UBC RENOVATION PROJECT WASTE MANAGEMENT

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UBC RENOVATION PROJECT WASTE MANAGEMENT

UBC RENOVATION PROJECTS CONSTRUCTION & DEMOLITION WASTE PRACTICES

By Kirin Ren | a SEEDS project | October 14, 2013

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EXECUTIVE SUMMARY

I. Project rationale

In support of UBC's Zero Waste Action Plan, to decrease C&D waste disposal and increase waste diversion for projects that fall outside of LEED and REAP green building systems, this project is implemented by two UBC master students from architecture and civil engineering department respectively. It intended to provide practical waste management methods for UBC authorities.

II. Methodology

This article focuses on over ten literature reviews and it also incorporates the interviews with UBC renovation projects contractors. By taking advantage of the conclusions from articles all over the world, and integrating the real situation on UBC campus, the waste management plans are presented and proposed accordingly.

III. Key findings

As the client of the UBC renovation projects, UBC authorities can establish dedicated requirements to guide and monitor the waste management process.

IV. Recommendations

1. The elaborate design for deconstruction and utilization of pre-fabricated construction materials will REDUCE the potential waste remarkably.

2. REUSE every materials before they become "waste".

3. The RECYCLE plan should be attached initially with the project contract, and the source-separated means should be encouraged.

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Table of Contents

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Part I: Construction and Demolition (C&D) Waste Management Literature Review

1. SOURCE OF RENOVATION PROJECT WASTE

During the Renovation projects implementation, the waste can be generated from both the demolition of existing building, and construction of the new parts of the building. (Figure 1. Renovation Projects Waste Generation)

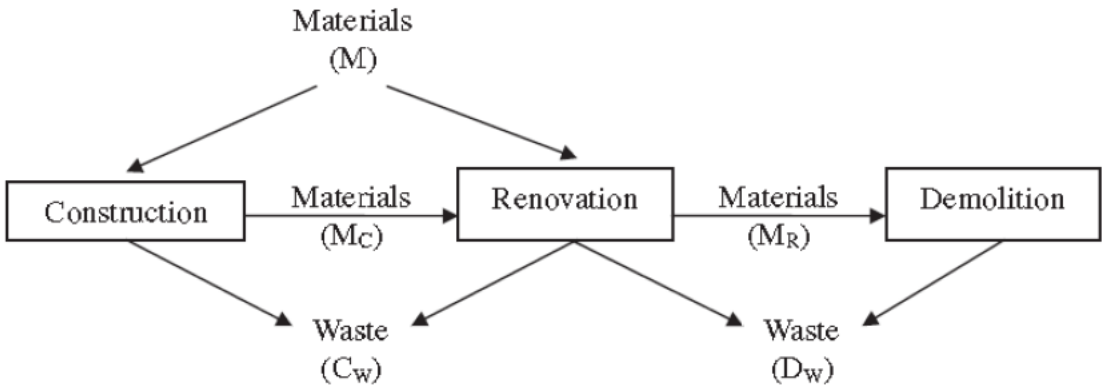

Figure 1. Renovation Projects Waste Generation[1]

2. CATEGORIES OF C&D WASTE.

a. Inert waste.

It comprises mainly sand, drywall, bricks and concrete. It can be reused or landfilled safely, which requires relatively low waste treatment fees.

b. Non-inert waste.

It is consisted of materials such as bamboo, plastics, glass, wood, paper, vegetation and other organic materials. It needs to be sorted again and treated separately, which requires relatively high treatment fees and time consuming procedures.

[1] K.M. Cochran, T.G. Townsend, "Estimating construction and demolition debris generation using a materials flow analysis approach", "Waste Management 30 (2010) 2247–2254", page 2

For renovation projects, the non-inert waste occupies a larger portion than other types of projects, which adds the difficulties to sort and divert it (Figure 2, Percentage of inert and non-inert material in C&D waste).

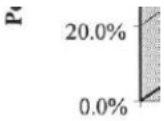

Figure 2. Percentage of inert and non-inert material in C&D waste[2].

3. COMPOSITION OF C&D WASTE

According to the regional study, wood occupies the largest portion for construction and demolition projects in Metro Vancouver (Figure 3. Typical construction waste by weight in Metro Vancouver landfills). The UBC renovation projects have similar waste composition.

[2] C.S. Poon, Ann T.W. Yu, L.H. Ng, "On-site sorting of construction and demolition waste in Hong Kong", "Resources, Conservation and Recycling 32 (2001) 157–172", page 4.

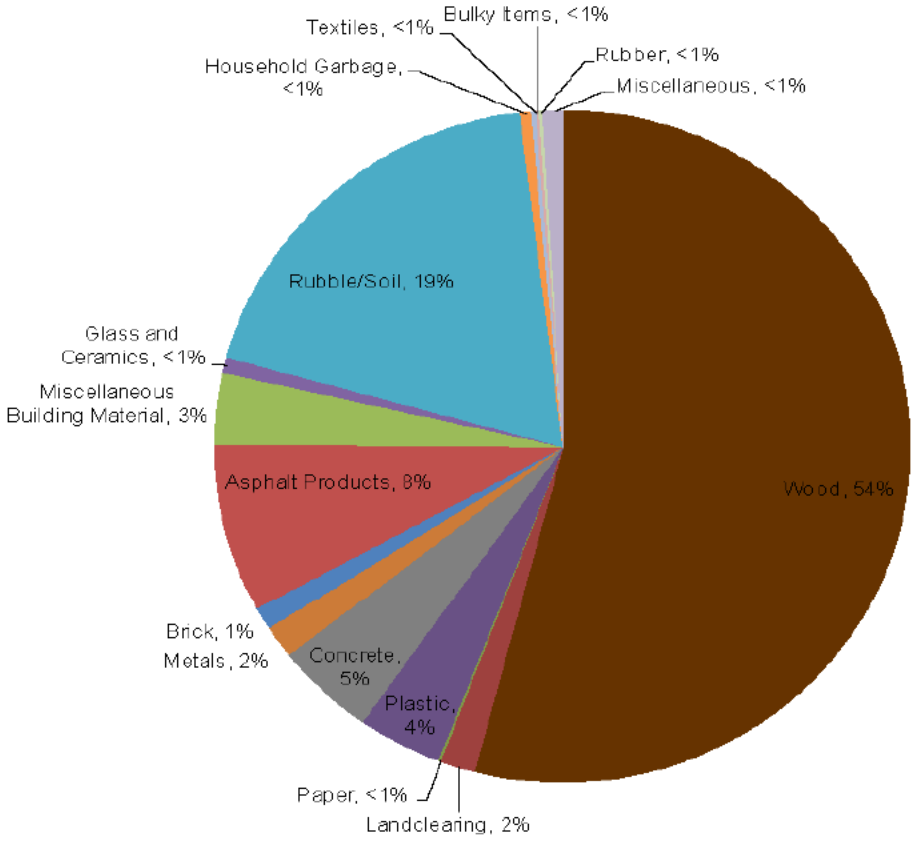

Figure 3. Typical construction waste by weight in Metro Vancouver landfills[3].

4. FACTORS WHICH INFLUENCE THE WASTE MANAGEMENT SUCCESS

Regulations, system development, awareness of stakeholders, low-waste construction technologies, design changes, research and development, and vocational training rank highest in the successful factors. (Figure 4. Rank of factors for the successful C&D waste management)

[3] AET Consultants, "2011 Demolition, Land-clearing, and Construction Waste Composition Monitoring". December 2011, Page 21

No.	Factors for C&D WM	Vi	Standard deviation	Rank	
S-5	WM regulations	3.745	0.32	1	CSF1
S-13	Waste management system (WMS)	3.745	0.54	2	CSF2
S-10	Awareness of C&D WM	3.529	0.45	3	CSF3
S-9	Low-waste construction technologies	3.510	0.84	4	CSF4
S-2	Fewer design changes	3.471	0.73	5	CSF5
S-15	Research and development in WM	3.451	0.67	6	CSF6
S-16	Vocational training in WM	3.412	0.78	7	CSF7
S-14	Housing industrialization programme	3.294	0.90	8	
S-1	Material usage and storage system	3.270	0.82	9	
S-17	Measuring C&D WM	3.268	0.60	10	
S-11	Improving conventional construction process	3.196	0.37	11	
S-7	On-site C&D waste supervision system	3.196	0.59	12	
S-6	C&D waste recycling and reuse	3.176	0.66	13	
S-3	Improving communication amongst project participants	3.157	0.72	14	
S-4	Lifecycle waste management	3.039	0.78	15	
S-12	Environmental management system	3.000	0.53	16	
S-8	On-site C&D waste sorting	3.000	0.62	17	
S-18	Taking WM into consideration in bidding and tendering	2.882	0.39	18	

Figure 4. Rank of factors for the successful C&D waste management[4]

5. METHODS FROM LITERATURE REVIEW FOR RENOVATION PROJECT WASTE MANAGEMENT

a. A BIM-based system for demolition and renovation waste estimation and planning

Material type and material volume are essential information when planning for recycling, which will lead to different requirements of time and money for both contractors and recyclers during demolition and renovation periods.

Taking advantage of BIM models, the following steps are implemented to help recycling construction waste[5]:

- Get detailed volume information of each element category.
- Get detailed volume information of each material type.
- Estimate total inert and non-inert D&R waste volumes.
- Estimate D&R waste disposal charging fee: each contractor will be able to know the difference in expenditure based on hard data from this estimation tool and then will be more motivated to minimize the waste generated and disposed in a renovation and demolition project.
- Estimate total number of pick-up trucks for D&R waste: the estimation will facilitate contractors for making decisions on the pick-up truck requirements.

[4] Weisheng Lua, Hongping Yuan, "Exploring critical success factors for waste management in construction projects of China", "Resources, Conservation and Recycling 55 (2010) 201–208", page 4

[5] Jack C.P. Cheng, Lauren Y.H. Ma, "A BIM-based system for demolition and renovation waste estimation and planning", "Waste Management 33 (2013) 1539–1551", Page 12

b. Pre-fabrication techniques

By adopting as many pre-fabricated components as possible, the new building process can reduce construction waste dramatically (Figure 5. Case studies results using prefabrication techniques in Hong Kong construction industry).

Building type: Residential	Year	Building technologies					Waste quantity/CFA (ton/m2)	Waste reduction level (%)
		Metal formwork (%)	Timber formwork (%)	Precast stairs (%)	Precast facade (%)	Other precast		
Public	2003	72	28	85	0	-	0.09	70
Public	2002	56	44	60	33	[a]	0.14	52
Public	2003	77	23	90	0	-	0.15	50
Average		68	32	78	32		0.13	57
Private	2003	71	29	70	35	[b]	0.21	29
Private	2003	72	28	97	97	-	0.23	24
Private	2004	72	28	75	80	[b]	0.23	23
Private	2003	73	27	62	0	-	0.26	14
Average		72	28	76	53		0.23	23
Total average		70	30	77	35		0.14	52

[a] Semi-precast slab.
[b] Lost form panel (permanent formwork) and semi-precast balcony.

Figure 5. Case studies results using prefabrication techniques in Hong Kong construction industry[6]

c. Source-Separated Recycling vs. Co-mingled Recycling[7]

There are 2 methods of recycling waste:
Source-Separated Recycling: Recyclable materials are collected in separate bins as they are generated. The recycling hauler takes the materials directly to a recycling facility or a transfer station that accepts source-separated materials for recycling.
Co-mingled Recycling: Recyclable materials are collected in one bin as they are generated. The recycling hauler takes the materials to a material recovery facility where they are sorted for recycling.
Pros and Cons of Source-Separated and Co-mingled Recycling:

- Source-separated recycling facilities have a 99.9% recycling rate.
- The recycling rate at co-mingled facilities varies between 12% and 99%.
- An extra step is involved to calculate a project's recycling rate when co-mingled recycling is used because the amount recycled is less than 100%.

[6] L. Jaillon, C.S. Poon,Y.H. Chiang, "Quantifying the waste reduction potential of using prefabrication in building construction in Hong Kong", "Waste Management 29 (2009) 309–320", page 5
[7] Resource Venture, "Construction Waste Management Guide, for Architects, Designers, Developers, Facility Managers, Owners, Property Managers & Specification Writers", Third edition, September 2005, page 12

- Source-separated recycling facilities are the most inexpensive option as they have the lowest tip fees, they take some materials for free and they pay for some materials.
- More administrative time is required on the job site to educate crew and sub-contractors on which materials to put in which containers.

However, On-site sorting of construction waste is restricted by the following factors[8]:

- Construction duration:
- Site space;
- Interference with normal construction activities;
- Market for recycled materials;
- Environmental considerations;
- Better management;
- Waste sortability;
- Manpower;
- Equipment for sorting of construction waste.

[8] Jiayuan Wang, Hongping Yuan, Xiangping Kang, Weisheng Lu, "Critical success factors for on-site sorting of construction waste: A china study", "Resources, Conservation and Recycling 54 (2010) 931–936", page 3

Part II: Current Situation of UBC Renovation Projects Waste Management

1. THE EXISTING FACILITIES ON UBC CAMPUS.

(Figure 6. UBC standard Waste Management container and vehicle types)

Type	Description	Size (W x D x H)	Weight (kg)
Waste Containers	3 cubic yard front-load	79 x 42 x 48"	320
	4 cubic yard front-load	79 x 54 x 48"	410
	6 cubic yard front-load	79 x 66 x 58"	550
	30 cubic yard roll-off	96 x 256 x 79"	3,270
	40 cubic yard roll-off	96 x 256 x 90.5"	3,400
Recycling Carts	35 gallon	22.75 x 22.35 x 39.5"	
	65 gallon	28.0 x 26.8 x 42.2"	
	95 gallon	28.0 x 30.5 x 46.5"	

Vehicle Type	Size (W x D x H)	Gross Vehicle Weight (kg)
Front-Load Compactor Truck	8.5 x 32.5 x 13.5'	25,000
Roll-Off Container Truck	9.75 x 33.3 x 9.75'	25,000
Side-Load Recycle Truck	9.5 x 31.5 x 12.5'	17,000
Side-Load Truck Extended	12.5 x 31.5 x 16.0'	-

Figure 6. UBC standard Waste Management container and vehicle types[9]

2. INTERVIEWS WITH CONTRACTORS[10]

- Contractors are not generally familiar with different costs of delivering waste to landfills (based on being separated or mixed) and there is not enough motivation for contractors to separate waste accurately and some contractors believe that separating waste does not worth their time.
- In small/medium size renovation projects, due to the higher quantity of demolition waste and also because demolition companies are more concerned about the benefits of separating waste, demolition waste is usually separated more carefully onsite.

[9] UBC Technical Guidelines, 2013 Edition Division 2 Site Work, Section 02995, Waste Management
[10] Zahra Hosseini, "Construction & Demolition (C&D) Waste Practices, Information Collection Phase", 09/20/2013, Page 12-13.

- Many contractors stated that they can track waste easily by requesting waybills from demolition sub-contractors/waste management companies.
- Major obstacles stated by contractors for material reuse are:

  - Old materials in renovation projects are mainly not in a good condition to be reused

  - Owners usually prefer new materials

  - Storage area is expensive/inaccessible

  - Sometimes it is against codes to use old materials (e.g. structures)

  - Old materials might be outdated and not efficient enough in terms of energy consumption

  - Salvaged materials might not fit in new design (size, length, color, etc.)

  - Processing materials for reusing in the same project may be time consuming and may result in delays in project schedule.

  - Finding customer for salvaged materials

  - Materials might be damaged through demolition/deconstruction

- Contractors/subcontractors stated the following points as major obstacles for waste diversion:

  - Small pieces of mixed waste

  - Materials which are difficult to separate (e.g. because of adhesives, nails, etc.)

  - Unrecyclable materials (Styrofoam, plastics and wrappers in packaging)

  - There is not much money in recycling

  - Lack of space on site to set up separate bins.

  - Educating the workers

  - Non-transparent garbage bags, used for small amounts of waste, can result in mistakes in waste categorization

  - Finding proper recycling facilities for each type of waste with decent price

  - Separating food waste (In large projects)

  - Competitive bidding fees among demolition sub-contractors

Part III: Suggestions on UBC Renovation Projects Waste Management

1. REDUCE

a. Look for ways waste can be prevented in the first place by identifying potential wastes early in the design process.

If we identify potential waste early in the design process, it could decrease waste generated during construction. There are following matters we need to pay attention to:

- Design with standard sizes for most building materials, which can avoid creating waste when standard sized materials are cut to unusual shapes.
- Design spaces to be flexible and adaptable to multiple uses, which avoids creating waste during remodels.
- Design for deconstruction, there are specific means such as: using the dis-entanglement of systems, choosing materials bolted together instead of glued, preparing a construction and deconstruction blueprint, adopting less hazardous materials and highly recyclable materials.

b. Pre-fabrication components.

It can reduce the onsite work, ensure the quality of building components, and minimize construction waste generated on site.

2. REUSE

Identify waste that can be salvaged for reuse on the current project, on another project or donated.

Sometimes, reused materials may also provide functional or aesthetic features not available in new materials. For example, salvaged wood is often of a quality and a variety of species that is difficult to find in the market place.
UBC can set up a database managing the overall campus renovation projects, providing the shared information of the second handed materials available. This will provide cheap or free materials for other projects on campus.
For some used furniture or electrical apparatus, sending a public email to students and faculties may draw the attention of the potential people who really need them at low cost or even for free.

3. RECYCLE

a. Make a construction waste management plan together with the contractor, and make it an attachment with the renovation project contract. (See attachment 1 for Sample Waste Management Plan)

b. Source-Separated Recycling.

UBC needs to provide separated bins for construction waste, together with plans for the temporary storage and design the hauler trucks access.

ATTACHMENT 1 SAMPLE WASTE MANAGEMENT PLAN[11]

Company:

Project:

Designated Recycling Coordinator:

Waste Management Goals:

 This project will recycle or salvage for reuse xx% [e.g. 90%] by weight of the waste generated on-site.

Communication Plan:

 Waste prevention and recycling activities will be discussed at each safety meeting.

 As each new subcontractor comes on-site, the recycling coordinator will present him/her with a copy of the Waste Management Plan and provide a tour of the recycling areas.

 The subcontractor will be expected to make sure all their crews comply with the Waste **Management Plan.**

 All recycling containers will be clearly labeled.

 Lists of acceptable/unacceptable recycle materials will be posted throughout the site.

Expected Project Waste, Disposal, and Handling:

The following charts identify waste materials expected on this project, their disposal method, and handling procedures.

Demolition Phase

Material	Quantity	Disposal Method	Handling Procedure

Construction Phase

Material	Quantity	Disposal Method	Handling Procedure

[11] Resource Venture, “Construction Waste Management Guide, for Architects, Designers, Developers, Facility Managers, Owners, Property Managers & Specification Writers”, Third edition, September 2005, page 23

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