50 States, D.C., and Puerto Rico

| | | | |
|-------------------|-------------------|--------------------|-------------------|
| 1. Massachusetts | 18. Minnesota | 35. North Carolina | 52. Minnesota |
| 2. Michigan | 19. Missouri | 36. Illinois | 53. Tennessee |
| 3. Pennsylvania | 20. Indiana | 37. Wisconsin | 54. Minnesota |
| 4. Texas | 21. Kansas | 38. Indiana | 55. Virginia |
| 5. New Mexico | 22. Illinois | 39. Texas | 56. Indiana |
| 6. Illinois | 23. Indiana | 40. Ohio | 57. Indiana |
| 7. North Carolina | 24. Michigan | 41. Oregon | 58. Ohio |
| 8. Oklahoma | 25. New York | 42. New Jersey | 59. New Hampshire |
| 9. Colorado | 26. New Hampshire | 43. Ohio | 60. Indiana |
| 10. Washington | 27. Virginia | 44. Connecticut | 61. Minnesota |
| 11. California | 28. Washington | 45. Texas | 62. Georgia |
| 12. Louisiana | 29. Minnesota | 46. Nevada | 63. Minnesota |
| 13. New York | 30. Indiana | 47. Indiana | 64. Illinois |
| 14. Florida | 31. Minnesota | 48. California | 65. Michigan |
| 15. Ohio | 32. Colorado | 49. Michigan | 66. New York |
| 16. Ohio | 33. Michigan | 50. Kentucky | 67. Idaho |
| 17. Illinois | 34. Nevada | 51. Pennsylvania | 68. Minnesota |

| | | | |
|---|-----------------------------|------------------|--------------------|
| 69. I do not reside in the United States | 73. District of Columbia | 78. Illinois | 84. Indiana |
| 70. Minnesota | 74. North Carolina | 79. Puerto Rico | 85. Indiana |
| 71. North Carolina | 75. Minnesota | 80. Pennsylvania | 86. Pennsylvania |
| 72. Indiana | 76. Connecticut | 81. Indiana | 87. New Jersey |
| | 77. Minnesota | 82. New York | 88. South Carolina |
| | | 83. California | 89. Illinois |

Deviation Set Questions (n = 37)

1. Where does your organization do business? Select all that apply.

- Exclusively within the USA (1)
 - North America (Canada, USA, Mexico) (2)
 - Internationally (3)
 - Only within One (1) state _____
- | | |
|--|--|
| 1. North America (Canada, USA, Mexico) | 19. Exclusively within the USA, Regionally |
| 2. Exclusively within the USA | 20. Internationally |
| 3. Internationally, Regionally | 21. Regionally |
| 4. Exclusively within the USA | 22. Regionally |
| 5. Exclusively within the USA, Regionally | 23. Exclusively within the USA |
| 6. Exclusively within the USA | 24. Regionally |
| 7. Internationally | 25. Only within One (1) state |
| 8. Exclusively within the USA, North America (Canada, USA, Mexico) | 26. Exclusively within the USA |
| 9. North America (Canada, USA, Mexico) | 27. Regionally |
| 10. Exclusively within the USA, Regionally | 28. North America (Canada, USA, Mexico), Regionally |
| 11. North America (Canada, USA, Mexico), Internationally, Regionally | 29. Regionally |
| 12. Regionally | 30. Exclusively within the USA |
| 13. Internationally | 31. Regionally |
| 14. Exclusively within the USA, Only within One (1) state, Regionally | 32. Exclusively within the USA |
| 15. Regionally | 33. Exclusively within the USA, Regionally |
| 16. Exclusively within the USA | 34. Only within One (1) state |
| 17. Exclusively within the USA | 35. Exclusively within the USA, Regionally |
| 18. North America (Canada, USA, Mexico) | 36. Exclusively within the USA, Regionally |
| | 37. Exclusively within the USA |

1a. States for sole business work:

14. Mississippi

34. California

25. Indiana

2. Has your company ever partnered with another to provide materials for creating/producing another finished product (e.g. the way tire brands partnering with tire shops to recover used tires for reselling in the playground padding industry)?

- | | | | | |
|-----------|---------|---------|---------|------------|
| 1. Yes | 9. No | 17. Yes | 25. No | 33. No |
| 2. No | 10. Yes | 18. Yes | 26. Yes | 34. Unsure |
| 3. No | 11. Yes | 19. No | 27. Yes | 35. Yes |
| 4. Yes | 12. Yes | 20. Yes | 28. Yes | 36. Unsure |
| 5. Yes | 13. Yes | 21. No | 29. Yes | 37. Yes |
| 6. Yes | 14. No | 22. No | 30. Yes | |
| 7. Unsure | 15. No | 23. Yes | 31. Yes | |
| 8. No | 16. Yes | 24. Yes | 32. Yes | |

3. Have you ever heard of the term 'Extended Producer Responsibility'?

- | | | | | |
|--------|---------|---------|---------|---------|
| 1. No | 9. No | 17. No | 25. No | 33. No |
| 2. No | 10. Yes | 18. No | 26. No | 34. Yes |
| 3. No | 11. Yes | 19. No | 27. No | 35. No |
| 4. No | 12. No | 20. No | 28. No | 36. No |
| 5. Yes | 13. No | 21. Yes | 29. No | 37. No |
| 6. No | 14. Yes | 22. Yes | 30. Yes | |
| 7. Yes | 15. No | 23. No | 31. Yes | |
| 8. No | 16. Yes | 24. No | 32. No | |

4. Extended Producer Responsibility (EPR)? 1 = heard of it, 5 = been involved/fully understand

- | | | | | |
|------|-------|-------|-------|-------|
| 1. 2 | 8. 2 | 15. 1 | 22. 2 | 29. 1 |
| 2. 1 | 9. 1 | 16. 3 | 23. 1 | 30. 3 |
| 3. 1 | 10. 2 | 17. 3 | 24. 1 | 31. 3 |
| 4. 1 | 11. 5 | 18. 1 | 25. 1 | 32. 1 |
| 5. 2 | 12. 1 | 19. 2 | 26. 2 | 33. 2 |
| 6. 1 | 13. 1 | 20. 1 | 27. 1 | 34. 2 |
| 7. 2 | 14. 1 | 21. 3 | 28. 1 | 35. 1 |

5. "As part of the EPA's new National Framework on recycling, they organize under the three strategic objectives of:

- Reduce contamination in the recycling stream
- Increase processing efficiency
- Improve markets

What role do you think the construction and demolition industry can play in achieving one or more of these objectives?"

1. If we use right means and method we can reduce contamination in the recycling stream
2. The primary impedence to recycling is the lack of markets for the materials recycled. Once the economics are in place the industry will create/ and invent methods to turn every present day cost item into a revenue item.
3. if the markets improve, efforts to increase processing efficiency and reduce C&D waste landfilled can be improved.
4. "A key role. We always seek to recycle demolition debris"
5. "We can reduce contamination in recycling by using smart recycling techniques. Find ways to reuse and recycle materials, making waste products into profitable usable products. "
6. Construction needs to remember that what they build today gets torn down in the future. Do away with the styrofoam insulation in cement blocks.The fake facade on stucco/styrofoam.The plastic under concrete.Use steel, copper ,aluminum and concrete instead of plastic and wood.
7. need to be seen as a leader, with full buy-in. This will help the general public find it legitimate.
8. Find more markets and profitable ways to re-use construction and demo debris
9. will depend on need to products produced
10. Industry knowledge is invaluable if a demo contractor's experience with salvaging materials is taken into account when evaluating some frequently overlooked opportunity costs of the recycling process. Their unique perspective is instrumental for an accurate cost-benefit analysis of recycling goals by shedding light on the feasibility of salvaging materials for reuse or recycling by taking the changes to their means & methods into account and assessing how they affect the project's budget, efficiency, and overall environmental impact. For example: increased pollution & waste from added time on equipment to preserve the integrity of reusable building materials or increased distance required to transport materials to recycling facilities, end reuse locations, or storage sites with the capability to market the materials for eventual reuse.
11. Demolition Contractor are the first contractors to utilize Green Practices and LEED, so we are very important

12. I believe responsible demolition contractors should take a proactive approach to achieve some level of participation in each objective. Recycling materials, reducing landfill disposal, and salvage resale are a few ways.
13. Processing applicable wastes at the demo site
14. I believe the demolition industry can play a large part in these. I have already seen our company try to reduce contamination because the benefit of providing clean, sized material is worth it with the pricing we receive.
15. Client needs to understand the costs
16. Enabling more diverse waste stream management, reducing commingling of "similar" recyclables to congruent recyclables, and the reduction of commingled "C+D" waste cans to congruent debris.
Unfortunately, this system decreases profitability due to low/no recycling value on non-metal recyclables i.e. drywall.
17. Not us. The manufacturers of the stuff we take down are the ones who need to be held accountable. As well as landfills being so picky about what they accept and jacking up rates
18. Demolition can play a roll in achieving all the above objectives.
19. Improve markets
20. take advantage of new technologies and machinery that help reduce contamination and increase efficiency in the recycling industry
21. Critical role in reducing contamination (carbon footprint) in the recycling stream.
22. By increasing recycling efforts. I think larger acceptance of recycled materials such as crushed concrete. A lot of owners do not want it used on their sites because of ambiguities in specifications on whether it is an acceptable material.
23. "Demolition is key in all areas. Contamination is expensive and so we try to minimize costs/expense so there is an incentive to reduce contamination. Demo companies do not generate an item and so efficiency is key in profitability. We work hard to improve markets - this allows us other avenues to manage generated materials or make sales or products included in our scopes of work"
24. A major role. Recycling and repurposing are crucial in the industry, especially when it comes to reducing contamination
25. demo companies can process materials on site into recyclable sections (metals / concrete & block / trash) to reduce the amount of material going into landfills.
26. All 3. Less influential with improving markets
27. With proper site separation we can assist with reducing contamination to various streams which in turn should improve the markets in which they apply.
28. The demolition industry is very experienced in recycling and effiecently removeing material. It's a matter of economics. Demolition contractors recycle to maximize profits.

29. A very positive role, in deed. All construction produces some form of waste stream, demolition produces the most. Its our duty as an environmental company to ensure proper disposal, recycling, reusing and reducing.
30. The demolition industry can have a direct effect on the reduction of contamination in the recycling stream due to the high quantity of recycled material that is generated during the demolition process. Contaminants such as asbestos, lead, PCB's, Mercury, oils, chemicals, gases and electronic waste can enter the recycling streams if proper work plans are not implemented during demolition. Safe and environmentally conscious work practices which remove contaminants prior to demolition greatly reduces the contamination of waste streams. Training and education of demolition workers and management raises awareness and compliance with environmental health and safety controls.
31. Source separating would be a place to start.
32. We take a large part in diverting waste from landfills. Building new construction with an end state in mind.
33. show me the money State plays tough everybody trucks across state lines
34. all of the above
35. I believe there is a tremendous avenue in the construction and demolition industry. Construction Waste is effectively playing it's part in making this happen.
36. IMPROVE ON EXISTING ENGINEERING CONTROLS AND DEVELOP NEW ONES
37. weighing in with equipment manufacturers on performance achieved in the field to aid in technology & equipment improvements

6. How easy do you believe it will be to meet the new National Recycling Goal by 2030?

- | | | |
|-------------------------------|--------------------------------|--------------------------------|
| 1. Neither easy nor difficult | 14. Somewhat difficult | 27. Somewhat difficult |
| 2. Neither easy nor difficult | 15. Extremely easy | 28. Somewhat easy |
| 3. Somewhat easy | 16. Somewhat easy | 29. Neither easy nor difficult |
| 4. Somewhat difficult | 17. Somewhat difficult | 30. Somewhat difficult |
| 5. Neither easy nor difficult | 18. Neither easy nor difficult | 31. Somewhat difficult |
| 6. Somewhat easy | 19. Somewhat easy | 32. Extremely easy |
| 7. Somewhat difficult | 20. Somewhat easy | 33. Somewhat difficult |
| 8. Somewhat difficult | 21. Somewhat difficult | 34. Somewhat difficult |
| 9. Extremely difficult | 22. Somewhat easy | 35. Neither easy nor difficult |
| 10. Somewhat difficult | 23. Somewhat easy | 36. Somewhat difficult |
| 11. Extremely easy | 24. Neither easy nor difficult | 37. Somewhat easy |
| 12. Somewhat easy | 25. Neither easy nor difficult | |
| 13. Somewhat difficult | 26. Somewhat easy | |

6a. Why do you think it will be difficult to meet the new National Recycling Goal? (Extremely Easy and Somewhat Easy answers skipped this follow-on question in the survey.)

1. Some of the state still has requirement that we cant use the recycle materials from demolition process in certain project
2. The overwhelming majority of demolition contractors are small family businesses. These companies cannot INVEST in the development of markets necessary to offset the costs to recover and recycled materials. Unless the government finances the government sponsors the CREATION OF MARKETABLE RECYCLED materials it will not develop.
3. -
4. Concrete debris when mixed with rebar can be costly to separate and process.
5. I don't think it is difficult. It depends how they are counting the 50% of recycling. In most demolition projects we achieve 85-98% of landfill diversion per weight. In this a big motivator will be the waste companies making the recycled products valuable. Incentivizing the owners and companies to use a more sustainable method.
6. -
7. shifting the mindset to accept this and find ways to make changes, profitably.
8. We need more end markets for stuff. way too expensive to reuse right now
9. The cost of recycling certain products and what portion of these costs can be recovered when sold. Also the need / requirements for these products vs new
10. There is a lack of feasible outlets for the recycled materials and also a need to improve the efficiency of the recycling processes themselves. For example: the need to transport carpet squares across the country to a recycling facility where over half of the material is rejected for its pile height.
11. -
12. -
13. Because it is voluntary and has no enforcement
14. I believe that the public as a whole does not see a benefit in recycling. One common refrain I hear is how the pollution associated with the recycling process does not make it worth it.
15. -
16. -
17. Because recycling is a feel good scam
18. I'm sure there are laws and or new expenses to reach these goals. Other than effecting the bottom line, it shouldn't be an issue...
19. -
20. -
21. Our society is generally focused on the cost of new in lieu of the longer, less expensive cost (tangibly and intangibly) of reuse and recycling.
22. -

23. -
24. A lot depends on the cost and getting funding. It's expensive to clean lead paint and things that are environmentally hazardous that would prevent things from being recycled easily
25. Many customers don't want to take the time to salvage materials from a structure prior to demo. They want the building down and out of the way yesterday. We are able to recycle metals and concrete easily but trash could be reduced if customers are willing to give us more time to remove salvageable items prior to demolition. It also takes a lot of room to store salvageable items for resale (doors, windows, cabinets, countertops, etc.) and can take a long time to find a buyer.
26. -
27. The majority of "waste reporting" seen boasts far higher percentages than what they actually achieve. To achieve 50% overall, it would require buy-in from everyone involved.
28. -
29. Convincing others of the importance. And even after convincing, ensuring they do it, especially if it cost more than not doing it.
30. Raising public awareness and promoting adherence will be a costly and prolonged affair. Many corporations already have shifted focus towards meeting this goal, but individuals outside of a professional setting are large contributors to non-recycled wastes. Increasing pedestrian compliance will require a combination of education, creating convenient means, and changing the choices of consumers. While this goal is not impossible, it will require strong commitment from all involved parties.
31. You need to have end markets available for the recyclables at a rate that turns a profit. Recycling needs a financial incentive in order to develop further.
32. -
33. Try this with a union shop labor cost \$100.00 per hour
34. somewhat
35. I believe the right channels are going to have to be in place. If we can find a way to stream line recycle facilities as we have with Landfills I think the difficult minimizes.
36. RECYCLING WASTE STREAMS CAN BE PROHIBITIVELY COSTLY AT THE CONSUMER LEVEL. SINGLE USE BOTTLES, FOOD CONTAINER WASTE, ETC. AT THE CONSTRUCTION AND DEMOLITION LEVEL THERE IS IMMEDIATE PROFITABILITY IN SEGREGATING WASTE STREAMS TO REDUCE TIPPING FEES AT LANDFILLS. ALL U.S. DEMOLITION COMPANIES RECYCLE SCRAP AND INERT WASTE TO REDUCE COSTS
37. -

7. Have you ever sold scrap in your personal life (e.g. aluminum cans, copper piping, etc.)?

- | | | | | |
|--------|---------|---------|---------|---------|
| 1. Yes | 9. Yes | 17. Yes | 25. Yes | 33. Yes |
| 2. Yes | 10. Yes | 18. Yes | 26. Yes | 34. No |
| 3. Yes | 11. No | 19. Yes | 27. Yes | 35. No |
| 4. Yes | 12. Yes | 20. No | 28. Yes | 36. Yes |
| 5. Yes | 13. No | 21. Yes | 29. Yes | 37. Yes |
| 6. No | 14. Yes | 22. Yes | 30. No | |
| 7. Yes | 15. Yes | 23. Yes | 31. Yes | |
| 8. Yes | 16. No | 24. No | 32. Yes | |

8. Does your company make or recoup money from reclaiming or scrapping materials?

- | | | | | |
|--------|---------|------------|---------|------------|
| 1. Yes | 9. Yes | 17. Yes | 25. Yes | 33. Yes |
| 2. Yes | 10. Yes | 18. Unsure | 26. Yes | 34. Unsure |
| 3. Yes | 11. Yes | 19. Yes | 27. Yes | 35. Yes |
| 4. Yes | 12. Yes | 20. Yes | 28. Yes | 36. Yes |
| 5. Yes | 13. No | 21. Yes | 29. Yes | 37. Yes |
| 6. Yes | 14. Yes | 22. Yes | 30. Yes | |
| 7. Yes | 15. Yes | 23. Yes | 31. Yes | |
| 8. Yes | 16. Yes | 24. Yes | 32. Yes | |

9. On an average demolition job, what percentage of materials are recycled before final disposal?

Percentages must total 100. - On-site Recycled, Off-site Recycled, Not Recycled

- | | | |
|----------------|----------------|----------------|
| 1. 5, 55, 40 | 14. 50, 10, 40 | 27. 30, 50, 20 |
| 2. 20, 30, 50 | 15. 40, 40, 20 | 28. 0, 90, 10 |
| 3. 10, 70, 20 | 16. 40, 30, 30 | 29. 50, 10, 40 |
| 4. 20, 20, 60 | 17. 5, 90, 5 | 30. 40, 50, 10 |
| 5. 70, 20, 10 | 18. 100, 0, 0 | 31. 0, 50, 50 |
| 6. 70, 25, 5 | 19. 5, 90, 5 | 32. 50, 20, 30 |
| 7. 20, 40, 40 | 20. 40, 40, 20 | 33. 10, 20, 70 |
| 8. 10, 50, 40 | 21. 2, 13, 85 | 34. 0, 100, 0 |
| 9. 60, 10, 30 | 22. 50, 40, 10 | 35. 90, 5, 5 |
| 10. 5, 35, 60 | 23. 20, 60, 20 | 36. 25, 60, 15 |
| 11. 30, 70, 0 | 24. 90, 8, 2 | 37. 20, 75, 5 |
| 12. 30, 50, 20 | 25. 10, 50, 40 | |
| 13. 15, 15, 70 | 26. 0, 72, 28 | |

10. Choose one or more races that you consider yourself to be: - Selected Choice

- | | |
|--|--|
| 1. Asian | 20. White or Caucasian/European American |
| 2. White or Caucasian/European American | 21. White or Caucasian/European American |
| 3. White or Caucasian/European American | 22. White or Caucasian/European American |
| 4. American Indian or Alaska Native | 23. White or Caucasian/European American |
| 5. White or Caucasian/European American | 24. White or Caucasian/European American |
| 6. White or Caucasian/European American | 25. White or Caucasian/European American |
| 7. White or Caucasian/European American | 26. White or Caucasian/European American |
| 8. White or Caucasian/European American | 27. White or Caucasian/European American |
| 9. White or Caucasian/European American | 28. White or Caucasian/European American |
| 10. White or Caucasian/European American | 29. White or Caucasian/European American |
| 11. White or Caucasian/European American | 30. White or Caucasian/European American |
| 12. White or Caucasian/European American | 31. White or Caucasian/European American |
| 13. White or Caucasian/European American | 32. Hispanic/Latin American |
| 14. White or Caucasian/European American | 33. White or Caucasian/European American |
| 15. White or Caucasian/European American | 34. White or Caucasian/European American, Hispanic/Latin American |
| 16. White or Caucasian/European American | 35. White or Caucasian/European American |
| 17. White or Caucasian/European American | 36. White or Caucasian/European American |
| 18. White or Caucasian/European American | 37. White or Caucasian/European American |
| 19. White or Caucasian/European American | |

11. Survey feedback/comments/questions for anything that were unclear, misspelled, or anything else to help the research. *Both Survey 1 and 2 combined.*

- | | |
|---|--|
| 1. While I am now somewhat retired, I answered the survey using my 50 years operating in the demolition industry. 1 company as an employee and 2 companies as founder / owner | 3. I would like to be apart of the board that helps to write some of these new regulations. My family has been in the demolition business since 1956 and we own/operate 2 C/D landfills, crushing plants and a transfer facility in Ohio. Run my name past Mr. [REDACTED], I believe he has taught at your university. [REDACTED] (identifying names redacted) |
| 2. It would help to have discussion of this topic at NDA events. We contractors get too little credit for the recycling and reuse that we do, from government officials who decline to listen and who want to write policies without considering all of the potential solutions we could find together to make our industry more sustainable. | 4. Most if not all companies will not switch to more sustainable/economical means until prices go down on electric equipment and zero-sort recycling facilities. Currently there is no incentive to spend more money |

internally if the profit margins remain the same. Outside forces, like regulations or incentive-based emissions/recycling targets will be the only major drivers that affect the companies standpoint on sustainability and emissions reductions.

5. "Order of how often you recycle in personal like - sliding scale should have had sometimes in the middle and most of the time before always. The order made it seem like sometimes had a higher quantitative value than most of the time.
6. Also, wasn't sure if annual income was supposed to be just mine or household, so just did mine. "
7. Sustainability is an economically unsustainable concept that increases costs to the consumer without any tangible or real reduction in overall pollution. Any time the cost of living goes up greater economic activity is required which requires increased energy consumption. Unless sustainability can dramatically decrease costs to the average consumer it's a self defeating concept.
8. Your personal questions seem intrusive and N/A
9. Maybe nclude some literature at the end, via links maybe, that we can access information on aforementioned sustainability practices. EPA's 50 by 30, circular economy and the

one mentioned at the beginning.. (case in point here, I can't even look it up on my own accord since I do not remember it).

10. Recycling operations ans sustainable products would have a much greater chance of survival if government would restrict or eliminate the lobbyist from interfering with laws and regulations. Large landfill operators have sabotaged the recycling efforts of small operations rendering the recycling effort fruitless. Our environment suffers and our natural resources are diminished due to their corporate greed.
11. While this may help in some manner for which you are trying to work toward a more direct approach of questions should be considered one being very simply the bottom line. At the end of the day, how much is the question. How much will it cost, how much time will it take, how much profit can I make. We are all competitors and nothing is handed to companies, we need to be low to win (Most of the time) so we cannot afford to take a higher cost but only do what we are allowed to. Any other means we will not win the work. No work, no pay, no pay, no company. Please take the time to do personal interviews and it will provide great insite.
12. ██████ responded (identifying names redacted)

APPENDIX C. INTERVIEW QUESTIONS

For the interviews conducted on the county emergency management personnel, the following semi-structured set of questions were asked to each participant:

1. What is your official title?
2. How long have you worked at (_____insert specific county management office)?
3. What work did you do prior to this position that helped you get to where you are now?
4. Do you have recycling in your neighborhood? If no, why?
5. Do you participate in recycling at work? If no, why?
6. What do you know about the term circular economy?
7. If a contractor is seeking a tipping waiver for debris cleanup, how do they get a waiver from your county?
8. What do you think about the cross-coordination of your organization in cleanup response?
9. What programs do you use regularly for resource and situational awareness supporting?
10. How do you prioritize a cleanup's priorities beyond safety and speed?
11. How do you think a sustainable debris management program looks like?

In each case, the over-the-phone interviews were restricted to an average of 29 minutes with the longest taking 46 and the shortest lasting for 20 minutes.

APPENDIX D. NDA RESULTS BRIEF

The following brief was delivered by the author to the Industrial Committee of the National Demolition Association (NDA) on 16 April 2021:

Opportunities from Disaster: The Case for Using the Circular Economy in Debris Management

Survey Insights

An Update to the National Demolition Association (NDA) Industry Committee

By: Toy Andrews

Co-Advisors: Prof. Randy Rapp & Prof. Emad Elwakil

Committee: Prof. Eric Dietz & Prof. Sam Baroudi

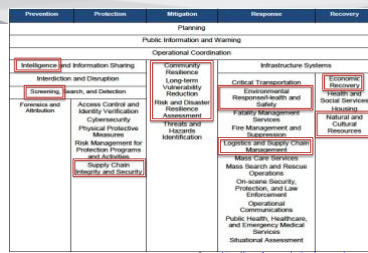
School of Construction Management Technology

April 16, 2021

PURDUE
POLYTECHNIC

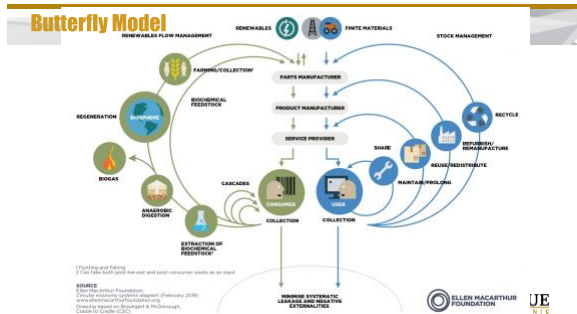
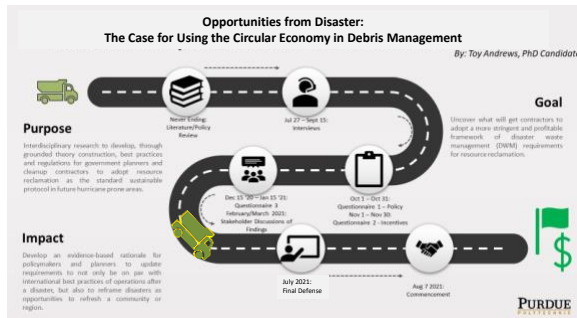
STUDY FRAMEWORK

1. Interviews with county planners
2. Interviews with successful business models
3. Two rounds of survey for contractors
4. Survey results to practitioners
5. Proposed new business models and planning policies



Opportunities

PURDUE
POLYTECHNIC



Slides 1-4

SWOT - Strengths



STRENGTHS

89 Overall Participants

Across multiple levels of Small-to-Medium Enterprises with most, 31, of 50 states, represented in the respondents. 52 for Survey 1, 37 for Survey 2.

Optimism for the Future

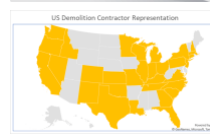
86.5% of respondents recycle in their personal lives.

Familiar with the Concept in Practice

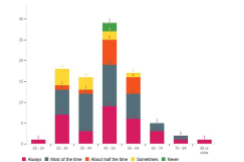
Creating for additional income is a goal for the mid- and part of the operational concept for demolition materials recovery.

PURDUE
POLYTECHNIC

Strengths Graphics

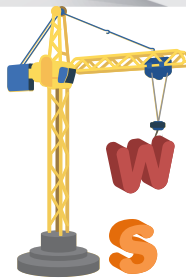


Personal Life Recycling



PURDUE
POLYTECHNIC

SWOT - Weaknesses



WEAKNESSES

Doubt

Those surveyed wanted to make sure the playing field was fair and uniform across the board. Continuity of policy following the global trends was indicated in the free text fields. Top 3 concerns shown.

Unrealized Potential

Partnerships with a secondary market use, such as a concrete recycling unit or soil amending material, were absent or still over 50% of those surveyed. Some of this lacking can be conjectured to be because of a lack of those secondary markets to begin with and those that have a contact, they are limited in their scope as well.

Lack of Diversity

Based on survey results, around 90% of all respondents are white and over 80% are male.

PURDUE
POLYTECHNIC

Weaknesses Graphics

Obstacles Not Rank

practice
safety
competition

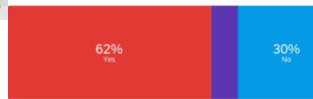
79

9

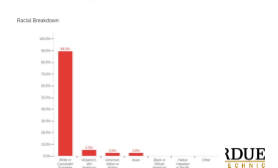
Public Safety

7 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

Secondary Market Partner

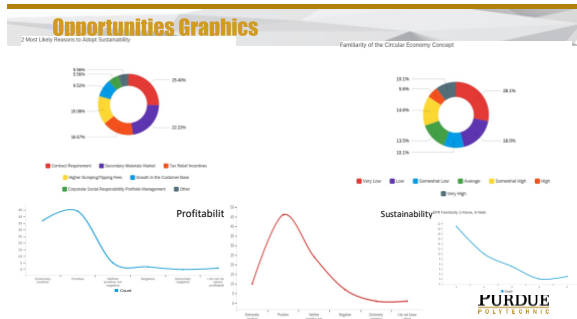


Racial Breakdown

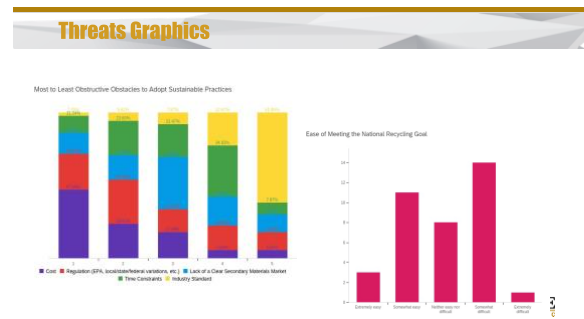


PURDUE
POLYTECHNIC

Slides 5-8



Slides 9-11



Slides 12-14

Industrial Committee Presentation Notes

Slide 1:

Request to record for personal and professional records and my absent co-advisor, Dr.

Emad Elwakil and for the rest of my committee not on the call today.

Intro

Professor of Restoration and Reconstruction, Primary Academic Advisor

Slide 2:

When looking at the National Preparedness Goals set out by the US Government through the lens of the disaster operations cycle, opportunities exist throughout the framework for

businesses and local governments/municipalities to seize the initiative and capitalize on the ways to get more out of the resources they currently have and can retrieve.

My research has been primarily concerned with the Response and Recovery parts of the national preparedness goals framework, as seen in the figure. As with most complex operations, there is no single source influence when it comes to response and recovery. Some of the forms to success throughout the disaster operations cycle are cast in the Prevention, Protection, and Mitigation phases too.

(After reading, CLICK mouse) The framed areas on the screen indicate where and how parts of this research highlights these preparedness goals within this continuum of disaster operations. These opportunities bubble up for businesses that deal in C&D debris operations, but also as part of a whole-of-community aspect in preparations, response, and a more sustainable model of operations.

Slide 3:

There is growing research of how the circular economy (CE) is gaining traction in applications for resource supply professionals everywhere in multiple sectors of the economy, so application in the DWM arena is a logical step in the right direction.

The PURPOSE of this study is to uncover the barriers to and profitability from implementing a sustainable disaster waste management enterprise.

The study's focus is on the subset of debris cleanup contractors (or potential ones) and analyzing their responses to both current situations and hypothetical methods to make more business opportunities, profits, and environmental sustainability.

Through NDA's access to the demolition field, the study can directly influence the business plans of the companies within the association. The results are summarized in the following slides using the (Strengths, Weaknesses, Opportunities, and Threats (SWOT) strategic analysis model. My intention is to share with the respondents and greater Association membership, these insights into the hesitancy, eagerness, and overall feelings of the growing industry trend presented in the surveys. Over the course of the study, many factors and best practices were gathered and will be included in the final report this summer.

Toy's research is looking at the following two questions:

1. What incentives are going to drive cleanup contractors to adopt sustainable resource reclamation practices?
2. Second, if presented with options the Association can champion, what is necessary to facilitate a speedier and more sustainable protocol?

NDA's role:

- Survey Facilitation: Through the network of demolition experts in the construction industry, surveys to those most sought out by state, county, and local governments for contract work for clean-up, the study can gain the critical insights to their motivations for business success, policies that are counter to making those profits, and appetite for making suggested changes in the business models.
- Survey Support: People tend to only do surveys if there's an incentive. NDA's funds would allow for a small (~\$20 each) reward for completing the survey. Total was under \$700.
- Results Championing: The outputs of this study are intended to find further business opportunities for those within the NDA and can lead to a branching out opportunity for all of the representative businesses for hazard pre-identification and rapid response.

Slide 4:

Committee, you've either been exposed to this or have been part of this cycle throughout your career in the C&D industry.

The cycle's right wing of the 'butterfly' show what industrial ecologist and authors of Cradle-to-Cradle call, "Industrial Nutrients". The Ellen MacArthur Foundation out of the UK further codified this notion into the Butterfly model you see before you.

Starting at the top, that's where items come into the system. That's the finite items of trees, cement, metal ores, etc.. The following steps in that column are where those raw materials are turned into items useful to builders and product manufacturers such as, following the same theme, lumber, concrete, and steel beams, etc. From there, the product that then goes into full assembly, the trusses, foundations, and steel—framed commercial walls, and then construction can begin with the USER...the builders.

As a demolition business, you perform the function as, what the model shows in the top right, of Stock Management.

Within the 4 loops back to the materials flow backbone, you're already familiar with the sharing concept when it comes to your leased heavy-machinery and how you may sub-contract out a function to another company for efficiency.

In the next outer loop, your businesses are already familiar with the maintenance and prolonging of either equipment or as part of a renovation to a building to get more service life out of it.

The next two loops are the most related to you in the Demolition and debris management fields. Redistribution and Recycling are how everything stays out of the landfills and back into the materials stream.

Slide 5:

Survey 1 was preliminary and common to both surveys. Survey 2 dealt more with the policy implications of the upcoming changes in EPA and other trends of the materials markets.

89 participants – Most of the states are represented with multiple multiples.

Optimism – The point of the next graph is to show that only 2 out of the 89 are stubbornly not recycling while over 97% are at least dialed into the concept at home, even if not habitually.

Familiarity – Scrapping is already a major part of approx. 92% of respondents' operations and to not continue that trend would be negligence.

Slide 6:

Graphics of Strengths

Slide 7:

Doubt – As part of the survey, I asked what, outside of those in the normal list of survey questions, is heaviest on their minds and the 3 most repeated amongst the 89 was this.

Unrealized – 38% of those surveyed are not taking part in the market at all. Even if that 8% that's unsure is yes, why is it that 1/3 of businesses are missing out on revenue?

Diversity – 79 male, 9 female, 1 Prefer not. 79 of those surveyed were white, 5 were Hispanic or Latin American, and 2 of each American Indian or Asian. 0% black or others.

Slide 8:

Graphics of Weaknesses

Slide 9:

Explanation of the CE Growth potential within the demolition industry.

Reasons to adopt a more sustainable business model in normal operations.

Trend lines discussion on sustainability, profitability, and extended producer responsibility concepts.

Slide 10:

Opportunities Graphics

Slide 11:

Explanation of threats, as perceived by the respondents, where NDA has the greatest influence for education, advocacy, and outright lobbying for demanding these standards being adopted industry-wide.

Discussion on respondents' hesitance in adopting the new National Recycling Goal and how to overcome the cultural inertia to taking business risks.

Also, quickly discuss latest NDA and US government policy recommendations on new infrastructure plans and how to address and better frame the new guidelines as business potential windfalls.

Slide 12:

Threats Graphics

Slide 13:

C40 - a network of the world's megacities committed to addressing climate change. C40 supports cities to collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change. Started at 40, now around 97.

Sendai – 7 Global Targets by 2030

The Sendai Framework focuses on the adoption of measures which address the three dimensions of disaster risk (exposure to hazards, vulnerability and capacity, and hazard's characteristics) in order to prevent the creation of new risk, reduce existing risk and increase resilience.

Point out learning resources for both NDA management, but to disperse amongst NDA members.

Slide 14:

End of presentation, biography, and questions slide.

APPENDIX E. INSTITUTIONAL REVIEW BOARD APPROVALS

Table E1. IRB Study Submission Log

| IRB # | Submission | Status | Type | PI | Decision | Date Decided | Date Created |
|--------------|---------------------------|-----------------|------------|------------|----------|--------------|--------------|
| IRB-2020-761 | Initial ¹ | Review Complete | Exempt | Randy Rapp | Exempt | 06 JUL 2020 | 12 MAY 2020 |
| IRB-2020-761 | Modification ² | Review Complete | Exempt | Randy Rapp | Approved | 23 JUL 2020 | 17 JUL 2020 |
| IRB-2020-761 | Modification ³ | Review Complete | Exempt | Randy Rapp | Exempt | 16 OCT 2020 | 16 OCT 2020 |
| IRB-2020-761 | Modification ⁴ | Review Complete | Exempt | Randy Rapp | Exempt | 15 DEC 2020 | 14 DEC 2020 |
| IRB-2020-761 | Modification ⁵ | Review Complete | Exempt | Randy Rapp | Exempt | 22 FEB 2021 | 14 FEB 2021 |
| IRB-2020-761 | Closure ⁶ | Review Complete | Unassigned | Randy Rapp | Closed | 26 APR 2021 | 25 APR 2021 |

Note 1: Delay between initial request creation and decision involved qualification recording anomalies within Purdue IRB system.

Note 2: Modified after the researcher made multiple attempts to contact FEMA representatives and was recommended to pursue local/county level emergency managers instead.

Note 3: Modified to declare rounds of surveys being administered to demolition contractors.

Note 4: Modified to declare changes in the participants' compensation amount of \$5 to \$20.

Note 5: Modified to declare data collection was completed and beginning analysis.

Note 6: Closed after all analysis and follow-up contacts completed.

APPENDIX F. COPYRIGHT ACKNOWLEDGEMENT

Copyright permission to use the “Butterfly Diagram” © by the Ellen MacArthur Foundation.

COPYRIGHT PERMISSION AGREEMENT

This agreement is entered between:

| | |
|------------------------|--|
| LICENSOR | Ellen MacArthur Foundation of The Sail Loft, 42 Medina Road, Cowes, Isle of Wight, PO31 7BX (a registered charity) |
| LICENSEE | Toy Andrews of 1190 Voyager Way, Lafayette, IN 47909, United States of America |
| EFFECTIVE DATE: | 8 December 2020 |

BACKGROUND

- (A) The Licensor owns and/or has the right use the Work and all IPR in the Work.
- (B) The Licensee wishes to receive and the Licensor is willing to grant to the Licensee a licence on the terms set out in this agreement to use the Licensed Material.

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| | |
|--------------------------|---|
| WORK | The infographic set out in the Appendix |
| LICENSED MATERIAL | The Work and the IPR in the Work. IPR is defined in this agreement as 'intellectual property rights anywhere in the world, including any copyright, design rights, database rights, rights in data and any other rights of a similar nature whether or not any of the same are registered, and the right to apply for any of them, subsisting in and to the Work to which the Licensor is or may become entitled'. |
| RESOURCES | A dissertation on sustainable disaster waste management by the Licensee as PhD candidate in Construction Management Technology at Purdue Polytechnic Institute, and in a final presentation on the dissertation. |
| LICENCE PERIOD | Perpetual |

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- 1.1 Subject to the Licensee's compliance with the conditions in clause 3 below, the Licensor hereby grants to the Licensee a non-exclusive, non-sublicensable, royalty-free licence to use the Licensed Material in the Resource for the Licence Period on the terms of this agreement. Other than this limited licence, the Licensee agrees that it shall not otherwise receive or acquire any title to or other interest in the Licensed Material.



APPENDIX G. RELATED CERTIFICATIONS

Lucerne University of
Applied Sciences and Arts

**HOCHSCHULE
LUZERN**

Engineering and Architecture

CERTIFICATE

For successful participation in
the Summer Academy, 2019
„Sustainability and Mobility / Design Thinking“
8 - 19th July

Toy Andrews

Head of International Relations



Prof Uwe W Schulz, PhD

Lucerne University of
Applied Sciences and Arts
**HOCHSCHULE
LUZERN**
Engineering and Architecture



PURDUE
UNIVERSITY



T
DUBLIN
TECHNOLOGICAL
UNIVERSITY DUBLIN

Coventry
University

Verified
Certificate



This is to certify that

Toy Andrews

successfully completed and received a passing grade in

CircularX: Circular Economy - an Introduction

a course of study offered by DelftX, an online learning initiative of Delft University of Technology.

A handwritten signature in black ink, appearing to read "Conny Bakker".

Conny Bakker

Associate Professor
Design for Sustainability / Circular Product Design
Faculty of Industrial Design Engineering
Delft University of Technology



Verified Certificate
Issued September 7, 2020

Valid Certificate ID
[47d510751c8f4abbb0d66ed883454287](#)

Verified Certificate



This is to certify that

Toy Andrews

successfully completed and received a passing grade in

SWM2001x: Solid Waste Management

a course of study offered by WBGx, an online learning initiative of World Bank.

SIMEON DJANKOV

DIRECTOR
DEVELOPMENT ECONOMICS

WORLD BANK GROUP



Verified Certificate
Issued February 12, 2021

Valid Certificate ID
[a5e0802cf15a4b3eafe8cd36e88d0bf9](#)

VITA

Toy Andrews

Graduate School, Purdue University

Purdue Polytechnic Institute

Education

B.A., English Literature, 2005, University of Mississippi, Oxford, Mississippi

M.S.H.S., Emergency and Disaster Management, 2012, Trident University, Cypress, California

Ph.D., Technology, 2021, Purdue University, West Lafayette, Indiana

Toy Andrews began his Naval career in 2005 commissioning at the University of Mississippi at Oxford, MS with his Bachelor of Arts degree in English Literature. His shipboard assignments have included division officer tours as the First Lieutenant and Damage Control Assistant on USS MOMSEN (DDG 92), department head officer tours as Operations Officer on USS BARRY (DDG 52) and as the First Lieutenant on USS WASP (LHD 1). Ashore, he was assigned to Base Command Group in Al Asad, Iraq as the Requirements Officer and where he first began researching sustainable recovery. His follow-on assignment was at Afloat Training Group in Norfolk, VA as a Training Liaison Officer where he earned on his Master of Science in Health Sciences for Emergency and Disaster Management from Trident University at Cypress, CA. After his department head tours afloat, he served at Naval Forces Central Command in Bahrain as the Ballistic Missile Defense Plans Officer and completed his Level One joint professional military education. Selected to the Purdue Military Research Initiative and began work on the intersectionality of disaster response and sustainability.

Research Interests

Disaster recovery management

Economics of disaster recovery

Social capital in disaster management

Intersectionality of disasters to sustainable economy

Circular Economy applications

PUBLICATIONS

The Military Engineer (TME) Sep-Oct 2020 Issue

ASSET MANAGEMENT 



Staff Sgt. Patrick Leach, USAF, an aircraft fuels systems craftsman with the 100th Maintenance Squadron, uses a 3D printed Pressurized Leak Detection Cup that he designed and which can potentially save the base more than \$1 million annually. U.S. AIR FORCE PHOTO BY AIRMAN 1ST CLASS JOSEPH BARRON

Sourcing Materials for Additive Manufacturing

As military supply chains increase their network of options to respond to challenges, by leveraging partnerships with local communities, feedstocks of ready-to-use materials for additive manufacturing can be put to use in normal and emergency operations.

By Lt. Cdr. Toy Andrews, M.SAME, USN, Randy Rapp, Ph.D., P.E., Emad Elwakil, Ph.D., P.E., PMP, J. Eric Dietz, Ph.D., P.E., and Sam Baroudi, Ph.D.

On March 11, 2020, the novel coronavirus, COVID-19, was declared a global pandemic by the World Health Organization. The United States announced a national

emergency two days later, setting in motion response efforts to contain the outbreak. Logisticians around the military, especially those supporting medical facility resupply and normal base operations, found many of their normal suppliers shut down or on limited operations in an effort to slow the spread of the virus. Now months later, as bases around the country have restarted limited normal operations, this is the opportune time to develop solid waste management partnerships with installation neighbors to strengthen resource resilience against any future disruption while bringing forth an overall higher level of readiness.

Additive manufacturing, as known as 3D printing, is a rapidly advancing technology that is already being implemented across each service branch to get mission-critical parts into use faster and at exacting specifications. However, while this technology allows for rapid production, it still requires the relative slower procurement of feedstock, or the materials for the machines to “print.”

The Military Engineer • No. 729



ABOUT

MEMBERSHIP

INDUSTRY RESOURCES



STORE

SEARCH

EDUCATION & EVENTS

ADVOCACY

NEWS & MEDIA

Opportunities from Disaster. The Case Using the Circular Economy in Debris Management

NDA News

On: April 20, 2021 | By:

[Surveyed Results - View survey and study overview in the document linked below.](#)

During the Fall of 2020, surveys were sent out in two waves to members of the National Demolition Association (NDA) through Purdue Polytechnic Institute's School of Construction Management Technology with 89 total respondents providing insight to the industry. One of the primary goals of the research was to link the demolition community's attitudes towards and willingness to adopting more sustainable practices in their debris cleanup operations. Since emergency managers seek out demolition and cleanup specialists to clear-out debris after a disaster, the researcher merged these attitudes and business-as-usual models, to the responses and were analyzed using the Strengths, Weaknesses, Opportunities, and Threats (SWOT) strategic planning tool to see where their roles and expertise can grow the business and bolster a community or region's resiliency.

Regarding Strengths, nearly 87% of those surveyed indicated they are already recycling in their personal lives. Another positive indicator was the nearly 92% of responses that said their businesses currently use salvaging as a means of company revenues. The ideas are not new or foreign to the respondents and by making those connections, the findings point toward an upward trend of embracing sustainability, even if not fully altruistically, but in a purely economic matter of business. On the other hand, the Weaknesses analyzed from the surveys indicated concerns of the 'trendiness' of the concepts by not being practical, safe, or fair across the industry. Additionally, there's almost 40% of waste handlers in the demolition industry that are not working with either another industrial or secondary market partner take handle or treat the debris coming off of sites. Lastly, while those surveyed may not directly reflect the demographic breakdowns of the NDA membership by race, gender, or age, but the over-representation of one group over another creates a distinct disadvantage in a fast-growing and evolving market like that of the circular economy.

Construction & Demolition Recycling – Online Article – April 21, 2021



Demo industry shares thoughts on sustainability and debris management practices

Professionals cited contract requirements, materials markets and tax incentives as what would promote better debris management practices.

April 21, 2021



Posted by Adam Reding



Demolition

Purdue Polytechnic Institute's School of Construction Management Technology sent surveys out to members of the National Demolition Association (NDA) during fall 2020. In all, the survey generated 89 total respondents.

One of the primary goals of the research was to assess the demolition community's attitudes and willingness to adopt more sustainable practices in their debris cleanup operations. This is especially pertinent since emergency managers seek out demolition and cleanup specialists to clear out debris after a disaster. Purdue Polytechnic Institute's researcher analyzed this community's responses using what is known as a strengths, weaknesses, opportunities and threats (SWOT) strategic planning tool to see where the industry can improve its sustainability in debris management to help bolster a community's or region's resiliency.

Regarding strengths found in the survey, nearly 87 percent of those surveyed indicated they are already recycling in their personal lives. Another positive indicator was the nearly 92 percent of respondents who said their businesses currently use salvaging materials for recycling as a means of company revenues. The idea of sustainability, therefore, is not new or foreign to the respondents. According to the researcher, these findings point toward an upward trend of embracing sustainability "even if not fully altruistically, but in a purely economic matter of business."

On the other hand, the weaknesses analyzed from the surveys indicated concerns of the "trendiness" of sustainability concepts and these practices not being practical, safe or fair across the industry. Additionally, the survey found that almost 40 percent of waste handlers in the demolition industry are not working with either another industrial or secondary market partner to handle or treat the debris coming off of sites.

As part of the opportunities analysis, more than half of those surveyed (54 percent) said they have a basic grasp of the idea and concepts embodied by the circular economy. When asked about what would drive them to adopt greater sustainability practices, the respondents said that contract requirements, secondary materials markets, and tax relief incentives, in that order, would be the most persuasive in forming their business decisions to move in that direction.

In terms of the threats, surveyed members echoed some of the same issues in the opportunities analysis on what needs to change regarding the hurdles to sustainable materials management. However, some of these threats can easily be refocused into opportunities, especially if new local, federal and international standards regarding debris management are embraced, the researcher found.

Toy Andrews is a doctorate candidate at Purdue Polytechnic Institute's School of Construction Management Technology. He can be reached at andrew93@purdue.edu.