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PennState College of Engineering ARCHITECTURAL ENGINEERING

End-user-oriented information:

Requirement identification for building material reuse and recycle

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Problem

Construction & demolition waste (C&DW) attributes to 600 million tons in landfills annually. Most C&DW does not break down naturally. In addition, building material shortage is high in the United States due to the high demand for new residential buildings causing delays in construction and affecting end-users. Currently, there is no consolidated location that allows for analyzing building material stock by end-users with information data that can be used to judge waste material status in the United States.

Objective

This research seeks to create a platform that uses BIM and GIS programming to find and create routes for the recycling or reuse of construction and demolition waste by identifying data requirements for building material reuse and recycling based on content analysis.

Policy

Currently, policy dictating the recycling or reuse of C&DW is inconclusive according to the Department of Environmental Protection (DEP) in Pennsylvania and the Environmental Protection Agency (EPA).

Entity Classification

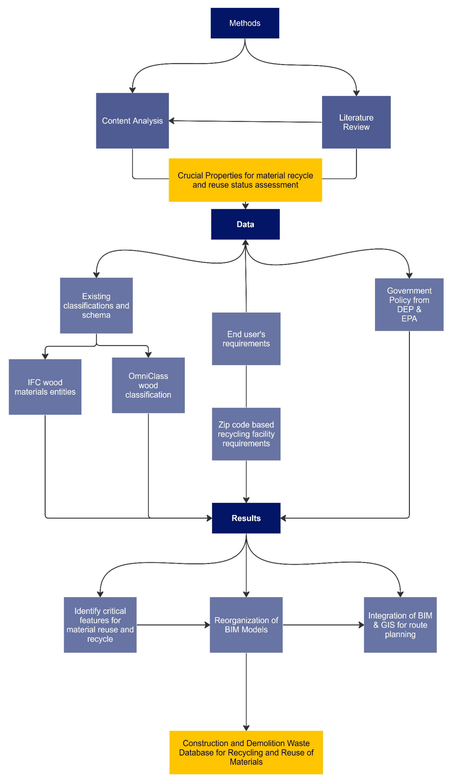
Diversity in construction materials during research lead to the focus on one material. The emphasis in this research is wood. Using building specifications from Industry Foundation Class (IFC) and OmniClass classifications, there will be the creation of a checklist based on specific properties as required by end-users across the state of Pennsylvania.

Roof type:		Flat	Pitched
Siding type:	Brick	1 (little)	2
	Wood	1 (little)	2
	Stone	1 (little)	2
	Vinyl/Synthetic	1 (little)	2
	Aluminum	1 (little)	2
	Other: _____	1 (little)	2
Wood flooring *(number of rooms)* :		1	2

Number of stories:	1	1 ½
Number of bedrooms:	1	2
Number of bathrooms:	1	2

Figure 1- Portion of the classification checklist; wood-based areas

Methodology Framework



This framework was used to determine the needs and attributes of various types of wood to compile a list of whether it is acceptable for recycling. Steps include:

- Content analysis for identifying properties of the chosen material (wood)
- Reviewing government policies and end-user company requirements
- Using classifications from OmniClass and IFC

Leading to

- Identification of essential features of wood
- Restructuring BIM modeling
- Planning material routes based on BIM & GIS

Figure 2- QR Code for research website

Results

NAICS_Code	Infra_Type	Materials	Accept Requirement Description	Non-Accept Requirement Description	City	State
562920	Wood Recycling Facility	Wood	timber 2. Untreated/unpainted wood 3. Wood pallets 4. Yard trim/brush 5. Tree stumps no larger than 24" in diameter 6. Empty cable spools	1. No stained, painted or treated wood 2. No railroad ties 3. No landscape ties 4. No furniture	Bellefonte	PA
562920	Wood Recycling Facility	Wood	1. Wood furniture 2. Flooring 3. Masonary and wood materials	1. Broken/ripped appliances and item	York	PA
562920	Wood Recycling Facility	Wood	1. dimensional lumber at least 6' in length (unless it is hardwood) 2. sheet goods of wood, plexi, sintra, etc. (half sheets or larger) 3. molding/trim 4. architectural accents/ elements 5. decorative windows and hardwood doors in good condition (no hollow core)	1. ANY wood with nails, screws, paint, warping, signs of rot or water damage 2. standard dimensional lumber less than 6' 3. sheet goods less than half sheet 4. pressure treated lumbers 5. MDF (Medium-density fibreboard) or chipboard	Allegheny	PA

Figure 3.1- End-user requirements table by location

Accept Requirement Description	Non-Accept Requirement Description
1.dimensional lumber at least 6' in length (unless it is hardwood)	1.ANY wood with nails, screws, paint, warping, signs of rot or water damage
2.sheet goods of wood, plexi, sintra, etc. (half sheets or larger)	2.standard dimensional lumber less than 6'
3.molding/trim	3.sheet goods less than half sheet
4.architectural accents/ elements	4.pressure treated lumbers
5.decorative windows and hardwood doors in good condition (no hollow core)	5.MDF (Medium-density fibreboard) or chipboard
	6.hardwood

Figure 3.2- End-user requirements accepted material stipulations

PredefinedType	Name	Name	Type	Description
	Pset_MaterialCombustion	Species	P_SINGLEVALUE / IfcLabel	EN Species Wood species of a solid wood or laminated wood product.
	Pset_MaterialCommon	StrengthGrade	P_SINGLEVALUE / IfcLabel	EN Strength Grade Grade with respect to mechanical strength and stiffness.
Concrete	Pset_MaterialConcrete	AppearanceGrade	P_SINGLEVALUE / IfcLabel	EN Appearance Grade Grade with respect to visual quality.
	Pset_MaterialEnergy	Layup	P_SINGLEVALUE / IfcLabel	EN Layup Configuration of the lamination.
	Pset_MaterialFuel	Layers	P_SINGLEVALUE / IfcInteger	EN Layers Number of layers.
	Pset_MaterialHygroscopic	Plies	P_SINGLEVALUE / IfcInteger	EN Plies Number of plies.
	Pset_MaterialMechanical	MoistureContent	P_SINGLEVALUE / IfcPositiveRatioMeasure	EN Moisture Content Total weight of moisture relative to oven-dried weight of the wood.
	Pset_MaterialOptical	DimensionalChangeCoefficient	P_SINGLEVALUE / IfcPositiveRatioMeasure	EN Dimensional Change Coefficient Weighted dimensional change coefficient, relative to 1% change in moisture content.
Steel	Pset_MaterialSteel	ThicknessSwelling	P_SINGLEVALUE / IfcPositiveRatioMeasure	EN Thickness Swelling Swelling ratio relative to board depth.
	Pset_MaterialThermal			
	Pset_MaterialWater			
Wood	Pset_MaterialWood			
Wood	Pset_MaterialWoodBasedBeam			
Wood	Pset_MaterialWoodBasedPanel			

Table 683 — IfcMaterial Property Sets for Obje

Figure 4- IFC Material Entity: table with wood-based construction characteristics based on identified requirements

Data summary

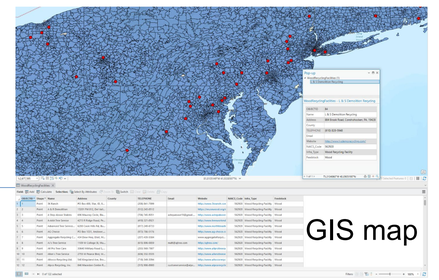


Figure 5- GIS Map of data summary table: locations of end-users in Pennsylvania based on location

Findings & Future Work

Location information collected on Pennsylvania state end-users and their requirements led to the creation of a GIS map. The methodology used to create this table can be repeated for other locations and materials from nationwide construction and demolition waste sites.

Next steps:

- Continue to complete the material judging information needs for end-users
- Refine programming inputs for more precise GIS map creation
- Utilize the program to create a platform of end-user requirements for building materials reuse and recycle

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