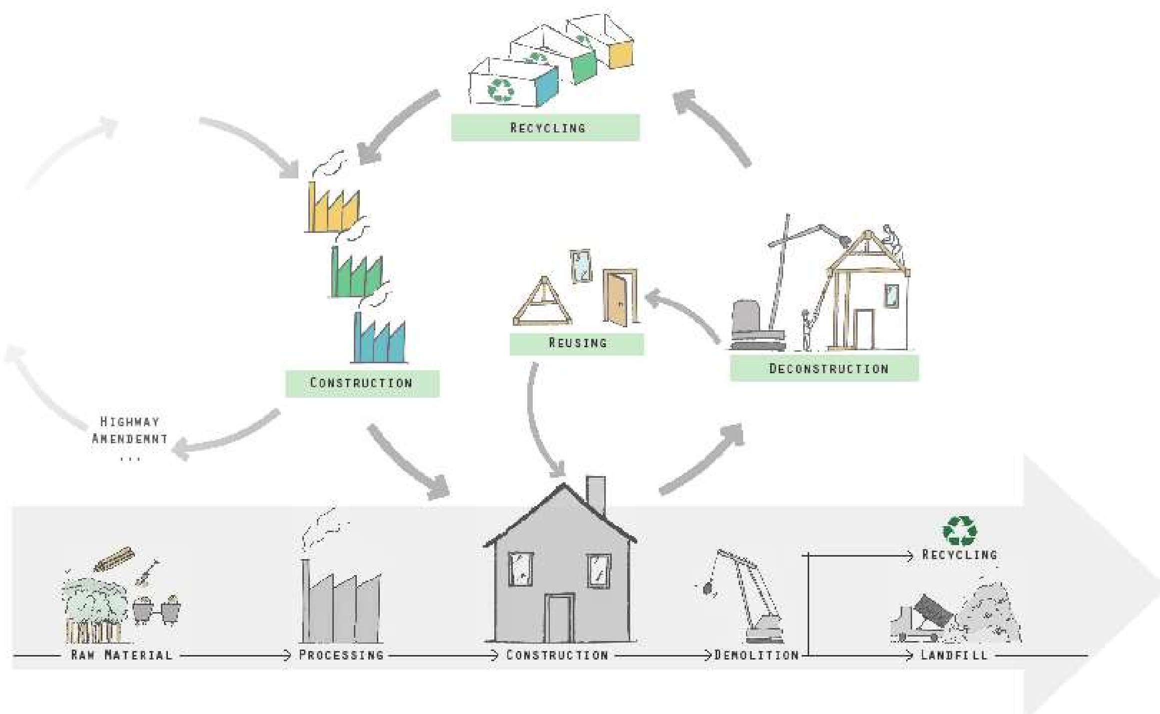
TRANSFORMING THE 21ST CENTURY BUILT ENVIRONMENT: SELECTED STUDENT PAPERS IN DOMICOLOGY

Spring 2017



Michigan State University
Center for Community and Economic Development
and the
School of Planning, Design & Construction's Urban and Regional Planning Program

CONTENTS

Introduction

Dear Readers,

For several decades, many U.S. cities have experienced significant economic and population decline that has resulted in large amounts of structural abandonment. This abandonment has pervasive social, environmental, and economic consequences that disproportionately affect already struggling communities. In response to this problem, scholars at Michigan State University have focused their efforts on understanding the complex circumstances that have led to blight, as well as a number of potential solutions. One such research area has focused on altering our perceptions of the built environment as a cyclical system, rather than in the traditional linear sense. Coined as the study of structural life cycles by Dr. Rex LaMore in 2015, *Domicology* examines the continuum from the planning, design, and construction stages through to their end of use, abandonment, deconstruction and reuse.

The following primer was developed during a special topics course offered in the Spring of 2017 in the Urban and Regional Planning Program, in the School of Planning, Design & Construction at MSU entitled "*Transforming the 21st Century Built Environment: Advancing the Science of Domicology*." The primer seeks to expand on the existing knowledge surrounding structural abandonment, explore various implications of "design for deconstruction" principles, as well as the social, environmental, and political considerations for adopting domicological practices. The primer should serve as an introductory reading for those seeking to explore the various concepts and considerations of the life cycle of structures. The research contained in this primer is by no means a complete work; as the built environment is a multi-faceted area of study, so too are its implications.

Contributors to this primer include selected students of the special topics course, and represent several disciplines in the built environment including planning, design, construction management, interior design, and other related disciplines. Special thanks to our editing team: Hafsa Khan, Madison Sorsen, and Lauren Ross. For more information on the study of Domicology, we invite you to visit domicology.msu.edu. We also welcome external research on the subject of structural abandonment, which can be submitted via the website.

We hope that you find these selected readings stimulating and informative as we seek to transform our understanding of the built environment.

Yours for stronger communities,

Rex L. LaMore, Ph.D.
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The statements, findings, conclusions, and recommendations expressed herein are solely those of the respective authors, and do not necessarily reflect the views of Michigan State University.

EXAMINING HISTORIC PRESERVATION TOOLS AS A MEANS TO ADVANCE THE SCIENCE OF DOMICOLOGY

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ABSTRACT

Globalization is changing the social and spatial fabric of cities. It is not only flattening the cultural and physical identities of cities, but also yields in creating an acute social and spatial polarization by razing the unwanted and undesirable physical settlements. Historic preservation is a tool to counteract the physical negatives of our neoliberal world by preserving the cultural identity of communities, acting as an architectural archive that strengthens the physical identity of given societies and places, and preventing the displacement of the disenfranchised. Reusing historic buildings for providing affordable housing is a tool to offset the negative social, economic, and physical effects of both globalization and abandonment of buildings. This paper unfolds the obstacles facing developers when applying for Federal Historic Rehabilitation Tax Credit for rehabilitating historic structures to affordable housing in the United States of America.

INTRODUCTION

The plummeting of environmental quality and the prevailing of social injustice in neo-liberal cities has urged urban scholars to seek tools and techniques to help assuage such dilemmas by manipulating and reorganizing the physical structure of cities. The practice of reusing and preserving abandoned historic buildings is a basic concept core of sustainable development and the focus of this paper. Synchronizing historic preservation and affordable housing can greatly relieve social and spatial injustice and help revitalize neighborhoods, spark local economy, and boost environmental wellness by reversing the decay of neighborhoods.[1] For the general public, historic preservation is often connected to the increase of property value, displacement, and gentrification and as a result always confronts their reluctance. However, when a dilapidated building is saved for its historic and architectural significance and rehabilitated as affordable housing, it encounters less community resistance. Preserving historic buildings for affordable housing use is becoming more acceptable and encouraged by the community and stakeholders.

While preservation advocates consider the Secretary of Interior's Standards for preservation as guiding principles for the preservation, restoration, rehabilitation, and reconstruction of historic structures, developers conceive these standards as obstacles that hinder the rehabilitation process of historic buildings. This paper will prove to be a tool for identifying and mapping the barriers of historic preservation, especially for the rehabilitation projects of historic structures for affordable housing, by tackling the following question: "Are the Standards of the Secretary of Interior for preservation considered obstacles for the rehabilitation of historic buildings into affordable housing?" From the literature review,

1 Mason, Randall. 2009. Reclaiming the History of Places. In Local Planning: Contemporary Principles and Practice , ed. Gary Hack, 127- 133. (Washington, D.C.: International City/County Management Association),127.

the paper will briefly unfold the evolution of historic preservation, and its different federal incentives, and the Secretary of Interior's Standards for preservation. The paper will also complement the literature review by introducing three case studies of historic buildings converted into affordable housing projects: the Pacific Hotel in Seattle, Washington, the Joseph H. Barnes School in Boston, Massachusetts, and the Miller's Court in Baltimore, Maryland. The three case studies are of different building types and with different original use to add more depth and more understanding for the barriers that developers encounter when rehabilitating historic buildings into affordable housing. The paper will conclude with answering the research question and extrapolate some key elements and recommendations that could facilitate the application process for Federal Historic Rehabilitation Tax Credit. Finally, further research recommendation will be addressed to encourage and expedite the process of rehabilitation of historic buildings for affordable housing use.

This paper is also an attempt to add to the advancement of a new field of study. Domicology is a new field that calls for sustainable techniques, such as deconstructing, retrofitting, or preserving historic buildings, to tackle the social and spatial dilemmas that accompany abandoned buildings. Dr. Rex LaMore defines Domicology as "the study of abandoned structures, policies and practices that result in abandonment, and ways that we can mitigate the negative social, environmental and economic implications of that." Abandoned structures have social, economic and environmental costs, such as attracting crime and drug activity, lowering the value of adjacent properties, discouraging investment, and imposing imminent health hazard on communities. The blind demolition of historic elements comes with its costs as well, including but not limited to: the loss of local identity and architectural archive.

THE EVOLUTION OF HISTORIC PRESERVATION

With the rise of social and spatial marginalization and the fall of social equity in the capitalistic world, in general and in globalized cities in particular, we, as city designers, need to find sustainable solutions to thwart the negative consequences of such urban dilemmas. There is no universal design formula for achieving sustainable and just cities, but it is widely accepted that achieving sustainability at the micro-level, using efficient urban design and urban form, can potentially yield sustainability and well-being at the macro-scales of cities and regions.[2] Much of the acute social degradation can be attributed to deficiencies in the urban structure of our contemporary neo-liberal cities, including inefficient land use patterns and transit systems, urban encroachment, physical segregation, and resulting abandonment of structures. The UN Agenda 21 and Habitat Agenda highlight some objectives for achieving spatial sustainability that include the following: creating compact urban form; conserving open space and diverse ecosystems; decreasing automobile dependency; reducing waste and pollution; providing affordable and properly located housing; promoting social equity; refreshing local economy; and creating livable and

2 Porta, Sergio, and John Luciano Renne. "Linking Urban Design to Sustainability: Formal Indicators of Social Urban Sustainability Field Research in Perth, Western Australia. " Urban Design International 10.1(2005): 51.

lively built environments for humans.[3] The practice of preserving historic buildings is a basic concept core of sustainable development.[4]

In response to the massive renewal projects that showered the country at the beginning of the 1960s, which resulted in razing historic neighborhoods of the disenfranchised population, a preservation system was developed.[5] The National Historic Preservation Act was created in 1966 and is considered a pivotal policy that stresses the importance of historic building stocks across the nation.[6] In 1966, the National Historic Preservation established the Secretary of the Interior's Standards for the Treatment of Historic Properties. The main reason for creating the Standards is to create "standards that are neither technical nor prescriptive, but are intended to promote responsible practices that help protect our Nation's irreplaceable cultural resources."[7] The Standards, as defined by the Secretary of Interior, are tools to encourage the protection of the unique architectural and structural features of historic properties and to minimize unnecessary and incompatible alterations, so as to avoid the construction of fake historical developments and to prevent any irreparable damages from occurring.

In general, historic elements are buildings, sites, districts, and objects identified on national, state, or local government historic registers.[8] The Secretary of Interiors defines historic preservation as the practice of safeguarding the existence and the appearance of such historic elements. Preservation of historic buildings creates a unique sense of history and preserves cultural identities in our contemporary homogenized, globalized cities.[9] Reuse is a form of historic preservation and acts as an archive for historic legacy. It is generally accepted that historic preservation and adaptive reuse developments help in bolstering the city's aesthetic value, encouraging people to live and work in well preserved downtown areas and providing them with a place to be proud of. This in turn reduces crime and is considered a solution to the broken windows crisis, remediating the social and physical blights of abandoned buildings.[10]

Some other benefits beyond conservation of history are using adaptive reuse as a tool to reduce the rapid pace of urban sprawl and to minimize construction waste. Reuse of existing abandoned buildings reduces

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3 Wheeler, S.M. "Planning for Metropolitan Sustainability." Journal of Planning Education and Research 20.2 (2000): 134.

4 Condello, Annette, and Steffen Lehmann. Sustainable Lina: Lina Bo Bardi's Adaptive Reuse Projects. Heidelberg: Springer, 2016.

5 David Listokin and Barbara Listokin, Barriers to the Rehabilitation of Affordable Housing: Finding and Analysis, report, vol. 1 (Washington, DC: U.S. Department of Housing and Urban Development, 2001)

6 Ibid.

7 National Park Service, "Introduction: Choosing an Appropriate Treatment for the Historic Building," The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing, section goes here, http://www.nps.gov.

8 Listokin, David, and Barbara Cyviner. Listokin. Barriers to the Rehabilitation of Affordable Housing. Rockville, MD: U.S. Dept. of Housing and Urban Development, Office of Policy Development and Research, 2001.

9 Ibid, 10.

10 Joseph M. Schilling, "The Revitalization of Vacant Properties: Where Broken windows Meet Smart Growth" (International City/County Management Association, 2002), 4.

the exploitation of the natural capital and lower acquisition, demolition, and material costs. Rehabilitation of historic buildings also lowers site preparation costs and environmental degradation through the use of available utilities and existing infrastructure on site. It allows cities and developers to concentrate their fiscal resources on maintaining and developing the existing public infrastructure instead of wasting money on extending the existing infrastructure to service urban sprawl.[11] Adaptive reuse reduces the depletion of non-renewable resources, reduces health hazards that result from demolishing structures, and increases the efficiency of energy use by reusing and recycling materials. Preserving historic buildings is also an economic drive. According to the National Trust for Historic Preservation, rehabilitation of buildings creates 20 percent more jobs than new constructions.[12] Also, such rehabilitation projects can act as a catalyst for creating jobs such as touristic hot spots, and could also act as a magnet for potential new developments, and flourishing of local businesses.[13]

HISTORIC PRESERVATION AND AFFORDABLE HOUSING

The National Historic Preservation Act is composed of 402 Sections, all of which "mandate the preservation of the historical and cultural foundations of the Nation as a living part of community life and development in order to provide the American people with a sense of orientation."[14] The Act established the grounds for plenty of programs, including State Historic Preservation Officers, and the Advisory Council on Historic Preservation. The U.S. Department of Housing and Urban Development (HUD) cooperated with the Advisory Council on Historic Preservation, the National Council for State Historic Preservation Officers, the National Park Service, and the National Trust for Historic Preservation to execute tangible reports about the possibilities of merging affordable housing policies with historic preservation policies.

Affordable housing according to HUD is housing that costs 30% or less of a household's annual income.[15] This also includes the affordability of the costs of materials consumed in the project and the affordability of the maintenance costs of the property after the completion of the project, preventing any additional costs to rental rates. HUD established the HOME program in 1990. It "aims to expand the supply of decent, safe, sanitary, and affordable housing and anticipates historic preservation as a tool for meeting its goals."[16] The Advisory Council on Historic Preservation acknowledges the role that historic preservation can offer to address the need for public housing and issued policies in 1995, 2002, and 2006. Affordable

11 Ibid.

12 Affordable Housing Through Historic Preservation, publication (Washington, DC: National Trust for Historic Preservation, 1998),1.

13 Mason, Randall. 2009. Reclaiming the History of Places. In Local Planning: Contemporary Principles and Practice , ed. Gary Hack, 127- 133. (Washington, D.C.: International City/County Management Association),127.

14 Advisory Council on Historic Preservation. Council Policy Statement: Affordable Housing and Historic Preservation. Washington, DC: Advisory Council on Historic Preservation. 2002.

15 The U.S. Department of Housing and Urban Development, "Glossary of Terms: Affordable Housing." HUDUser.gov | HUD USER. Web. 23 Apr. 2017

16 Ibid.

housing is considered one of the nation's most prominent housing challenges.[17]According to *The State of the Nation's Housing Report*, "the National Low Income Housing Coalition estimates that only 57 units were affordable and available for every 100 very low-income renters in 2014. The shortfall for extremely low-income households is even more acute, with just 31 housing units affordable and available for every 100 of these renters."[18] As such, there is a dire need for affordable housing in the United States, and it is expected to continue to increase in the future. Such housing dilemmas are attributed to the market's failure to meet the needs of low-income households, such as the provision of affordable housing in remote suburbs that prohibits the disenfranchised from enjoying the conveniences of the city and its job opportunities.

CHALLENGES OF REHABILITATING HISTORIC BUILDINGS

Historic preservation projects contribute notably to reduce housing shortages.[19] While the need for affordable housing is increasing, the quality of housing stock in the United States is crumbling and aging. In the U.S., the median age of housing is nearly 40 years old.[20] Some of the challenges that developers encounter in rehabilitation projects are mainly related to time and money. They argue that retrofitting old buildings for modern residential needs consumes more money and time than demolition. Truly, such projects require highly skilled labor to save and protect the unique architectural details of historic buildings, increasing costs. In addition, the rehabilitation process is usually delayed due to disagreements between the developer and the State Historic Preservation Office. Developers conceive the Secretary of Interior's Standards as strict, while officials strive to maintain the original esthetic integrity of the historic structure. Adding to this lengthy process is the poor physical conditions of aging historical buildings. Such buildings usually suffer from pest infestations, structural corrosion, asbestos, lead paint, etc.

In order to encourage historic preservation and mitigate some of these costly development actions, the federal government created some incentives for owners and developers, defined in the Federal Historic Rehabilitation Tax Credit. Owners of certified historic structures can receive a federal income tax credit up to 20% of the amount spent on qualified rehabilitation costs or a 10% credit for older, non-historic buildings.[21] In order to get such tax credit, the rehabilitation of the historic property should be substantial, which must be equal to or greater than $5,000.[22] In addition, the historic structure must be either listed on the National Register of Historic Places or qualified to list on the register. The federal government also allows Developers of affordable housing projects to combine the Low Income Housing Tax Credit and the Federal Historic Rehabilitation Tax Credit in order to alleviate the extra monetary burdens of such projects

17 The State of the Nation's Housing (2016). Http://www.jchs.harvard.edu. Web. 22 Apr. 2017.

18 Ibid.

19 Listokin, David, and Barbara Cyviner. Listokin. Barriers to the Rehabilitation of Affordable Housing. Rockville, MD: U.S. Dept. of Housing and Urban Development, Office of Policy Development and Research, 2001.

20 Ibid.

21 Ibid.

22 Ibid.

and to encourage the production of affordable housing.[23] In addition, the Secretary of the Interior is accountable for creating standards for all programs “under Departmental authority and for advising federal agencies on the preservation of historic properties listed in or eligible for listing in the National Register of Historic Places.”[24] To act as a guideline for historic properties, the Secretary of the Interior also developed standards for the treatment of historic properties. There are standards for preservation, rehabilitation, restoration, and reconstruction.[25]

The Historic Preservation Certification Application includes three steps.[26]

1. If the building is not already listed on the National Register of Historic Places, the developer must establish the building’s certified historic status through the Evaluation of Significance
    a. The Evaluation of Significance explains the architectural, historic, and social values that the building represents
    b. If this part of the application is accepted as a certified historic structure after the National Park Service has examined it, the applicants then prepare for the second step in the application process
2. Next, descriptions of all rehabilitation proposals for the project, including structural, mechanical, and architectural must be submitted.
    a. The State Historic Preservation office reviews the descriptions provided, using the Secretary of Interior’s Standards for Rehabilitation to ensure compliance with the standards, and then forwards it to the applicant with recommendations, if applicable
3. Finally, the application is accepted, depending on the adherence of the projects to the suggested recommendations. At this point, the final decision of acceptance is made to obtain the tax credit certificate before beginning construction.[27]

David Listokin, a professor at Rutgers University in New Jersey, collaborated with HUD and the National Trust for Historic Preservation to recognize the most common barriers that hinder the smooth success of rehabilitating buildings for affordable housing. Listokin, along with other scholars, analyzed in detail the barriers to the rehabilitation of historic structures for affordable housing in *Barriers to Rehabilitation of Affordable Housing Report*. The report identified several barriers that usually surface along the different development stages of a rehabilitation project: development stage rehabilitation barriers, construction stage rehabilitation barriers, and occupancy stage rehabilitation barriers. Development barriers include acquiring property and estimating costs. Construction barriers are building codes, lead regulations,

23 Escherich, Susan, Stephen Farneth, and Bruce D. Judd. Affordable Housing through Historic Preservation: Tax Credits and the Secretary of the Interior's Standards for Historic Rehabilitation. Washington, D.C.: U.S. Department of the Interior, National Park Service, National Center for Cultural Resource Stewardship & Partnerships, Heritage Preservation Services, Technical Preservation Services, 1997.

24 "The Secretary of the Interior's Standards for Rehabilitation." APT Bulletin 37.4 (2006): n. pag. Https://www.nps.gov.

25 Ibid.

26 U.S. Department of the Interior, National Parks Service, Preservation Tax Incentives for Historic Buildings (Washington, DC: National Park Service, 2007), 4.

27 Ibid.

asbestos regulations, energy regulations, and historic preservation regulations. The occupancy barriers include property tax and rent control. The study listed historic preservation under the construction stage barrier category.[28] The study attributes such barriers to the rigidity and inflexibility of Section 106 review, tax credit review, and local regulations.[29] The report highlights that local preservation regulations can be stricter than the Secretary of Interior's Standards for Rehabilitation. A rehabilitation project has to comply not only to federal and state preservation requirements, but also with local preservation requirements.[30] Listokin argues that such requirements impede the encouragement of historical preservation.

CASE STUDIES

MILLER COURT

Figure 1: Miller Court Building
Source: Google Images

Miller Court is located in Baltimore, Maryland. It is a brick building previously known as Miller & Sons Tin Box and Can Manufacturing Plant and built in 1910.[31] It was one of the nation's largest manufacturers of tin boxes and cans in the early 20th century. It has a U-shaped floor plan with painted brick walls, heavy, iron doors, and unique wooden beams.[32] In 1950, the Tin Box and Can Company expanded, opening a new factory in southwest Baltimore, which negatively affected the original Miller and Sons factory. Due to the convenience of the new location, this Miller's factory was transformed to an office building. The building suffered from deterioration due to lack of maintenance. After few years, the Seawall Development Corporation showed an interest in purchasing and rehabilitating this facility into affordable housing, yet, simultaneously, it provided office space for nonprofit organizations that support Baltimore's public schools. Approximately 40,000 square feet is dedicated to affordable housing units, and almost 35,000 square feet is dedicated to office space. Seawall developers gained most of the tax credits back by taking advantage of combining the New Markets Tax Credit and the Historic Rehabilitation Tax Credit.

The rehabilitation process included the demolition of unsteady structures and additions, such as partitioned walls built in the 1970s; the cleaning of brick and mortar; using existing windows to make new door openings; and restoring the locations of windows to the original 1910 plans.[33] According to Seawall,

28 David Listokin and Barbara Listokin, Barriers to the Rehabilitation of Affordable Housing: Finding and Analysis, report, vol. 1 (Washington, DC: U.S. Department of Housing and Urban Development, 2001), 11.

29 Ibid.

30 Ibid, 120.

31 Johnston, Edna. NRHP Nomination: American Can Company-Miller Factory. Report. Part 1 of HRTC Application. National Park Service, 2002.

32 Ibid.

33 Ibid.

almost 80 percent of the overall windows were in a very poor condition and needed total replacement.[34] The Seawall Development Corporation encountered very few barriers while rehabilitating the Miller's Court building into affordable housing. The corporation filed smoothly for the Federal Rehabilitation Tax Credit. The success of this case study was due to the sincere commitment of the developer to protect the historical significance of the property. Despite the fact that almost all of the windows were changed, which was a highly controversial issue between the developer and the State Historic Preservation Office, the developer took advantage of combing tax incentives and used it to cover extra monetary expenses.

PACIFIC HOTEL

Figure 2: Pacific Hotel Building
Source: Google Images

The Pacific Hotel is located in downtown Seattle, Washington. The hotel was built in 1916 and originally known as the Leamington Hotel and Apartments.[35] The building has a very unique architectural style that is now rarely found in the downtown area. The Plymouth Housing Group currently owns the property and the building is fully dedicated to low-income housing. The building is divided into two main sections; one section is dedicated for single hotel rooms, while the other section provides bigger rooms to extended-stay guests. The developer was able to take advantage of the variety of room sizes. They transformed the smaller guest rooms into 75 Single Room Occupancy (SRO) spaces for the homeless and the more spacious rooms into studio and one-bedroom units for low-income people.[36] The two new uses share the same lobby and green courtyard, but they have separate elevators.

Unable to compete with the surrounding modern convenient hotels, the building started to deteriorate in the 1960s. It was vacant for almost ten years and then went through foreclosure. A homeless advocacy group urged the Plymouth Housing Group (PHG), a non-profit housing developer, to purchase the building and retrofit it to affordable housing. PHG purchased the property in 1993 for $2,100,000.[37] PHG applied for the Historic Preservation Certification in order to take advantage of the Historic Preservation Tax Credit and got approval for part 1 - Evaluation of Significance, in the same year. The developer established detailed architectural plans and descriptions, and there were regular meetings between the State Historic

34 Seawall Development. American Can Company: Miller's Court. Application for Federal Historic Rehabilitation Tax Credit. 2008.

35 Sullivan, Aleca, Case Studies in Affordable Housing Restoring through Historic Preservation, http://www.historycolorado.org/sites/default/files/files/OAHP/crforms_edumat/pdfs/1600.pdf (accessed March 22, 2017).

36 Ibid.

37 Ibid.

Preservation officer and the architects in charge of the rehabilitation project. The developer then submitted the plans and detailed descriptions for the rehabilitation process required for part 2 of the application. Although the officer made additional requests, the developer was granted approval for part 2 and the rehabilitation process started immediately. The developer was able to get loans from the City of Seattle with forgiven interest since it furnished affordable housing and was a historic building.

JOSEPH H. BARNES SCHOOL

Figure 3: Joseph H. Barnes School Building
Source: Google Images

The Joseph H. Barnes School is located in East Boston, Massachusetts. This building, built in 1901, was previously known as the East Boston High School. It has a unique neoclassical architecture with rich façades and iconic columns covered with limestone and granite.[38] The main façades of the school are decorated with carved-stone balconies and most of the interiors have vaulted ceilings. The school used to have a spacious lobby, gymnasium, and library that had unique architectural details. This school used to educate the children of immigrants in the neighborhood. The neighborhoods surrounding the school are homes mostly to Russian and Italian immigrants. The school was in use until the beginning of the 1980s, when the city of Boston decided that there was no longer a need for this school due to its limited space and poor physical conditions.

The East Boston Community Development Corporation acquired the property in 2001 and reused it to provide 74 affordable housing units for seniors.[39] The developer and the hired architect restoring the facility decided to make some additions to accommodate the new use, such as adding two elevator towers to serve future senior residents and complying with accessibility and safety codes. The architect was careful to construct the new elevator towers out of buff brick to stay in accordance with the design and the materials of the old school. Most of the rehabilitation was done to the interior of the school, transforming classrooms into housing units and the gymnasium into a kitchen and adult daycare. In addition, new heating, ventilation, and cooling systems were installed throughout the entire building. As

38 East Boston Community Development Corporation. Barnes School. Application for Federal Historic Rehabilitation Tax Credit. Part 2. 2003. 2,3.

39 Cara H. Metz, NRHP Nomination: Old East Boston High School, report, Part 1 of HRTC Application (National Park Service, 2002).

for the exterior, the windows were in poor condition, needing replacement, and the facades needed cleaning.

The architect of the rehabilitation project was in frequent connection with the State Historic Preservation Office to assure necessary renovations would be met without compromising the historical significance of the building. The three main design challenges the architect encountered were the height of the elevator towers, the installation of the new ventilation system, and the windows. The architect and the State Historic Preservation Office worked conjointly to determine the optimal height for the elevator towers and the best alternative to the original windows. The developer was successfully granted the Historic Preservation Tax Credit along with a $9.6 million loan from the Massachusetts Housing Finance Agency in 2004. The rehabilitation project started immediately.

CONCLUSION

The three case studies, along with David Listokin's report, reveal that the Secretary of Interior's Standards are not an obstacle that threatens rehabilitation projects meant to convert historic buildings into affordable housing. The case studies prove that although the application for Federal Historic Rehabilitation Tax Credit might be a lengthy process, working with the State Historic Preservation Office from the beginning of the project is key in preventing delays and conflict. Mutual understanding and negotiations between the different parties involved is necessary and possible in the rehabilitation process. The developer needs to be dedicated to preserving the authentic and historic character of a historic structure and fulfilling affordable housing needs, while providing full cooperation and willingness to adhere to the given laws, if a lengthy application process and unresolved conflict are to be avoided.

The State Historic Preservation Office and the National Park Service need to pay attention to the priority needs of affordable housing projects when reviewing the tax credit applications. The decisions made by the State Historic Preservation Officers and the National Park Service should also be based on a broader scope, stretching beyond the required historic preservation codes. Historic Preservationists must also take into consideration that energy efficiency requirements are critical in low-income housing to lower maintenance costs and utility bills.

The Federal Historic Rehabilitation Tax Credit is a huge incentive for rehabilitation and is even more efficient if combined with other monetary incentives, such as the support of the city, as was the case with Pacific Hotel in Seattle. This financial support was to cover any unexpected or additional rehabilitation costs. With the rising need for affordable housing, the governance structures with their multi-tiered agencies must create more incentives for developers to facilitate the rehabilitation process of historic structures for affordable housing. They have to take into consideration the barriers that developers encounter when dealing with multiple sources of subsidies, as well as the requirements of affordable housing. In some rehabilitation cases, other barriers might surface, such as the lack of compromise between developers, construction site, local agencies, the historic preservation agencies, and HUD.

Although the affordable housing and historic preservation policies both aim to enhance social justice and sustainable developments, they have different avenues for achieving such goals. As such, the Advisory Council on Historic Preservation must work together with the city and HUD to shape policies that are feasible and flexible to adopt. They should conduct studies and reports that tackle the diverse yet common barriers that developers encounter in order to mitigate and avoid any conflict between the different entities involved in the process. Flexibility, enthusiasm, and dedication on behalf of the architect, developer, and preservation officer, accompanied by regular communication between them, are prerequisites for the success of the rehabilitation of affordable housing. It is evident from the case studies that the Secretary of Interior's Standards are flexible and willing to creatively meet case-by-case needs. Therefore, synchronizing historic preservation and rehabilitation for affordable housing can definitely be accomplished to appease the acute social and spatial polarization between the disenfranchised population and high-income people. Historic preservation and affordable housing can go hand-in-hand to produce sustainable developments that are just, equitable, and environmentally conscious.

FUTURE RESEARCH

Additional case studies with different building typologies and funding resources need to be conducted to map and identify other barriers that surface during the rehabilitation process of the historic buildings to affordable housing use. Also, it would be crucial to further study other case studies that encountered long and complicated rehabilitation processes and pinpoint the difficulties that slowed and stretched the process. Creating a compiled manual to assist and to guide developers for such rehabilitation process will be a crucial tool for the advancement of Domicology. The manual might include a combination of critical case studies, along with a set of particular and general recommendations for developers. Such contributions can provide greatly to the development of Domicology, and to strengthen the social and spatial realms, assure collective well-being, and reverse environmental degradation through reusing and preserving buildings. City designers, including architects, urban designers, and planners, should engender and embrace the principles of Domicology as a model to create environmentally and socially conscious buildings and sustainable cities.

A COMPARATIVE ANALYSIS BETWEEN DEMOLITION AND DECONSTRUCTION

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INTRODUCTION

Abandonment of houses has been a major issue in the United States. Cities like Detroit, MI, Jacksonville, FL and Cleveland, OH etc. are some of the major cities which are facing this serious problem. The state and local government have to deal with problems such as drug trafficking, homeless encampment, prostitution, arson etc. due to abandonment (Accordino et.al, 2000). To respond to this problem, domicology has been proven to be very helpful. According to LaMore (n.d.), domicology can be defined as "the study of the economic, social and environmental factors relating to the "life cycle" of structures". To eliminate abandoned properties, deconstruction and demolition have proven to be helpful methods. The approaches of deconstruction and demolition are different. Deconstruction is disassembling the house to take out maximum material for salvage, which is a more ecofriendly process. It is also known as selective dismantling as the house is dismantled in the reverse order of how they are originally constructed (Guy and McLendon, 2000). In contrast is the where in the demolition process, the whole house is completely knocked down with heavy equipment and major amount of demolished material goes into landfills and hence, this process is not environmental friendly. Further, deconstruction preserve as most of the material is reused or recycling. Deconstruction is an effective way to reduce the waste which generally goes into landfills. The environmental effects of demolition are significant, wasting large amounts of energy and resources, whereas deconstruction creates a lesser impact. As deconstruction is more time and labor consuming process, it has been widely not adopted in the United States. A comparison between the two processes is required to select a better method that considers the various social, economic and environmental factors.

PROBLEM STATEMENT

Theoretically, it is possible to deconstruct every building and reuse most of its components. However, in practice it is difficult, expensive and has achieved success only on very small projects (Morgan et.al, 2005). Hence, most owners and contractors prefer demolition over deconstruction despite the environmental and cost benefits of deconstruction.

OBJECTIVES AND METHODOLOGY

Domicology, which studies the abandoned structures at different stages of their life, also studies the post-abandonment stages of the structures where clearing the land is essential. Especially the Midwest region of United States is facing problems with blighted properties. The focus of this paper is to comparatively analyze the deconstruction and demolition processes by considering the various environmental, social and economic factors. This paper will collect and analyze various research studies conducted to understand the deconstruction and demolition processes and highlight their merits and demerits. Further this paper will also discuss about the supply chain of the salvaged material in which selecting the source of material, its transportation and storage will be discussed. Also the brief description about the current market condition and targeted customers will be mentioned in the paper.

ENVIRONMENTAL FACTORS

Deconstruction requires diligent inspection of hazardous material and hence the removal of asbestos dust lead particles is performed in a controlled manner, which cannot be controlled in demolition (Macozoma, 2001). The demolition of building structures produces enormous amounts of materials that, in most countries, result in a significant waste stream. In the U.S., construction and demolition (C&D) waste is about 143 million metric tons (MMT) annually, which is for the most part landfilled (Chini et. al 2003). The debris that goes into landfills can generate some greenhouse gases and hence deconstruction is helpful in reducing the emission of greenhouse gases (Benefits of Managing Debris , n.d.) . The processing of used materials uses less amount of energy as compared to raw materials. When a comparative life cycle assessment (LCA) is performed on used and raw materials, it was found that the used building materials create less environmental impact as compared to raw materials (Thiel et. al, 2013). Further, when LCA comparison was performed for demolition and deconstruction projects, it was found that deconstruction creates less environmental impact as compared to demolition (Kuikka, 2012). The waste generated by demolition contains various harmful substances such as lead, asbestos etc. When such substances are released into the environment, either directly by demolition process or by landfills, they can possibly pollute the environment. These contaminated landfills could lead to serious negative health effects (Marzouk et. al, 2013). The pollutants can contaminate the nearby soil and even the underground water by mixing with rainwater. It is estimated that closer to 90% of the building materials can be recovered via reuse and recycling (Webster, 2003), which means less landfills, less energy usage and pollution.

SOCIAL FACTORS

Sometimes, implosion is used for demolition, which generates large amounts of particulate matter over an extended period of time. Inhalation of such particles causes asthma and other serious health issues (Cooney, 2017). Further, demolition uses heavy equipment which creates noise pollution in the neighborhood. While deconstruction is a more labor intensive process, small tools are used in it and less particulate matter is generated. Also, noise pollution is generally less. Deconstruction has been successful in creating more job opportunities compared to demolition. It has been estimated that every deconstructing activity provides ten times more opportunities than demolition (Chini et. al, 2003). Deconstruction also provides job related trainings to labors that are marketable in the construction industry. As demolition uses heavy equipment and requires less number of laborers, deconstruction directs public capital toward jobs instead of fees for landfills and equipment. In addition, the reusable material stimulates the economy through creation of salvage markets which, in turn, develop employment opportunities for small salvage businesses. Of course, the availability of cheap building materials also saves costs for the community. Particularly in low income areas, deconstruction results in the availability of high quality used building materials that may not otherwise be affordable. Overall, the deconstruction industry could have a beneficial impact on low income segments of the society by offering low price goods along with the financial resources to pay for those products (Endicott et. al, 2005). In addition, the deconstruction process provides for the architectural preservation of a given region, style or period of history. Deconstruction helps families, businesses and communities develop their surroundings by providing cheap materials, resulting in cleaner, pleasant and safer neighborhoods. In addition, such deconstructed material can be given as charity to nonprofit organizations that develop houses for low-income families.

ECONOMIC FACTORS

In general, deconstruction is a more time and labor consuming process as it disassembles the components of houses without affecting their structural and aesthetic properties. Various studies have shown that deconstruction is more expensive than demolition but resale of salvaged building material can reduce its cost. For example, the reuse of materials such as timber and sheathing means reduction in construction materials that need to be extracted, processed and transported to the new construction site. This also means that the energy consumption is reduced. Deconstruction results in cost saving from avoided transportation and disposal cost of demolition waste. Such cost saving promotes the growth of the deconstruction industry. For the average 1500 square foot residential deconstruction project, an estimated 50% of the materials are reused, 25-30% are recycled, and the remainder is trashed (Greer, 2004). The main factor that increases the cost of deconstruction project is duration as it is more manual work rather than machine related. An average 1000 square feet house approximately takes about 7.4 days to deconstruct with a crew of 5 members, while demolition take only one-third to one-fifth of that time (Dantata, et. al 2004). Hence the increased cost is due to labor intensive manual work. However factors such as condition and age of the house, skill level of the labors, presence of hazardous material also affects the duration and cost of the deconstruction and demolition. Table 1 shows the financial report of deconstruction and demolition conducted by Powell Center for Construction and Environment (PCCE) in Gainesville, Florida (Guy, 2003).

Table 1: Deconstruction versus Demolition Cost for a Residential Building)

	Total Net Demolition			**Total Net Deconstruction**		
COSTS ($)						
Permit	50.00			50.00		
Asbestos Survey	1200.00			1200.00		
Asbestos Abatement	740.00			740.00		
Disposal	5873.67	**96.67 tons**		1344.01	**22.12 tons**	
Toilet	63.00			63.00		
Supplies	10.00			637.93		
Labor and Equipment	3504.36			8469.38		
Total costs	11441	**5.68 per SF**		12504	**6.21 per SF**	
REVENUES ($)						
Salvage	0.00			9415.00	**4.67 per SF**	
Total Net Costs	11441	**5.68 per SF**		3089.32	**1.53 per SF**	

Source: Powell Center for Construction and Environment (PCCE)

The case suggests that even though the initial cost of deconstruction is more than demolition, the final cost can be less after salvaging the deconstructed material. One more hindrance to the deconstruction is the materials and construction techniques used in structures built after 1950 are not ideal for deconstruction (Alternative demolition and land use 2017). Such structures are not a good source of income and need to analyzed before deconstruct. And to make deconstruction more efficient labors needs more training. According to the Environmental Protection Agency (2003) report, deconstruction can be profitable if executed in the correct order. Table 2 shows one of the analysis from the EPA report a scenario where deconstruction is more profitable than demolition. With the advancement of technology and training of labor, deconstruction will be a profitable business.

Cost Savings with Deconstruction		
9,180 Sq. Ft. Wood Construction		
Item	**Deconstruction Cost**	**Demolition Cost**
Labor	($33,000)	
Equipment/Disposal	($12,000)	
Administration	($8,000)	
Total Expenses	($53,000)	($16,800)
Material Salvage Value	$43,660	
Net Cost	($9,340)	($16,800)
Savings	**$7,460**	

Table 2: Cost Savings with Deconstruction: Presidio Building

Source: Environmental Protection Agency (2003) Report

SUPPLY CHAIN OF SALVAGED MATERIALS

To make deconstruction a profitable business, there is a need to design a supply chain for salvaged materials which reduces the overall cost and creates a vibrant resale market. The supply chain consists of selection of materials and their sources, their transportation and storage, and bringing it to relevant markets and customers. This section focuses on some of the basic requirements of the supply chain for salvaged building materials.

FINDING THE SOURCE OF THE MATERIAL

To manage the supply chain of salvaged materials, there is a need to find out the source of the materials. The source should be such that it has availability of large amounts of material at cheaper prices. Cities like Detroit and Flint in Michigan can be the best sources as these cities have a large number of vacant houses which are now being tore down. There are approximately 80,000 vacant properties in Detroit, which could have remarkable material worth $15 million to $100 million ("Construction & Demolition Recycling," 2014). Considering that a 1,200 square foot wood-framed home can generate 6,000 board feet or more of such lumber, an estimated 240 million board feet of old lumber still exist in those dilapidated and abandoned homes (Northwest Economic Research Center, 2016; Goulet, 2014). Most of these houses are from pre-World War-II period and have high quality lumber. These lumber are good in strength and clarity. These salvaged lumber can be used for structural and non-structural purposes, or for aesthetic purposes. Many builders find the old rough-hew or weathered board aesthetically good. People who want to renovate their old homes find matched products in salvaged lumber. The other cost-effective materials can be bathroom and kitchen fixtures, doors, windows etc. Such materials from deconstruction are reusable and can be sold either through websites or yard sales. Structural components such as steel beams, columns, bricks cladding panels etc. do not need any treatment and can be used directly in the new construction.

TRANSPORTATION AND STORAGE

Transportation of material to the warehouses and then, to the stores depends upon the distance between the deconstruction/demolition site, storage facility and the market. Sometimes, salvaged materials are stored only temporarily and then shipped to the shops and warehouses. Selecting a transportation method mainly depends on cost of transportation, feasibility and the volume of material. If the supplier has a large volume of the material, then they generally use trains or ships because of their high capacity and cheaper prices. Contractors and suppliers always try to find the cheapest source to minimize overall cost. Most of the deconstruction contractors in Michigan generally supply their materials by trucks because of the high freight charges of trains and low connectivity to the waterways. On the other hand, selecting the warehouse mainly depends on the target markets. Some deconstruction contractors have their own warehouses while some rent them closer to the markets. Contractors generally target big markets like New York City and Chicago. Hence, they locate their warehouse near these cities.

TARGETED CUSTOMERS AND MARKETS

Reuse stores carry smaller amounts of materials that are typically higher value items, such items as used furniture and antique fixtures. Situating stores in the correct areas and finding the right customer are important components of the profit-making strategy. Just like the warehouse, location of the store should be close to the customer. The facility should be located on major streets as a strategy of promotion. In addition, high ceilings and easy loading areas are advantageous. Further, parking, home delivery etc. should be kept in mind to attract buyers. The customers for salvaged materials are mainly middle-income homeowners, investment property owners and a few contractors. Such home owners and contractors look for functional and economical values of the material (Delta Institute, 2017). Many contractors and building owners are targeting Leadership in Energy and Environment Design (LEED) certification for their buildings, which offers a maximum of five points for reusing salvaged materials ("Resource Reuse", 2017 USGBC) and hence the store should keep their products while keeping those such owners. In addition, architects, artists and craft builders who buy salvaged materials are typically representative of customers who are concerned for environmental and historic values. Most of these customers buy products for their aesthetic and antique purposes. The Delta Institute Delta Institute report on Rebuilding Exchange Business Case for Expansion has shown a chart of the customers segment which is interested in buying the salvaged material. It can be inferred from the chart that homeowners are the biggest buyers because of the low prices of salvaged materials.

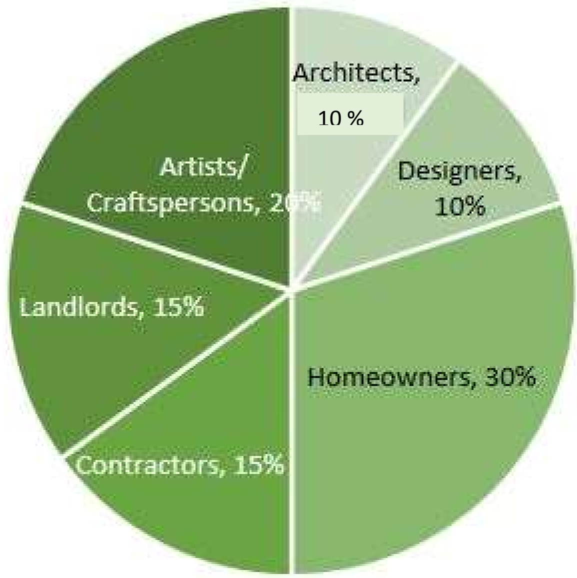

Image 1: Reuse materials customer characterization
Source: Delta Institute. Rebuilding Exchange Business Case for Expansion.

CONCLUSION

Deconstruction seeks to maintain high value for existing buildings that can be used for future recycle or reuse. It is emerging as the better alternative to demolition. The recycling and reusing of construction materials is helpful in preserving natural resources such as petroleum, forests, mines etc. however certain issues like age of the building, training of the labors, limited demand of recycled material makes the deconstruction business less profitable. But, deconstruction has increase the number of jobs. It has been estimated that nearly 3000 jobs will be available in the Detroit region in the deconstruction industry in the near future (Swift, 2014). However, there is limited demand of recycled material as it not strong enough. If a proper business model is designed where there is a specific source of material is available along with the high demanding market then contracts can be able to make a good profit. Many restaurants owner, home owner etc. are very interested in the decorating their buildings with antiques materials. The salvaging market is rising as an alternative cheaper option in the building construction. With technological changes and proper training, deconstruction can not only be a profitable market but also help in community development and environmental preservation. Deconstruction provides a wide scope for research in the fields of construction materials and management, community development and environmental science.

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PROGRAMS AND INCENTIVES FOR DIVERTING CONSTRUCTION & DEMOLITION WASTE FROM LANDFILLS

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Introduction

As the infrastructure in America continues to age, along with changing practices to construction projects - demolition is commonly used for the removal of dated structures prior to new development. A more sustainable approach to demolition is deconstruction, the process of removing materials from a structure for the intent of reuse or salvage. Deconstruction is a relatively new practice, and has started to gain popularity in planning policy in parts of the United States. However, demolition has been used for decades, making it challenging for contractors to change their current practices and business models to become more sustainable. While in many states, legislation does not enforce or incentivize deconstruction methods, some states, such as California, have implemented programs that encourage more sustainable methods of construction and demolition through local planning policy. San Jose, California, for instance, has a sophisticated program in place that acts as a financial incentive for developers and contractors to incorporate deconstruction methods into their projects in order to benefit the community and attain a more sustainable approach to current construction and demolition [C&D] practices.

Methods

San Jose, California, as part of their *Construction and Demolition Diversion Deposit Program (CDDD),* collects a deposit from the developer on construction and demolition projects. The deposit is based on a formula that takes into account the square footage of the structure and the type of project being developed (Nancey & Patterson, 2006). It is at the discretion of the contractor to either landfill the materials, or take the materials to a certified facility and/or reuse or donate the materials in order to receive their deposit back. The deposit is fully refundable by the City of San Jose “with proper documentation that the C&D debris has been diverted” from landfills (California Resources For Sustainability, 2008).

This program, established in 2001 as part of the City's zoning ordinance, includes several details on how to properly divert C&D waste, as well as the programs requirements and exemptions. The ordinance states that, "except as otherwise specified in this part, on or after July 1, 2001, each person who applies for a building permit…shall remit a diversion deposit in the amount set forth by resolution of the city council [and] the diversion deposit shall be remitted at the same time the permit application is filed" (City of San Jose, 2013). Therefore, any C&D project in the City of San Jose that must obtain a building permit is also subject to a diversion deposit. As mentioned earlier, the diversion deposit will be refunded after documentation of diversion of waste is provided and approved by the city council. The requirements for refunding of this deposit are found in section 9.10.2440 of the San Jose Ordinance, which can be found in **Picture 1.** The director of the program may refund the total deposit, or a portion of that based on the amount of waste generated and diverted from landfill disposal. However, the deposit will not be refunded if the contractor does not file for a refund within 12 months after the project is completed.

In order for San Jose to continue to improve and enforce their program, the City-certified facilities used for hauling C&D waste are monitored through monthly reports and annual site visits (City of San Jose, 2012). These site visits ensure that the facilities are recycling these materials as expected by the CDDD program. Waybills are also provided at the diversion facilities, which "include the project's building permit number" to help track and report the amount of waste diverted from the project (City of San Jose, 2012). A waybill is a shipping document that travels along with a shipment to record the origin, destination, weight, and any cosigners of the shipment (Web Finance Inc., 2017). These waybills help both the contractors to gain approval at the end of their projects, and the City Council to determine refunding the deposit by tracking the C&D waste.

9.10.2440 - Refund of diversion deposit.

A. The director may authorize the refund of any diversion deposit which was erroneously paid or collected.

B. The director may authorize the refund of any diversion deposit when the building permit application is withdrawn or cancelled before any work has begun.

C. The director may authorize the refund of a diversion deposit when at least fifty (50) percent of the waste generated by the project was diverted from landfill disposal.

D. The director may authorize a partial refund of a diversion deposit when less than fifty (50) percent by weight of the waste generated by the project was diverted from landfill disposal. The partial refund shall not exceed that portion of the diversion deposit that is in the same ratio as the demonstrated amount of diverted waste bears to fifty (50) percent by weight of the total waste generated.

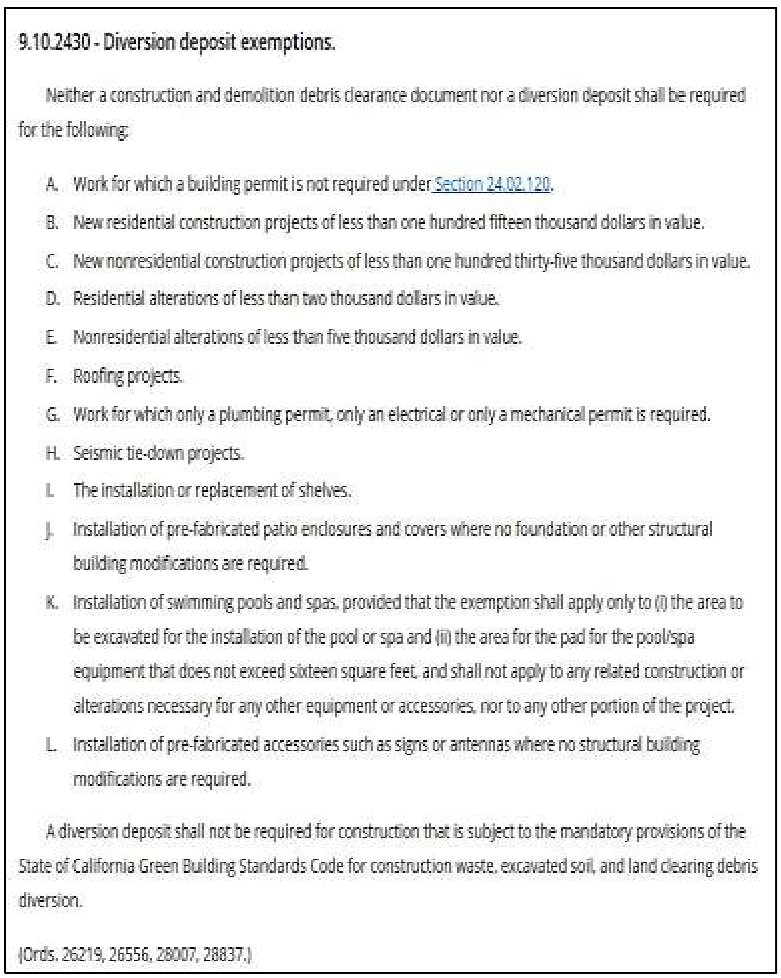
E. The director shall not authorize the refund of any diversion deposit, or any portion thereof, unless the original building permit applicant files a written request for refund no later than twelve (12) months after the building permit is no longer active for any reason (including because the project has been completed, the permit has been withdrawn, or the permit has been revoked), and the applicant provides documentation satisfactory to the director in support of the request.

(Ord. 26219, 28007.)

Picture 1: Section 9.10.2440 Refund of diversion deposit, part of San Jose's zoning ordinance (City of San Jose, 2001)

A later section of the ordinance (9.10.2470), explains how the City of San Jose uses the deposit, and what is done with money not refunded to contractors through the diversion program. It is clearly stated that "moneys received by the city as diversion deposits shall be used only for payment of diversion deposit refunds," (City of San Jose, 2013). This statement, however, is followed by several exemptions in the ordinance (City of San Jose, 2013). Deposits not refunded to contractors, due to reasons outlined in **Picture 1**, will be used to cover costs of the program, such as "cost of administration," "cost of programs that divert from landfill disposal," as well as the "cost of programs that develop or improve the infrastructure needed to divert from landfill disposal" from C&D projects (City of San Jose, 2013). This money may also be transferred to the "general fund" of the program (City of San Jose, 2013). Overall, any money kept by the City acts as a disincentive to contractors as money lost, and an incentive to the City of San Jose to continue to fund, operate, and advance their CDDD program.

The City of San Jose's zoning ordinance is thorough in its requirements and exemptions of the diversion program, and includes a definition of waste diversion and a list of how this can be achieved in building projects. A detailed list of certified recycling facilities and authorized "C&D waste haulers" are made available, as well, by the program, and can be found on their website (City of San Jose, 2013). Some projects, however, are exempt from the deposit; about twelve exemptions in total, and can be found in **Picture 2** (City of San Jose, 2013). The zoning ordinance states that "neither a construction and demolition debris clearance document nor diversion deposit shall be required" for projects such as "new residential construction projects of less than one hundred and fifty thousand dollars in value," for instance (City of San Jose, 2013). Exemption A, "work for which a building permit is not required," is referring to another part of the zoning ordinance regarding building permits – explaining that building permits are not required for "one-story detached accessory buildings…provided the floor area does not exceed 120 square feet" (City of San Jose, 2013). In other words, buildings such as sheds, playhouses, and the like are exempt from obtaining a building permit, and therefore, exempt from the CDDD program. Likewise, "fences not over seven feet high," "oil derricks," and "non-fixed and movable fixtures," do not require building permits in the City of San Jose, either (City of San Jose, 2013).


9.10.2430 - Diversion deposit exemptions.

Neither a construction and demolition debris clearance document nor a diversion deposit shall be required for the following:

A. Work for which a building permit is not required under Section 24.02.120.
B. New residential construction projects of less than one hundred fifteen thousand dollars in value.
C. New nonresidential construction projects of less than one hundred thirty-five thousand dollars in value.
D. Residential alterations of less than two thousand dollars in value.
E. Nonresidential alterations of less than five thousand dollars in value.
F. Roofing projects.
G. Work for which only a plumbing permit, only an electrical or only a mechanical permit is required.
H. Seismic tie-down projects.
I. The installation or replacement of shelves.
J. Installation of pre-fabricated patio enclosures and covers where no foundation or other structural building modifications are required.
K. Installation of swimming pools and spas, provided that the exemption shall apply only to (i) the area to be excavated for the installation of the pool or spa and (ii) the area for the pad for the pool/spa equipment that does not exceed sixteen square feet, and shall not apply to any related construction or alterations necessary for any other equipment or accessories, nor to any other portion of the project.
L. Installation of pre-fabricated accessories such as signs or antennas where no structural building modifications are required.

A diversion deposit shall not be required for construction that is subject to the mandatory provisions of the State of California Green Building Standards Code for construction waste, excavated soil, and land clearing debris diversion.

(Ords. 26219, 26556, 28007, 28837.)

Picture 2: Section 9.10.2430 - Diversion deposit exemptions, part of San Jose's zoning ordinance (City of San Jose, 2001)

DISCUSSION

Currently, San Jose, California, has one of the highest overall recycling rates in the country, "recycling over 73% of solid waste citywide" (City of San Jose, 2012). When the CDDD program was first enacted in 2001, the goal for waste diversion for C&D projects was set at 65% (City of San Jose, 2012). Since then, and in addition to the adoption of the 2013 CalGreen program, San Jose has modified their CDDD program to set a goal of 75% waste diversion rate. The CalGreen program is a similar program, however, it "established mandatory waste diversion targets at 50%," compared to San Jose's 75% diversion goal, "for all municipalities in the State of

California" (City of San Jose, 2012). With the relatively recent addition of the CalGreen program to state legislation, San Jose has had to make a few adjustments to their local policies, in order to be in compliance with the CalGreen program. For instance, the CDDD program now includes that all C&D projects are "subject to a non-refundable $100 Review fee" (City of San Jose, 2012). Furthermore, in 2016, an addendum was added to the San Jose zoning ordinance regarding the "adoption of CalGreen provisions," stating:

Except as otherwise provided for in this chapter, the residential mandatory measures and nonresidential mandatory measures of the California Green Building Standards (CALGreen) 2016 edition, together with those omissions, amendments, exceptions and additions thereto as amended in Title 24 of the California Code of Regulations are approved and adopted, and are hereby incorporated in this chapter by reference and made a part hereof the same as if fully set forth herein (City of San Jose, 2001).

Before CalGreen, most C&D projects were subject to the CDDD program in San Jose, besides those exempted that are outlined in **Picture 2.** Since the adoption of the CalGreen program, a majority of C&D projects are subject to CalGreen 2013 requirements, before review through the CDDD program. The only projects explicitly remaining under the City of San Jose's CDDD system are "non-residential alterations under $200,000 in value, non-residential additions under 1,000 square feet, and residential alteration/addition activities that do not increase the building's area, volume, or size" (City of San Jose, 2012).

California has several municipalities, along with San Jose, that aim to encourage more sustainable approaches to demolition and deconstruction. For example, the City of San Diego has formally adopted an "immediate 50% reduction goal," since the 2013 CalGreen program was adopted (NEMCOG, 2016). San Diego has also "implemented a demolition permit fee, waste disposal fee, and waivers" as methods to induce businesses to utilize "acceptable recycling facilities for recycling concrete and bricks" (NEMCOG, 2016).

Similarly, the City of Los Angeles has "formally adopted a 70% diversion goal for the year 2020" (NEMCOG, 2016). Los Angeles is currently exceeding their goal, since 2013, diverting at a rate of 76.4% (City of Los Angeles, 2013). The City has recently adjusted their local zoning ordinance to comply with the CalGreen requirements, as well. In order to continue to maintain their goal and encourage sustainable practices, Los Angeles is "actively engaged in the community and in the education and outreach business" (NEMCOG, 2016). Education and outreach are two of the biggest barriers to promoting deconstruction methods, and connecting businesses with educational resources can be beneficial for the City's goals and the environment (Nancey & Patterson, 2006).

Engaging local businesses to practice deconstruction methods can provide community benefits, as well. For instance, in Oakland, California, "a collaborative effort between the Youth Employment Partnership and Beyond Waste, Inc. trained at-risk youth to deconstruct a former Navy supply center," (NANCEY & PATTERSON, 2006). A team of "4 supervisors and 15 youths" were able to divert "over 425 tons of waste and salvaged 315,000 board feet of lumber for further processing" (NANCEY & PATTERSON, 2006). Generally, hard-to-employ individuals and at-risk youth are in need of basic jobs skills and experience; and this project was able to not only provide jobs for the at-risk youth, but also generate benefits to the community of Oakland, California.

Some cities impose a delay on demolition projects to encourage deconstruction practices. Gainesville, Florida has the ability to place a 90-day demolition delay on any residence 45-years old, or older (Nancey & Patterson, 2006). During this period, the structure is “advertised as free to anyone willing to pay the costs of relocating it to their own site” (Nancey & Patterson, 2006). In the property shown in **Picture 3**, a historical home was being offered for free to anyone willing to relocate it. The delay was imposed because this home, in particular, was built in the early 20th century – over 45 years ago. This particular site was intended to be developed into a new medical facility (The Gainesville Sun, 2015) therefore, it needed to be relocated within 90 days or else be demolished. Melanie Barr, a community member, and member of the Alachua County Historical Commission, said that “there is no need to destroy it, people just need time and it should not be thrown in the dump” (The Gainesville Sun, 2015). Her statement reflects the practices of sustainability and deconstruction, because there are materials and appliances within the home that can be recycled or salvaged, making it unnecessary to demolish and landfill the materials. However, it could be argued that this strategy might pose a challenge for public members to find the space and storage for relocating structures within the 90-day time period.

Picture 3: Section 9.10.2430 - Diversion deposit exemptions, part of San Jose’s zoning ordinance (The Gainesville Sun, 2015))

CONCLUSION

While the State of California, and many other places in the United States have been successful in promoting and encouraging sustainable approaches for construction and demolition projects, many other areas in the country are lacking. As mentioned, there are several barriers to promoting deconstruction today. Labor costs, education, and government involvement are a few of the biggest concerns for contractors and developers to engage in more sustainable C&D practices. However, the State of California, along with several of its municipalities have engaged their communities and local zoning ordinances to incorporate provisions that encourage deconstruction methods. Hiring hard-to-employ and/or at-risk youth for basic work and trade skills – as in Oakland, California, and providing outreach and education programs, such as those in Los Angles, are a few strategies used to overcome the current barriers to deconstruction. A growing market in places like California and Florida for deconstruction materials, could perhaps encourage and influence the remainder of the United States to begin to adjust their current C&D methods to more sustainable approaches, and soon realize that deconstruction has the ability to provide benefits to the environment, the economy, and the community.

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IMPLEMENTING DECONSTRUCTION METHODS IN THE UNITED STATES

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INTRODUCTION

While the United States recycles a large amount of waste, a small fraction of construction and demolition materials are recycled, and instead are left in landfills, leaving less room for materials that cannot be reused as easily. The existing benefits that come from recycling construction and demolition (C&D) materials heavily outweigh the benefits of trashing them, but it is the implementation of deconstruction that is challenging to many developers. European counties are setting the example in becoming sustainable, both with their recycling habits, government regulations, and deconstruction policies. If the United States wants to become sustainable, they might need to look towards Europe's deconstruction policies that will help reduce the volume of waste that is currently filling landfills.

BENEFITS OF RECYCLING C&D WASTE

Recycling construction and demolition materials yield benefits that can have a significant impact on communities at the local level and the environment on a global scale. Charles J Kibert and Abdol R Chini of the University of Florida point out in *Overview of Deconstruction in Selected Counties* that "C&D waste represents about one-third of the volume of materials entering landfills" (Kibert/Chini, 7). Seeing that the United States creates massive amounts of waste per capita, landfills would be left better off if they were not already filled with C&D waste. But, diverting these materials is only the first advantage deconstruction has over demolition. Another advantage is that developers can reuse salvaged materials, including the possibility of trading them or selling them for profit. The deconstruction business is one that has much potential in the eyes of the construction industry, and other countries are already taking advantage of this business.

Enhancing environmental protection is possibly the most important advantage that comes with deconstruction, an advantage that is so easily overlooked by many governments. Deconstruction "preserves the invested embodied energy of materials, thus reducing the input of new embodied energy in the reprocessing or remunerating of materials" (Kibert/Chini, 7). This process helps prevent the unnecessary extraction of virgin resources, including the processing and transportation that go along with manufacturing these materials. All these resources are currently being taken advantage of in many European countries; however, it is important to note that this may be because their collective waste streams are less than that of the United States. Also, with an excess of land in the United States, there is no sense of urgency when it comes to protecting what little natural open space is left. When one landfill is filled up, it is simply relocated, without considering any consequences that come with creating a new landfill. These deconstruction advantages could incentivize developers to consider this new process rather than resort to demolition.

THE CURRENT STATE OF LANDFILLS IN THE US

According to the National Association of Home Builders (NAHB), an estimated 8,000 pounds of waste is created from the construction of a 2,000-square foot home. The average sized home in Michigan comes in at about 2,500 square feet, and seeing that most housing materials are not recycled, that is a terrifying amount of wasted materials. However, when waste reduction becomes a major focus, there are a number of benefits. First, a focus on waste reduction brings down the price of construction, builders often over order materials such as dry wall and wood, and these over ordered materials often find themselves in landfills. Simple planning can help keep these unnecessary materials out of landfills, as well as keep money in builder's pockets. Another benefit is waste reduction provides materials for future projects, simply by recycling these materials. It is estimated by the EPA that up to 40% of the nation's total waste is due to C&D waste (in-text citation needed).

The reuse of building materials in crucial to keeping landfills uncluttered and open for appropriate waste. This is a topic that rarely comes across the mind of the everyday consumer, even though landfills are a collection of everybody's waste. Without knowing it, the average person produces around 4.6 pounds of waste every day. When it comes down to it, construction material recycling is critical to reducing the total quantity and volume of the waste stream, especially in smaller communities, where construction materials could easily overflow a landfill. Part of the reason US landfills are filling up at alarming rates is because of how uneducated people are when it comes to waste and recycling habits. Estimates from the EPA indicate that only 53% of paper products in the United States are recycled every year. While this number has increased dramatically in recent years, half of all paper products are still making their way to landfills, but compared to statistics from the 1960s, the United States is currently producing three times as much waste. As if these facts are not alarming enough, it gets worse. The United States have over three thousand active landfills and ten thousand reactive or "old" landfills that are no longer being used. While recycling is increasing each year, so is consumption. The scary reality is that without change, the United States could be sacrificing natural open space for future landfills, space that could be used for parks or future sustainable development.

CHALLENGES FACING DECONSTUCTION

With appropriate policy making, the challenges facing deconstruction can easily be overturned. As Kibert and Chini point out, these challenges can be categorized as either design challenges or policy challenges, which is why is it important for local communities to start incorporating deconstruction policies into their master plans. The most obvious challenge is the fact that the buildings were not designed for deconstruction, thus making it difficult to integrate deconstruction methods into existing development. Not only are buildings not built for deconstruction, but the costs for disposing C&D waste is extremely low in the United States. This incentivizes developers to stick to their old methods, but we have witnessed ways to fix this, such as the United Kingdom's land fill tax programs. In this program, there are two tax rates, a lower rate and standard rate, depending on the type of waste. "Inactive waste", such as rocks and soil, would fall under the lower rate, which is significantly lower than standard rates waste. A challenge that is of major concern by developers is the additional time deconstruction requires, however, this is not always the case. Deconstruction extends the C&D waste removal process only slightly, and the advantages greatly outweigh this specific challenge. While the re-certification of salvaged materials is not always possible, a large amount of the materials can be recycled for future purposes, specifically wood, brick, concrete, and metals. Probably the most apparent challenge is the fact that the benefits of deconstruction are not well established, both within local governments and the construction industry. Through education and awareness, these benefits can be brought to light and deconstruction can become more established in the United States, thus lowering the volume of C&D waste in landfills, awhile while protecting the environment, creating jobs, and so much more.

MATERIALS THAT CAN BE RECYCLED

Nearly every material that is used for construction can be repurposed one way or another. It is up to the developer how these materials are reused before deciding to pitch them instead. Looking at the waste management hierarchy from the *Overview of Deconstruction in Selected Countries,* landfills truly are a last resort for disposing C&D waste.

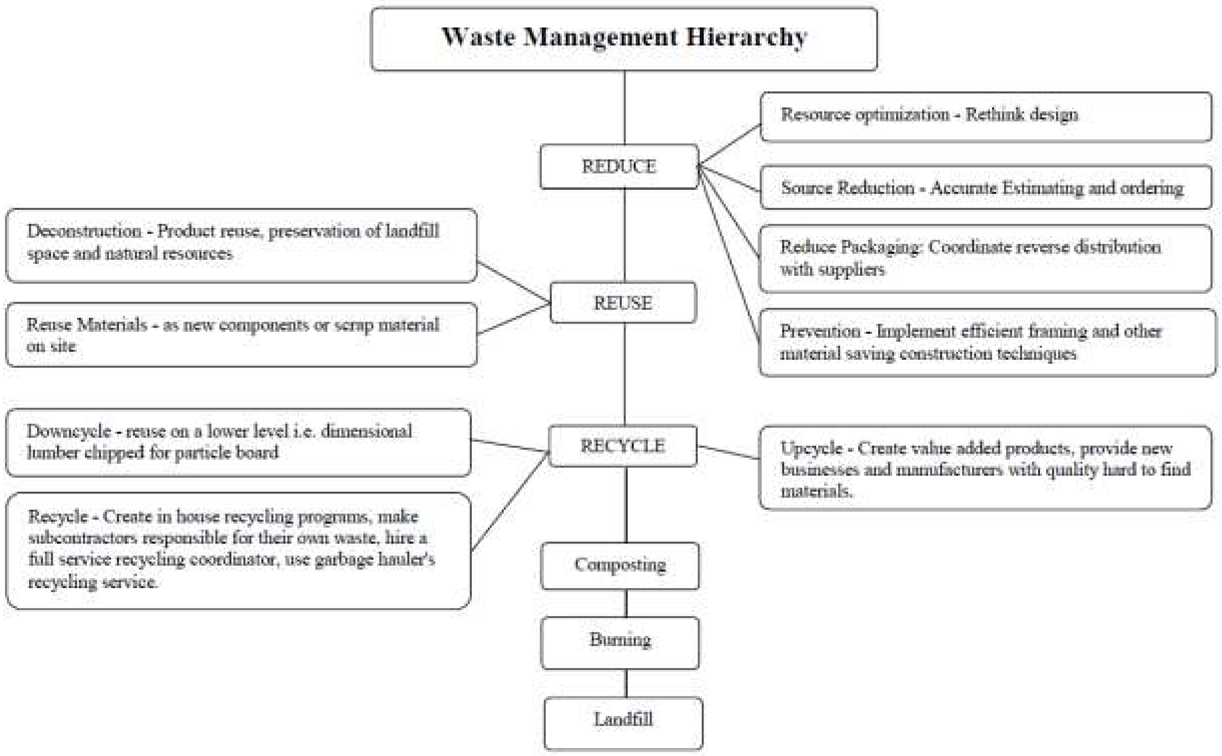

Figure 4: Waste Management Hierarchy

The best way to reduce waste is to rethink design before development, an argument that support designing buildings for adaptive reuse or future redevelopment. Reducing construction materials goes a long way, cutting down carbon emissions and the extraction of limited raw materials. Reusing and recycling materials follow closely behind reducing waste, and both concepts can greatly help divert C&D waste from landfills. But what materials can be recycled? This is a common question among developers, and the answer is simple. Almost every material can be reused or recycled in some way, starting with wood. Wood is a resource that is prioritized heavily in development, and there are several recycling opportunities that come with wood. Examples of reusing and recycling woods include incorporating used wood into new building projects, such as tables, doors, trim, desks, chairs, and so on. Wood can also be repurposed as mulch for landscaping, pulp for paper production, and even as fuel. Wood is considered one of the most wasted resources that fill landfills, so it is important that developers consider their options before throwing it away.

Brick, concrete, and asphalt can all be used as well, mainly in the production of new roads. This idea is often practiced by the US Federal Highway Administration, seeing that they generally recycle concrete and asphalt from old roads in the production of new highways. By recycling these heavier materials, there is less need to continue gravel mining, just one of the benefits derived from recycling. Plastics are an obvious material that most American consumers understand is recyclable, so there is little to no excuse why developers would dispose of plastic related building materials into landfills. Glass is another C&D material that can be recycled easily. Through demolition, glass is completely destroyed and can no longer be used, possibly in the reproduction of fiberglass insulation products, AstroTurf, ceramic sanitary ware, and so forth. Seeing that there are numerous ways each material can be recycled or even repurposed, encouraging developers to stray away from landfills and instead recycle is a key way to help divert unnecessary materials into landfills.

EUROPEAN TRENDS

Countries such as Switzerland, among other European countries, lead the charge in waste reduction and energy efficiency. Granted, there are some striking differences between European countries and the United States. First, there is a much larger population on the United States, and with a greater population comes more waste, it is inevitable. European counties, especially Scandinavian countries, pride themselves on being eco-friendly, pledging to become complete reusable energy efficient by 2050, and the United States should follow in their footsteps.

Another striking difference lies within the different plans for infrastructure growth. The world is changing quickly, and it is no longer centered on the automobile. The growing concern of climate change is one reason why people are moving away from their cars towards public transportation, such as cars, buses, trains, and so on. Europe does a good job with centering their cities on sustainable means of transportation, and they do so in an ecofriendly way. But, with President Donald Trump's promise of revamping America's infrastructure, it is essential that the C&D waste does not end up in landfills, but is instead incorporated into future development.

All construction waste management in Switzerland lies under the regulations and procedures of the Environmental Protection Law, which requires waste to be avoided by reusing as much as possible (cite). According to the Department of Civil, Environmental and Geomatic Engineering in Switzerland, "approximately 11.1 million tons of construction waste is generated per year, excluding excavated earth, 84% is reused" (Wallbaum, 1). This is made possible because of the resources available for waste owners, such as was disposition companies and waste-law executing authorities. A majority of the recycled building materials is used for road construction, aiding Europe's ongoing efforts in creating solid infrastructure. The remaining 16% of construction waste is either disposed of into landfills or incinerated, and wood makes up two-thirds of the burnt construction materials. Among their efforts to reduce waste, Switzerland encourages developers to go a step further in hope of becoming as sustainable as possible. The Swiss have created an agenda aiming to strengthen and boost sustainable development at all levels through the 2030 Agenda.

Europe has a certain mindset when it comes to creating new policies that do not overshadow the importance of protecting the environment. The United Kingdom set a good precedent with their landfill tax, which was introduced in 1996. Since then, it has "contributed to a significant increase in the number of fixed and mobile crushing and recycling sites" (Kibert and Chini, 162). This is important to note not only because of the C&D waste that is being diverted from landfills, but it has helped produce jobs that work with the recycled materials. In fact, the United Kingdom's reclamation industry has created many jobs that would otherwise not be available, as seen in the chart below. However, European efforts do not stop with Switzerland and the United Kingdom. Germany, between 1991-1999, revealed in a case study that there was a high recovery rate of construction materials through deconstruction in many structures, ranging from industrial to residential.

Table 1 - Size of reclamation industry and market (U.K.)

Sector	Sales £ million	Employment	Tonnes 000's
Architectural antiques			
Stone	17	2100	71
Timber	4	1100	7
Iron & steel	4	800	7
Clay	1	800	2
Ornamental antiques			
Stone	16	1170	22
Timber	36	1740	22
Iron	9	1000	9
Clay	1	100	1
Reclaimed materials			
Timber beams	42	3600	137
Timber flooring	29	2960	105
Clay bricks	31	4300	457
Clay roof tiles	63	3600	316
Clay and stone paving	19	1300	694
Stone walling	29	2450	1118
Salvaged materials			
Iron and steel	11	2800	77
Timber	36	7800	383
Antique bathrooms			
Sinks, baths, taps, WCs	41	1900	1
TOTAL	**389**	**39520**	3430

Figure 5: UK's Reclamation Industry/Market

The Netherlands have been making their mark on the deconstruction industry as well. They have placed strict government regulations that divert nearly 80% of all C&D waste from landfills to future construction projects, usually for creating materials for road bases. Alongside their various government regulations, "efforts are underway to being the process of informing architects and other actors in the construction industry about the potential for designing buildings for deconstruction" (Kibert and Chini, 9). This was viewed as a challenge for deconstruction, seeing that a small fraction of existing buildings in the United States are designed for deconstruction. By informing architects and other players about the importance of designing for dismantling, demolition could become a tool of the past. Norway fits into this practice as well, as the Gaia development group, a group of architects, have already established the "Building Systems for Reuse." This concept reflects environmental concerns because while designing for reuse, they are also including smart growth tactics and green infrastructure in the development of future buildings. Europe has the upper hand when it comes to deconstruction, and incorporating these tactics into development in the United States could save time, money, resources, and the environment.

IMPLEMENTING EUROPEAN TRENDS

While the United States is still a far way off from being as environmentally conscious about deconstruction as Europe, there are efforts currently underway that provide a glimmer of hope for developers in the states. The Environmental Protection Agency (EPA) does a good job when it comes to providing resources for those who are interested in reducing, reusing, and recycling construction material. Through their website, many resources are available, such as trade associations, research and education organizations, and buyers and sellers of reusable and recyclable commodities. As far as trade associations go, the Associated General Contractors of America (ADC) are the largest construction trade association in the United States, representing over 26,000 firms. The idea of a trade association representing so many firms is important in connecting developers to resources that are vital to construction, it offers them the possibility of buying recycled materials instead of buying new materials, which is not nearly as sustainable.

By including research and education organizations, the EPA is doing their part in getting the word out there, considering the lack of deconstruction education is a major challenge facing the industry. One group that sticks out the most is the Smart Growth Network, a coalition of organizations, including the EPA, which promote sustainable community development. Deconstruction and sustainable development go hand in hand, seeing that sustainable development focuses on reducing the environmental impact development has on the built environment while taking the natural environment into consideration. Included on the EPA's website is a list of websites that link buyers and sellers of reusable and recyclable commodities. This help increases the awareness of the ability to reuse materials before throwing them into landfills, and at the very least, it may incentivize developers to possibly sell their materials before pitching them. These resources are beneficial to both the developer and the environment, and the next step in establishing deconstruction as a consistent and reliable resource of C&D removal is to incorporate these tactics into United States legislation.

RELEVANCE TO DOMICOLOGY

Domicology focuses on the lifecycle of buildings, so it is only fitting that once a building exceeds its lifespan, is it disposed of in an appropriate way. Demolition is an unsustainable method when it comes to removing C&D waste and it reduces any possibility of reusing or recycling the materials. Domicologists also have the job of identifying "potential innovative tools, models, policies, practices and programs that can sustainably address structural life cycles and abandonment" (LaMore, 4). Both Domicology and deconstruction, which are fairly new concepts, could help reduce the number of abandoned structures in urban areas though environmentally friendly processes.

CONCLUSION

Today, the recycling of construction materials is becoming a necessity to become sustainable, as seen in many European countries. When considering the pace in which population is rising, landfills will not be able to answer waste problems forever, especially when they are being filled with building materials that could be reused or recycled. There are many ways building materials can be recycled, and it is the job of the planner to make sure that natural land is protected from becoming just another landfill. While the United States recycles a large amount of waste, there is still work to be done, especially when it comes to dealing with construction materials. If the United States were to reuse the same percentage of building materials as Europe does, landfills might be not as abundant. Landfills should be reserved for waste that is useless, not for materials that could save developers money or help preserve the environment. Deconstruction promises a brighter future which includes new jobs within the construction industry and environmentally friendly policies that reflects the growing concerns of landfill overflow.

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Concrete and Asphalt: Workhorse Construction Materials with Useful Recyclable Applications

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INTRODUCTION

Asphalt and concrete are two of the most common building materials utilized in the construction industry. Both materials have a wide variety of uses in buildings, including, but not limited to: foundations, structural supports, walls, and roofing. They are critical components of modern infrastructure, such as roads, bridges, and parking surfaces. Despite the utility of both materials in the construction process, they are routinely discarded after the demolition process. Townsend et al. (2015) estimated that approximately 480 million tons of Construction and Demolition Waste (CDW – also commonly termed C&DW) were generated in the United States in 2012. The vast majority of concrete and asphalt demolition waste finds its way into landfills, thwarting its potential as a recyclable commodity on the open market. Over the past few decades, however, there has been increasing interest in reutilization of these materials instead of trashing them. Well-defined recycling processes exist that are conducive for these materials to be crushed and sorted before being successfully reutilized in new applications. This process fills material needs while also reducing the overall cost of the formulation of new material mixes. While the processes vary by the material and its initial form, the concept is the same: reuse the material for a beneficial purpose. Townsend et al. (2015) estimates that significant amount of CDW material in the United States currently enters a recycling process for eventual reutilization, demonstrating a vested interest on the open market for repurposing recycled materials.

In order to best explain the value of these two materials in the emerging field of Domicology, this paper will provide an in-depth examination of the recycling processes and uses for recycled asphalt and concrete. The first goal is to explain why both concrete and asphalt are recyclable materials worthy of interest and investment and why sending them off to a landfill as trash is not prudent in light of their value. Their value is primarily derived from the reduced necessity of both extraction and processing of virgin material to re-create what is already on site. A second goal shall be to describe both the demolition and recycling processes for both materials. A third goal is to define how recycling asphalt and concrete provides a sustainable source of post-consumer material that can be utilized in new construction. The concepts of recycling and "thinking green" have become well-entrenched in the paper and metal industries, but are still in the development stage regarding demolition waste. Marketing concrete and asphalt as environmentally-sustainable products, is necessary to understand how recycling these materials may provide a sustainable alternative option. Lastly, obstacles that are present in the recycling process, such as the release of dust particulates, shall be explained, along with the methods being used to counteract the dangers and increase the overall amount of material that is deemed to be recyclable.

CONCRETE APPLICATIONS IN THE BUILT ENVIRONMENT

Concrete is the result of mixing two important materials: Portland cement and water. Portland cement is the keystone element in the formulation of concrete. It is produced by the mixing of limestone, shells, cement rock, clay, silica sand, and fly ash, and then heating the mixture to a very high temperature in a rotating kiln. The heating process, called "calcining", reduces and recombines the ingredients (Portland Cement Association, nd.a). After the final product is ground down into a powder form, it can be stored or shipped, but must be kept dry. When concrete is needed, the Portland cement powder is combined with water to create concrete paste (Portland Cement Association, n.d.b). Over the course of the next several hours, the paste begins to harden until it is capable of retaining a shape while forming an interconnected system of gel pores (a structure of chemical bonds that act as binders) and capillary pores (open space) (Powers, 1958). Additional elements, such as iron and aluminum, may also have been intentionally added to the Portland cement; these elements impact how the concrete mixture reacts to differing environmental conditions (Powers, 1958). Its hardness and durability make concrete a very good building material; it is estimated that over 2 billion tons of concrete are produced annually (Crow, 2008).

Concrete is the most-commonly used anthropogenic material in the world. Due to its ubiquity within the global construction industry, the World Business Council for Sustainable Development postulates that twice as much concrete is in use in structures and roads than all other building materials combined (World Business Council for Sustainable Development, n.d.). Some of the main uses for concrete within the building construction sector include the manufacture of concrete blocks, roof tiles, or building foundations. Concrete buildings rival steel buildings as solidly-constructed structures which can last in varying weather and other environmental conditions. Concrete homes offer strength and durability while also providing cleaner home air quality (due to fewer volatile organic compound emissions, which are generally found in paints, sealants, and treated wood products) and recycling potential after the useful life of the structure (Portland Cement Association, n.d.c).

Asphalt Applications in the Built Environment

Asphalt, according to the European Asphalt Pavement Association, "is a mixture of aggregates, binder, and filler, used for constructing and maintaining all kinds of roads," (European Asphalt Pavement Association, 2015a). A binding agent, such as bitumen, a byproduct of oil extraction, is used to coat larger pieces of aggregate material (such as sand or crushed rock). Finely-ground filler material is present to help plug open spaces within the pliable mixture before it is compacted and allowed to cool, forming a solid mass with high hardness. Asphalt pavements have proven to be cost-effective yet durable, thereby reducing overall installation and maintenance costs. The water-resistant properties of asphalt allow for increased runoff and drainage abilities of asphalt-based pavements over pavements made from other materials (European Asphalt Pavement Association, 2015b). The National Asphalt Pavement Association (n.d.) estimates that 94% of the paved roads in the United States are comprised of asphalt pavement. Asphalt pavement is also used for varying purposes such as airport runways, sport courts, and as liners for water reservoirs or landfills due to its high tensile strength and impermeability (National Asphalt Pavement Association, n.d.).

In the construction of buildings and homes, asphalt is most often found in composite asphalt roofing shingles. Asphalt has notable water-resistant properties that make it an attractive choice for roofing shingles; the material typically comprises 20-30% of the total mass of a composite shingle (Zhou et al., 2013). When combined with other materials such as sealants, stabilizing fillers, fiberglass binding, and mineral granules which form the exterior of the shingle unit, asphalt shingles are popular choices to protect buildings with steep-slope roofs from the outside elements (Noone and Blanchard, 1993). Over time, that resistance will diminish due to weathering from repeated exposure to the elements. Major detriments to shingles include moisture, the growth of mold or bacteria on or inside shingles, and the freeze-thaw cycle (Berdahl et al., 2008). A study on the effects of hail pellets on shingles found that despite initial resistance when new, shingles experienced more damage from hail when weathered (Cullen, 1992). Thermal heating, generally arising from exposure to the sun is another detrimental factor for asphalt shingles; Kemp and Predoehl (1981) found that a rise in temperature of only 10 degrees Fahrenheit caused a doubling of thermal oxidation in road-based asphalt pavement. The Asphalt Roofing Manufacturer's Association has mandated that asphalt roofing shingles not be placed over thermal insulation due to the repeated exposure to high temperatures for this reason (Asphalt Roofing Manufacturer's Association, 1996).

REMOVAL METHODS FOR CONCRETE AND ASPHALT MATERIALS

The destruction of concrete structures may be carried out in a number of ways. A crane equipped with a wrecking ball attachment is one of the most frequent demolition methods used on concrete structures. Other common methods include pneumatic or hydraulic breakers (more useful for smaller projects), pressure bursting (accomplished by shooting high-pressure liquid into the material, causing it to fracture), or the placing and detonation of explosives within the structure (Hudgins, 1989). Different methods may be required depending on the context in which the demolition is to be conducted. In the middle of a crowded urban block, utilizing a controlled series of explosives may minimize damage to surrounding buildings. Where more space is available, or other constraints prevent explosives from being a viable option, non-explosive methods such as the wrecking ball, bulldozers, or other heavy equipment may be required to demolish a concrete structure (Usman and Said, 2013).

Asphalt pavement is fractured through similar processes to those used for concrete demolition. The most common method is through a specially-equipped bulldozer or pneumatic pavement breakers that cause fracturing for complete pavement removal. Milling, a process in which only a portion of the asphalt pavement is removed from the surface, is mostly used for resurfacing projects and not for complete pavement removal (Federal Highway Administration, n.d.). Frequently, milling acts as a precursor step to the use of recycled material as replacement pavement in new asphalt mixes. Asphalt shingles, on the other hand, are typically torn off a roof by hand during a re-roofing job or when a structure is demolished. The shingles are then sent to be recycled if the material is suitable for such an end purpose.

CASE STUDY: DEPAVE – PORTLAND, OREGON

Although the use of heavy equipment is commonplace for the removal of asphalt and concrete surfaces, interest in small-scale material removal projects is burgeoning. Depave, a nonprofit organization started in Portland, Oregon, in 2007, aims to tap into community resources and participation in its mission to green the city. Depave seeks to instill a sense of nature back into the urban landscape through: 1) Providing information, inspiration, and technical assistance to those wishing to remove concrete and asphalt, 2) Educating the public about the benefits of pavement removal, 3) Advocating to minimize and/or reduce the amount of impervious pavement in public construction and repair projects, 4) Promoting responsible and creative reuse and recycling of concrete and asphalt, and 5) Providing an opportunity for greater connection with the natural world." (Depave,a, n.d.)

The organization fields requests from schools, places of worship, or other community organizations for small-scale asphalt or concrete removal projects. Many projects include the removal of unwanted parking lot or playground space. Once the projects are determined, the organization seeks grants or other funding opportunities to cover overhead costs for rental equipment and personnel. Community members are then invited to join in the demolition process, utilizing hand tools such as prybars and wheelbarrows to break up the unwanted material and to transfer it to drop boxes. Once the material is collected in the drop boxes, it is shipped to a recycling plant. The depaved space can then be reclaimed as ‘greenspace’, which are transformed into a variety of uses such as rain gardens, outdoor learn-and-play spaces, and green landscaping (Depave,a, n.d.; Personal Communication with Eric Rosewall, January 2017).

Depave, and its sister organizations in the Puget Sound, Washington region and city of Calgary, Alberta, Canada, rely on a unique business model in its approach to asphalt and concrete removal. While the jobs the organizations complete could be finished quickly by a trained demolition crew using power tools or heavy machinery, Depave involves the community in the demolition process. Not only does community involvement remove the need for trained and paid work crews (Depave work crew leaders are all volunteers), but it also provides community members with a sense of personal accomplishment in the process. Through their efforts, community members are able to reclaim a small bit of nature in their own community that can then be transformed into a distinct part of the urban landscape. As more communities around the United States are showing interest in the depaving process and reclaiming urban greenspace, Depave and its fellow organizations aspire to be a source of vital knowledge and resources for all interested parties (Depave,b, n.d.; Personal Communication with Eric Rosewall, January 2017).

After the demolition process is completed, it is necessary for the demolished materials to be sorted according to their ability for repurposing. Such a process typically requires the demolished material to be placed into dumpsters or drop-boxes and trucked to a recycling plant if it has recycling potential. Hendriks and Janssen (2001) classify CDW materials into five distinct categories based on their ability to be salvaged for reuse. Grade ‘A’ material according to the metric are materials which may be removed from a structure and are easily reusable; such material includes wood or steel that is in good condition. Grade ‘B’ materials have reuse in the same application after being processed; concrete, masonry, and certain forms of wood fall under this category. Grade ‘C’ materials have been termed ‘Combustibles’, and comprises fibrous materials such as poor-grade wood, paper, and fabrics. Grade ‘D’ materials can be reused in another application to somewhat useable if recycled correctly; such materials include metals, glass, and plastics. Grade ‘E’ materials are materials which are infeasible for processing or recycling; these materials may be contaminated with dangerous components such as asbestos, or be a mix of CDW (Hendriks and Janssen, 2001). Many materials, especially those which contain hazardous components such as lead or asbestos, cannot be recycled and are subjected to hazardous material disposal protocols.

THE PROCESSING OF WASTE CONCRETE MATERIAL

Concrete-based demolition material must first go through processing before it is available to be reused, as shown in Figure 1. It is first crushed to an appropriate granular size (Hansen, ed., 1992). The material is then cleaned and cleared of undesirable contaminants. Additional cleaning and screening processes of the remaining materials are necessary to achieve the desired concrete mix grade (Construction and

Demolition Recycling Association, nd.). Some construction operators have implemented mobile crushers and sorters into the work site to reduce the need for a secondary recycling plant; most recycling operations still rely upon a designated recycling plant to refine the recycled material into high-quality aggregate (World Business Council for Sustainable Development, 2009).

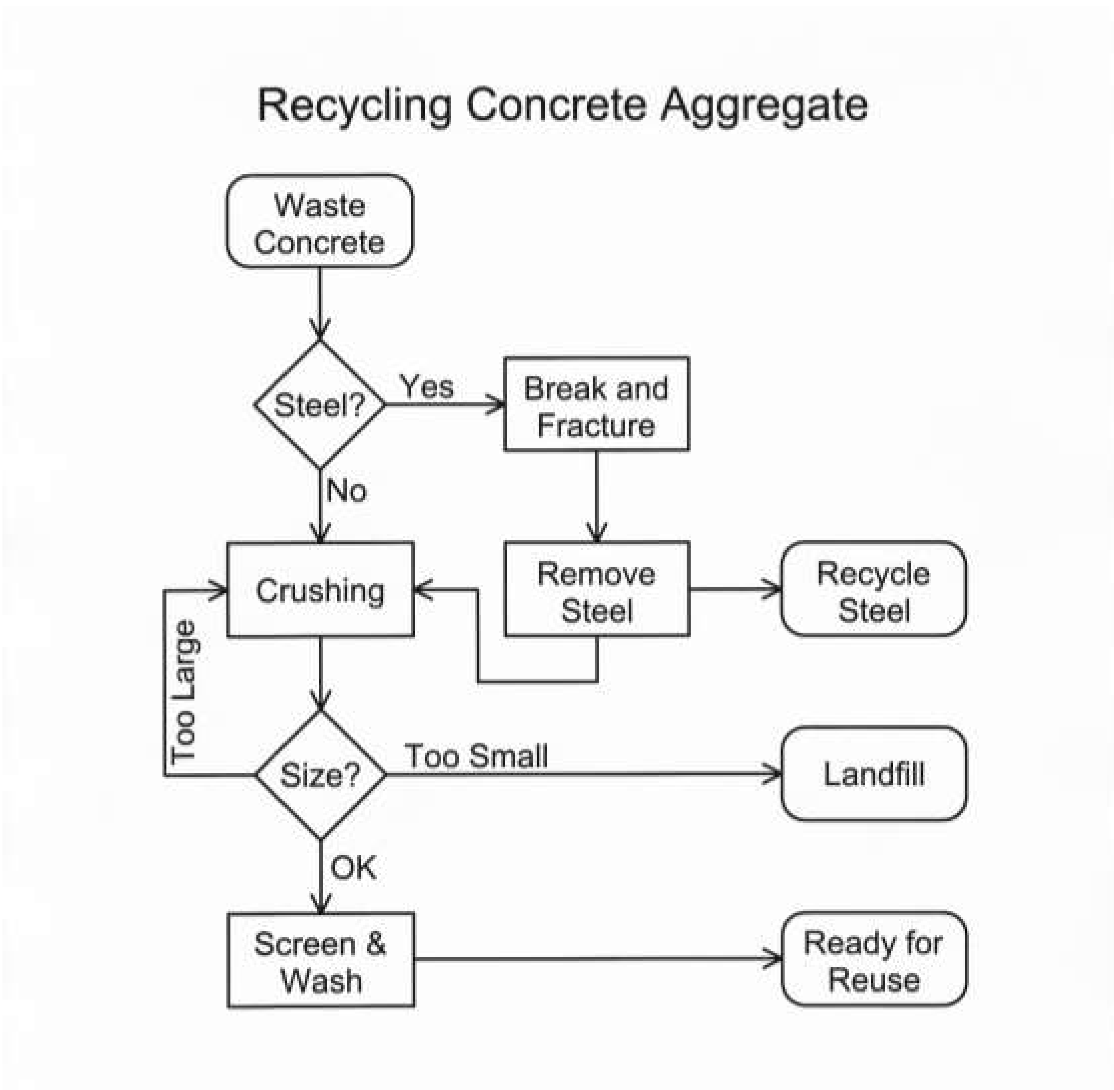

Figure 1: The recycling process for concrete aggregate requires crushing, screening, and washing prior to potential reutilization.

Reinforced concrete sheets prove more difficult to crush than standard concrete blocks because of the addition of steel components within the concrete. This metal, termed 'rebar', is utilized to strengthen concrete tasked with supporting heavy loads such as bridges or high-rise buildings. Over time, exposure to road salts and weather may impact the strength of the reinforced concrete, resulting in fractures of the concrete and corrosion of the rebar. Such degradation requires eventual replacement of the concrete to prevent system collapse (Vorster et al., 1992). Rebar and steel mesh, another common reinforcing agent, must be removed from concrete before either material may be repurposed. The reclamation process can take many forms, including the use of a specialized crusher that is capable of breaking the reinforcements. The crushed material is then sorted so that both concrete and rebar may be recycled (Abudayyeh et al., 1998). Other common methods of rebar removal are the use of a jackhammer to break up the concrete surrounding rebar, or the use of magnets to attract steel components from a concrete slab prior to crushing of the slab. Reclaimed steel has value as scrap material, which may offset some of the costs involved in its removal.

THE PROCESSING OF WASTE ASPHALT MATERIAL

Asphalt recycling has increasingly been utilized as a method of removing older asphalt pavement sheets (termed as Recycled Asphalt Pavement – RAP) or recycled asphalt shingles (RAS) and subsequently using the processed recycled material as a binding agent or filler in new asphalt pavement mixes (ARRA, 2001). These mixes are often utilized to lay down a fresh sheet of asphalt on existing surfaces that have previously been milled (Karlsson and Isacsson, 2006). Asphalt recycling was identified as a cost-saving and environmentally-minded measure for the replenishment of existing asphalt surfaces by the United States Army Corps of Engineers in the 1986 “Asphalt Pavement Recycling Primer”. Recycled asphalt in general costs less than a virgin asphalt mix, thereby saving money on materials, while also providing an avenue by which to repurpose worn-down and aesthetically displeasing asphalt surfaces (Vollor, 1986). Husain and Assas (2013) speculated that the utility of recycled concrete for pavement fill is a promising end-product.

Recycled Asphalt Shingles (RAS) terms any composite material garnered from the recycling of asphalt shingles. Two main categories of RAS exist on the market: Tear-off asphalt shingles (TOAS) and Manufacture Waste Asphalt Shingles (MWAS). TOAS shingles are shingles that have been removed from a structure (having been torn off a roof), whereas MWAS shingles are waste material left behind during the manufacture of new asphalt shingles. It is estimated that 10 million tons of TOAS and 1 million tons of MWAS are available to be recycled (Zhou et al., 2013). Despite their ready availability, TOAS often face little demand in the recycling market due to the strong influence of MWAS material. MWAS has traditionally been well-accepted due to its high-quality product; much of this is due to its qualities as a “clean” and contaminant-free material (Cochran, 2006). Available MWAS is commonly comprised of cast-off pieces and cutouts from work sites, as well as low-quality materials that are rejected before reaching the open market (Construction Materials Recycling Association, 2007; Jameson, 2008). TOAS faces a quality issue because many shingles may still contain asbestos despite the material being banned in new asphalt shingle construction. Fears over the possibility of asbestos or other contamination in TOAS have further incentivized the recycling of manufacturer scrap material over recycled tear-off equivalents (Cochran, 2006). In 2007, the Construction Material Recycling Association proposed that TOAS only be taken for recycling if they came from private, residential homes with no more than four units per structure to reduce the inflow of asbestos-containing RAS into the recycling process (Construction Material Recycling Association, 2007).

METHODS FOR UTILIZING RECYCLED CONCRETE AND ASPHALT AGGREGATES

The Asphalt Recycling and Reclaiming Association (ARRA) identified five methods for the recycling of asphalt: cold planing (CP), hot recycling, hot in-place recycling (HIR), cold recycling (CR), and full depth reclamation (FDR) (ARRA, 2001). Each recycling method utilizes the RAP or RAS in a different manner, depending on the requirements necessary for the recycling location. For instance, RAP may be derived from material initially removed by the milling process. A hot mix asphalt (HMA) mix containing the RAP may then be used to replace the original asphalt sheet (ARRA, 2001). According to the US Army Corps of Engineers, cold-mix recycling is the process of adding a binder or lubricant to the RAP without the use of heat (Vollor, 1986). Typical applications are for the patching and rehabilitation of existing asphalt to carry additional vehicular loads. Hot mix recycling, on the other hand, necessitates the crushing of the RAP and the subsequent mixing of all necessary materials in a heat process. The typical use of hot mix asphalt is for the replacement of existing asphalt pavement sheets (Vollor, 1986). Full-depth reclamation is the removal of an entire asphalt surface to be recycled and replaced by a new hybrid mix of RAP and virgin materials without the use of heat (ARRA, 2001).

The use of RAS in the formulation of new shingle materials comprises a fraction of the market for recycled asphalt material (Townsend et al, 2007). The Asphalt Roofing Manufacturing Association (ARMA) conducted tests on utilizing recycled shingles as material for the creation of new asphalt shingles. However, ARMA encountered numerous difficulties in the process (Snyder, 2001; cited in Townsend et al., 2007). One major difficulty is the additional cost to blend and transport granules of chipped shingle to meet the necessary manufacturing specifications for new shingles (Jameson, 2008). However, testing undertaken by the Owens Corning Corporation suggested that tear-off shingle granules were more applicable for this purpose than shingle manufacturing waste granules because the components in the waste shingles tended to re-agglomerate faster than those found in the tear-off shingles. This allowed for easier sieving of tear-off shingle granules, hence making this material more useful for manufacturing new shingles (Jameson, 2008).

Recycling both asphalt and concrete has been identified as a key way to reduce the necessity of creating new mixes from virgin materials. The reutilization of asphalt shingles, in particular, provides a market opportunity for not just waste shingles, but also unused manufacturers' castoff shingles. The use of shingles in hot-mix asphalt provides material by which to reduce the need for virgin asphalt materials. This is especially important during peak pricing for virgin asphalt, when the use of recycled materials may lower the overall cost of hot-mix projects. However, the current level of utility of recycled asphalt remains less than that of virgin mixes. McGraw et al. (2007) outlined two experiments using various amounts of RAS material in Minnesota and Missouri, respectively. In both projects, RAS-containing mixes (comprising up to 20% recycled material) were stiffer than those utilizing less RAP (approximately 5%) or only virgin asphalt; this stiffness left the mixes more prone to fracturing while in place, reducing their overall applicability within asphalt sheets (McGraw et al., 2007). Zhou et al. (2013) found that the use of soft binder materials or increasing the design density improved crack resistance within the RAS mix by increasing the overall flexibility of the mixture. Despite these advances, most RAS mixes do not yet meet industry guidelines for strength and durability, and must be combined with virgin asphalt material before being suitable for asphalt paving projects.

The use of recycled concrete aggregates in the formation of new concrete mixes promises to reduce the overall resource requirements for mixes. Water and limestone resources are the two main energy burdens for the creation of Portland cement, and both are finite resources. Naik (2008) proposed the use of recycled water (graywater) in the creation of Portland cement from recycled aggregates instead of fresh water (Naik, 2008). Such a conversion in method would allow a secondary use for recycled water, and would reduce the need for new water. Similarly, the recycling of old concrete prevents the necessity of harvesting fresh limestone for use in new concrete mixes. Both water and limestone have been recognized as finite resources; the ability to utilize waste or recycled material offers an opportunity within the industry to reuse existing materials and therefore reduce the overall need for new resource collection. Tam (2008) analyzed a current method for concrete recycling and a theoretical process that was optimized for maximum net benefit. The theoretical approach not only aimed to repurpose old concrete for new uses, but also would utilize recycled water and a mechanical separator to remove useable metal from the concrete debris for eventual resale. She concluded that the theoretical approach would result in a positive net benefit. The reduced environmental impact and improved sustainability in the construction process would outweigh the higher overall cost for recycling aggregate material. Likewise, the current method of dealing with old concrete would result in a negative net benefit due to a higher environmental burden through the landfilling of removed materials and the necessity to collect virgin aggregates from raw material sources (Tam, 2008).

Despite its overall appeal, the recycling of waste concrete material and utilization of the product in the formulation of new concrete has produced mixed results. One easy method for the recycling of concrete is through its use as a low-grade bulk fill material; such a use does not require prior processing (Yong and Teo, 2009). If the concrete is tabbed to be used as an aggregate to create new concrete, it must not be overly contaminated, as contaminants may interfere with the binding properties of the aggregates. Secondly, the recycled material must first be processed before it can be utilized (Ravindrarajah, 1987; Yong and Teo, 2009). In general, the aggregates in recycled concrete are more angular than the aggregates present in new concrete, and often covered in cement mortar from their past useful life (Ravindrarajah, 1987; Obla et al., 2007). Recycled aggregates also feature more coarse aggregates than fine aggregates due to the effects of weathering and chemical reactions between materials from its previous use (Ravindrarajah, 1987).

Despite its promise as a building material, recycled waste concrete has not been explicitly proven to mirror the effectiveness of virgin concrete mixes. Waste concrete typically features less tensile strength and flexibility than fresh concrete due to being comprised mostly of coarse aggregates instead of fine aggregates (Ravindrarajah, 1987). Fine aggregates have been shown to provide more strength in concrete mixes due to its tightly-packed structure; coarse aggregates cannot be packed as tightly and therefore do not provide as durable a resulting material. Rasheedzzufar and Khan (1984) found that the durability of recycled concrete mixes was less than in fresh concrete mixes. The waste material had to be reinforced with additional aggregate material, such as additional Portland cement in order to provide similar strength to the virgin mixes (Rasheedzzufar and Khan, 1984). The utility of recycled concrete for buildings still remains mostly theoretical. Husain and Assas (2013) stated the need for caution in the building process when using recycled concrete. Until recycled concrete aggregates can provide similar strength and durability characteristics to virgin concrete mixes, the authors state that its use should be limited. Secondly, they urged for safety guidelines to be written for the use of recycled concrete due to the uncertainty about both its suitability and durability in that application. The main fear stems from recycled concrete potentially being unable to successfully hold a structural load, which may lead to building collapse and potential human injury or death.

GREENING THE CONCRETE INDUSTRY

Given the importance of concrete within the global building industry, it is necessary to develop sustainable approaches to meet demand while also reducing the impact of concrete production on the natural environment. Concrete has a considerable environmental footprint given sheer production totals and the energy-intensive process required to formulate Portland cement in particular. This is also true for carbon dioxide (CO2) emissions given off during the process of creating Portland cement. Once concrete is has been made, it is impossible to extract the cement out of the resulting mix; this preventing reutilization of the Portland cement fraction by itself. Therefore, research has focused on finding alternatives to Portland cement within concrete mixtures. Meyer (2009) outlined several recycled materials that could be utilized in concrete mixes to reduce the overall need for Portland cement. The highlighted materials included fly ash, which features cement-like properties and is a byproduct of the coal combustion process, ground granulated blast furnace slag (a byproduct of the production of steel), and recycled rubber tires, along with recycled concrete aggregates that are becoming increasingly important in new concrete mixes (Flower and Sanjayan, 2007; Meyer, 2009). Dhoka (2013) postulates that India, which is one of the largest consumers of concrete, could utilize alternative and abundant waste materials such as quarry dust or marble powder to strengthen concrete mixes while reducing the overall necessity for Portland cement. Imbabi et al. (2012) proposed that the use of Calcium Sulfoaluminate could utilize existing Portland cement equipment and provide similar functionality to the aforementioned product, yet release fewer CO_2 emissions due to being heated at a lower temperature.

Despite the benefits of recycling CDW materials, it may prove difficult to convince general contractors or demolition teams to recycle materials. In the 2005 report “Recycling and Construction Waste: A Guide for Architects and Contractors”, the relationships between the owners of a structure, the architect, and the general contractor are highlighted as critical to the success of recycling efforts from a work site. Waste materials from a construction or demolition work site are commonly left behind during the work process, garnering little attention. In order for recycling efforts to be effective, two key steps must be achieved. The contractor must be willing to put forth additional effort to ensure that recycling of CDW materials occurs, despite this extra attention to detail potentially not providing much financial incentive. The second major key is the existence of a local market for recycled CDW. If such a market does not exist, then potentially-recyclable materials are likely going to be sent to the landfill instead of to a processing plant; likewise, if a market for recyclables is robust, and there is demand for reusable or repurposed products, then the likelihood that a contractor will expend additional effort increases (The Institution Recycling Network, 2005).

THE HEALTH DANGERS OF CONCRETE AND ASPHALT DEMOLITION

While the recycling process may be an effective means of reutilization of CWD material, the material may be a hotbed for the release of dangerous particles into the environment. Airborne particulates that pose a major risk to humans include fine particles (FP) and ultrafine particles (UFP). FP are much smaller than standard airborne particulates, measuring less than 2.5 nanometers in diameter (Donaldson et al, 2001); UFP typically are particulates that measure less than .1 nanometers in diameter (Brunekreef and Forsberg, 2005; Terzano et al, 2010). Ambient air quality testing in the United States is commonly conducted at three levels: PM10, PM10-PM2.5, and PM2.5. PM10 measures the total number of particles under 10 µm in diameter, PM10-PM2.5 measures the concentration of particles within that diameter range (termed 'coarse'), and PM2.5 tests determine the number of particles that are less than 2.5 µm in diameter (termed 'fine') (Schwartz et al., 1996). Coarse particles are most commonly a result from the airborne release of particles from dust, soil, or mechanical processes, while fine particles are often derived from combustion processes from materials such as diesel fuel (Pope and Dockery, 2006). When concrete buildings are demolished, a significant amount of PM_{10} particulates are released into the surrounding area from the broken material (Usman and Said, 2013).

Fumes from both the asphalt paving and asphalt removal process are suspected respiratory irritants to humans. Asphalt workers, who are exposed to large quantities of the material on a daily basis, are especially at risk of inhalation of dust particulates. Some of the compounds found in asphalt dust include polycyclic aromatic compounds (PAC), benzene-soluble particulates (BSP), as well as a variety of nitrogen and sulfur-based compounds (National Institute for Occupational Safety and Health, 2000; Tepper et al., 2006). Some of these compounds are known carcinogens, especially in tar-infused asphalt products. While the long-term effects and possible carcinogenicity of extended asphalt dust exposure are not fully understood, research has indicated that asphalt dust is indeed an irritant that may lead to varying respiratory symptoms and conditions. In a study of Norwegian asphalt workers, Randem et al. (2004) found increased risk of Chronic Obstructive Pulmonary Disease (COPD), decreased lung function, or other respiratory issues in the asphalt workers compared to other outdoor construction workers.

A variety of methods have been utilized to reduce overall particulate emissions from asphalt. Engineering controls are commonly utilized on paving machines to reduce the overall emissions from the asphalt as it is laid down. Mickelsen et al. (2006) found that when used, engineering controls were effective in suppressing asphalt dust emissions. Cavallari et al. (2012) experimented with methods other than on-board engineering controls by which to reduce asphalt emissions in hot-mix asphalt paving. They found that replacing diesel fuel with biodiesel for cleaning processes, as well as lowering the temperature at which the hot-mix asphalt was mixed at, may reduce overall compound emissions (Cavallari et al., 2012). However, there is a consensus that more needs to be done to protect asphalt workers from dust particulates on worksites.

FP and UFP pose a unique challenge compared to larger particles because they can penetrate deeper into the human respiratory system when inhaled (Schwartz et al., 1996; Oberdörster et al., 2005) Upon entering the body, FP may cause inflammation events in the lungs, arteries, or other respiratory systems; acute exposure may also cause changes in blood viscosity or heart rate. Such occurrences increase the risk of cardiac distress (Seaton et al., 1995). UFP are especially dangerous, since such particles are often small enough to enter into the bloodstream. Once inside, the contaminants are then sent throughout the body and can make it to the brain or other vital organs (Terzano et al., 2010). Some of the most common adverse effects from FP and UFP inhalation are inflammation of the lungs or shortness of breath. Such impacts may worsen existing symptoms of COPD or asthma, heart attacks, and strokes (Pope and Dockery, 1999; cited in Donaldson et al., 2001) The elderly, young, and those with compromised respiratory systems are more susceptible to FP and UFP due to their adverse respiratory effects (Pope, 2000; Donaldson et al., 2001; Lee et al., 2007).

For the case of concrete, the requirement of Portland cement in the formulating of cement requires a combustion process that releases FP or UFP as airborne particulates (Pope and Dockery, 2006). However, concrete-based FP and UFP are more pronounced during the demolition phase of a concrete structure. The fracturing of the interconnected pores of Portland cement causes nanoparticles to be released from the material and become airborne (Kumar et. al, 2012). Kumar and Morawska (2014) found high UFP readings at demolition work sites, concluding that current methods for protecting individuals close to a work site from UFP were inefficient. They theorized that further research needed to be conducted to reduce the risk of exposure to these particles. Testing of cutting and mixing of concrete on work sites demonstrated that the cutting of concrete material seemed to release the most UFP, although the authors stated that more work had to be done on real work sites to assess the overall level of risk that concrete work can pose beyond normal background emittance levels (Azarmi et. al., 2014).

Of particular concern for the recycling of concrete are silicates. Fracturing Portland cement during the demolition process exposes silicates which had formerly been part of the cement bond structure into the atmosphere (Kumar et al., 2012). This phenomenon may be further exacerbated by the grinding process of CDW concrete during recycling. Prolonged or high levels of exposure to silica may lead to dangerous health conditions such as silicosis and lung cancer, among other maladies (Flanagan et. al., 2006; Akbar-Khanzadeh et. al., 2007; Akbar-Khanzadeh et. al., 2010). Within the field, it has been conjectured that using water to spray down concrete before it was ground down would lessen overall silica emissions (Thorpe et. al, 1999); however, overall results have been inconclusive. The National Institute for Occupational Safety and Health (NIOSH) suggested that water does not significantly suppress the release of silica particulates when used in indoor or cold outdoor settings (National Institute for Occupational Safety and Health, n.d.).

Gray (2010) proposed several methods by which dust particulates could be better controlled on demolition work sites. The methods cited include the covering of building material piles to prevent contamination, screening the site to prevent the spread of dust, and cover and monitor piles of toxic materials (Gray, 2010; cited in Usman and Said, 2013). Roe (2003) cited the utility of several methods of dust suppression. Although Gray (2010) and Thorpe et al., (1999) cite the utilization of a fine water stream to suppress dust, this method is only effective for a short period of time. Mechanical dust suppressors such as hoods or filter bags only have applicability in an indoor setting, and are of minimal value outdoors. Their upfront cost also makes them potentially cost-prohibitive (Roe, 2003). Utilizing chemical agents for dust suppression offers a more promising approach. Surfactant agents are used to further the wetting process, which if spread through demolition material can suppress dust emissions better than water. Binding agents bind the dust to existing matter, which suppresses the release of “fugitive” (unbound particles) dust particulates. While these methods offer a more efficient way to suppress dust emissions, the cost of such techniques are likely to be higher than using water or other suppression approaches (Roe, 2003; Usman and Said, 2013). During the recycling process, caution must be taken to prevent the widespread release of dust particulates from recovered materials.

Conclusion

In conclusion, concrete and asphalt are key construction materials in the urban landscape, and are prime candidates for post-consumer recycling after being removed from the urban landscape. Recycling the materials as coarse aggregates for concrete and as RAP or RAS for asphalt provides a consistent source of useable material for the creation of new mixes. In some cases, the material is of sufficient quality to be utilized in new material mixes and suffer no drop-off in suitability for construction projects. However, since the quality of all aggregate material may not consistently equal that of virgin mixes, it is important for new recycling techniques and technologies to be developed to provide high-quality recycled aggregates for future material needs. New methods are also necessary to deal with obstacles facing recycling, such as fine and ultrafine particles that are released as airborne particulates and can cause major health hazards to workers and neighbors alike. More research must be conducted to determine the most effective and cost-efficient methods by which to reduce the release of fine particles or to deal with contaminants such as lead or asbestos. Lastly, organizations such as Depave are working to increase awareness of urban landscapes and reclaim natural greenspace within communities. By involving community members in the demolition process, these organizations strive to cultivate interest in community stewardship while also practicing sustainable demolition methods that can be a basis for future asphalt and concrete removal projects throughout the United States.

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MINIMIZING STRUCTURAL ABANDONMENT AND MAXIMIZING MATERIAL REUSE WITH LEED GREEN BUILDING STANDARDS

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INTRODUCTION

BACKGROUND

Michigan and mid-west region has been experiencing the abandonment and blighted structures since 1960s (LaMore, 2013). Abandoned properties not only cause public nuisance but also fix nuisances which has detrimental social, environmental, and economic effects on the communities (Force, 2014). A blighted neighborhood weakens the city vitality, reduces the economic activity and investment and threatens the public safety (Force, 2014). A blighted structure needs to be either rehabilitated or demolished, because if not, sooner or later, it negatively affects other adjoining structures, the neighborhood and eventually the city (Force, 2014).

Although the factors contributing to the buildings' abandonment differ in case by case, the economic factors are leading (Shane, 2012). Job loss and population loss, rising property taxes, and owners' absenteeism are among the factors that contribute to the abandonment of properties (Shane, 2012). While it is difficult to overcome the issue of blight and structural abandonment, it is possible to adopt means and methods that contribute to more sustainable built environment.

There are several approaches to creating value in abandoned buildings and preventing blight. This research exams how green building ratings and certification could help to prevent future blight and minimize the current abandoned structures. A sustainable structure in a sustainable neighborhood designed and constructed with sustainable material is less likely to be abandoned and strengths to market for material re-use. For instance, one of the principles of a LEED® or Leadership in Energy and Environmental Design project is that the process of a green building begins with the idea of the project and continues until the project is re-used and recycled. This encourages the construction of green and deconstruct-able projects, however the current LEED® detailed prerequisites and credit systems may not be adequate to particularly address blight prevention and abandoned structures. Pre-abandonment and post-abandonment measures are specific points where more detailed recommendation and credits could potentially improve the effectiveness of LEED® to address blight.

This proposal outlines a method of addressing blight and structural abandonment by sustainable design and construction practices, specifically via green building rating and certification systems. Programs such as LEED® will be reviewed. The current measures in the green building certifications that address blight removal and material re-use, will be considered, and the appropriate future potential pilot credits specifically focusing on addressing structural abandonment and blight removal will be suggested.

STATEMENT OF PROBLEM

Given that the social, environmental, and economic downturns of structural abandonment and blight are detrimental factors in for a safe and sustainable community, the goal of this research is to add to the current body of knowledge by proposing methods of minimizing structural abandonment and blight via green building rating and certification processes.

Preliminary Research Question

The primary research question is "how can LEED® green building ratings and certifications reduce structural abandonment and increase the market reward for re-used structural material?" The subsequent questions which will help to provide response for the primary question are the following:

- What are the current measures in LEED® green building rating systems that specifically relates to addressing the issues of structural abandonment and material re-use?
- What new points can be recommended in the existing LEED® green building rating system to encourage blight removal and material re-use?

Proposed Methodology

Figure 6: Proposed Methodology

The objectives of this study are divided into steps as shown in Figure 1. First, the existing LEED® green building rating system is studied and the points relevant to blight removal and material re-use are extracted. For the purpose and scope of this study, only LEED® Building Design and Construction (BD+C) system is studied. A table consisting the summary of the points found in the existing LEED® is provided. Next, the findings are discussed in professional interviews in academia and in the construction operations industry, and additional opportunities and challenges in proposing more LEED® points for blight removal and material re-use are discussed. The findings of the literature review and interviews are analyzed and discussed, and the future work is recommended.

Study Significance

Green building verifications via third parties such as United States Green Building Council (USGBC)'s LEED® program has significantly contributed to the sustainable building and communities. Structural abandonment and material re-use will lead to unsustainable communities. The significance of this research will be to seek and propose green building and sustainable means to plan, design, construct and deconstruct buildings in such a way that will have less potential for future abandonment, and lead to a healthier, productive, sustainable communities. The suggested additional pro blight removal and pro material re-use credits, will promote the way owners, planners, designers, and builders think about the location of future LEED® building and neighborhoods.

REVIEW OF LITERATURE

STRUCTURAL ABANDONMENT

Vacant and abandoned property is increasingly recognized as a significant barrier to the revitalization of central cities (Accordino & Johnson, 2000). Vacant and abandoned property and lots weaken the appearance and economic value of surrounding buildings, localities, and city districts, and is one of the most observable and depressing signs of inner city decline (Accordino & Johnson, 2000).

Highest Vacancy Rates Among the 75 Largest Metropolitan Statistical Areas, 2012

#	Metropolitan Statistical Area	Vacancy Rate (%)	Vacant Units
1	New Orleans-Metairie-Kenner, LA	12.6	68,181
2	Jacksonville, FL	12.1	72,735
3	Las Vegas-Paradise, NV	11.8	100,005
4	Detroit-Warren-Livonia, MI	11.7	220,931
5	Birmingham-Hoover, AL	11.5	57,874
6	Memphis, TN-MS-AR	11.5	63,692
7	Cleveland-Elyria-Mentor, OH	11.4	108,558
8	Dayton, OH	10.9	42,063
9	Columbia, SC	10.8	36,358
10	Atlanta-Sandy Springs-Marietta, GA	10.7	232,667
11	Orlando-Kissimmee-Sanford, FL	10.6	100,412
12	Indianapolis-Carmel, IN	10.4	79,771
13	Oklahoma City, OK	10.4	56,484
14	Tampa-St. Petersburg-Clearwater, FL	10.3	139,840
15	Albany-Schenectady-Troy, NY	10.3	40,524
16	Toledo, OH	10.1	30,426
17	Houston-Sugar Land-Baytown, TX	10.0	235,299
18	Tulsa, OK	9.9	41,156
19	Akron, OH	9.8	30,683
20	Cincinnati-Middletown, OH-KY-IN	9.8	89,880
21	Greensboro-High Point, NC	9.6	31,214
22	St. Louis, MO-IL	9.6	118,525
23	Richmond, VA	9.6	51,088
24	Columbus, OH	9.4	75,357
25	Phoenix-Mesa-Glendale, AZ	9.4	170,883

Table 1: Highest Vacancy Rates Among the 75 Largest Metropolitan Statistical Areas, 2012
Source: United States Census Bureau. 2012. American Community Survey 1-Year Estimates.
Note: Vacant units do not include seasonal, recreational, or occasional uses. Accessed from < https://www.huduser.gov/portal/periodicals/em/winter14/highlight1.html>

Per American Community Survey of highest vacancy rates among the 75 largest metropolitan statistical areas in 2012, about 220,931 units were found to be vacant. The number of vacant units for other major metropolitan cities are shown in Figure 1 and the numbers are unfortunately disturbing.

Structural Abandonment and Unemployment Rate

Comparing the relationship between overall economic health community and building vacancy rates shows that unemployment rates are considerably higher in the states with higher vacancy rate than those with lower vacancy rates as shown in the below table.

Unemployment Rates for States, 2012 Annual Averages								
National Average: 8.1								
State	**Rate**	**Rank**	**State**	**Rate**	**Rank**	**State**	**Rate**	**Rank**
North Dakota	3.1	1	Maryland	7	18	Connecticut	8.3	35
Nebraska	4	2	Wisconsin	7	18	Indiana	8.3	35
South Dakota	4.3	3	Alaska	7.1	20	Florida	8.5	38
Iowa	5	4	Louisiana	7.1	20	New York	8.5	38
Vermont	5	4	New Mexico	7.1	20	Oregon	8.8	40
Oklahoma	5.2	6	Delaware	7.2	23	District of Columbia	9	41
Wyoming	5.3	7	Idaho	7.2	23	Illinois	9	41
Utah	5.4	8	Ohio	7.4	25	Mississippi	9	41
New Hampshire	5.5	9	Maine	7.5	26	Michigan	9.1	44
Minnesota	5.6	10	West Virginia	7.5	26	Georgia	9.2	45
Kansas	5.7	11	Arkansas	7.6	28	South Carolina	9.2	45
Hawaii	6	12	Pennsylvania	7.8	29	New Jersey	9.3	47
Montana	6	12	Tennessee	7.8	29	North Carolina	9.3	47
Virginia	6.1	14	Colorado	7.9	31	California	10.4	49
Massachusetts	6.7	15	Alabama	8	32	Rhode Island	10.4	49
Texas	6.7	15	Washington	8.1	33	Nevada	11.2	51
Missouri	6.9	17	Kentucky	8.2	34			
Note: Rates shown are a percentage of the labor force. Data refer to place of residence.								

Table 2: Unemployment Rates for States, 2012 Annual Averages
(Source: https://www.bls.gov/lau/lastrk12.htm)

The factors contributing to the problem of vacant and abandoned property are multi-dimensional. Some blame ill-conceived federal policies and subsidized outmigration of much of the middle-class from central cities (Bennett, 1990; Gelfand 1975; Moore & Thorsnes, 1994; Myers, 1991).

Although there is no one-solution to all the factors contributing to the problem of vacant and abandoned property, Green Building Certification programs, such as USGBC's LEED® program and other green building rating systems may be able to address current blight and improve the re-use of materials from structural abandonment. Buildings that are certified under LEED® certification, have prerequisites and credits that could support blight removal and material re-use and recycling.

LEED® GREEN BUILDING RATING SYSTEM

LEED® is applicable to all project types. Schools, hospitals, datacenters, warehouses and distribution centers, are the examples. There is a LEED® for every type of building as following:

Figure 2: LEED® Project Types (Source: www.usgbc.org/leed)

For the purposes of this study, Building Design and Construction (BD+C) is being considered. This section is explored to determine how many points and what percentage are relevant to the blight removal and material re-use. The BD+C scorecard as shown below, categorizes the available points that can be achieved in eight credit categories namely, Location and Transportation (LT), Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Material and Resources (MR), Indoor Environmental Quality (EQ), and Innovation, and Regional Priority.

After reading through each of the credit categories, author determine what credits helped minimize blight and maximize material re-use.

LEED v4 for BD+C: New Construction and Major Renovation

Project Checklist

Project Name:

Date:

Y	?	N			
			Credit	Integrative Process	1

0	0	0		Location and Transportation	16
			Credit	LEED for Neighborhood Development Location	16
			Credit	Sensitive Land Protection	1
			Credit	High Priority Site	2
			Credit	Surrounding Density and Diverse Uses	5
			Credit	Access to Quality Transit	5
			Credit	Bicycle Facilities	1
			Credit	Reduced Parking Footprint	1
			Credit	Green Vehicles	1

0	0	0		Sustainable Sites	10
Y			Prereq	Construction Activity Pollution Prevention	Required
			Credit	Site Assessment	1
			Credit	Site Development - Protect or Restore Habitat	2
			Credit	Open Space	1
			Credit	Rainwater Management	3
			Credit	Heat Island Reduction	2
			Credit	Light Pollution Reduction	1

0	0	0		Water Efficiency	11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
			Credit	Outdoor Water Use Reduction	2
			Credit	Indoor Water Use Reduction	6
			Credit	Cooling Tower Water Use	2
			Credit	Water Metering	1

0	0	0		Energy and Atmosphere	33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
			Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2

0	0	0		Materials and Resources	13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
			Credit	Building Life-Cycle Impact Reduction	5
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
			Credit	Construction and Demolition Waste Management	2

0	0	0		Indoor Environmental Quality	16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
			Credit	Enhanced Indoor Air Quality Strategies	2
			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
			Credit	Indoor Air Quality Assessment	2
			Credit	Thermal Comfort	1
			Credit	Interior Lighting	2
			Credit	Daylight	3
			Credit	Quality Views	1
			Credit	Acoustic Performance	1

0	0	0		Innovation	6
			Credit	Innovation	5
			Credit	LEED Accredited Professional	1

0	0	0		Regional Priority	4
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1

0	0	0	TOTALS	Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Figure 3 LEED® Building Design and Construction (BD+C) Scorecard (Source: www.usgbc.org/leed)

Although the green building certifications are still voluntarily in a lot of occasions, LEED credits encourage certain level of certifications under existing green building rating systems. Currently, the residential building codes in Michigan do not mandate green building certifications. Several green building rating systems have evolved in the recent years, with USGBC's LEED® program being one of the leading rating systems. For this study, LEED® v4 program is selected to study the points related to the removing blight and material re-use.

MINIMUM PROGRAM REQUIREMENTS (MPR)

There are three minimum program requirements (MPRs) that must be met in order for a project to be eligible for LEED® certification (Cottrell, 2014).

MPR 1. Must be in a Permanent Location on Existing Land

The first MPR requires that the project must be in a permanent location on existing land. The LEED rating system is designed to evaluate buildings, spaces, and neighborhoods in the context of their surroundings. This requirement, causes the project to be built in an existing land; therefore, the building will not be exposed to displacement and disrupted ecosystems (Cottrell, 2014).

This MPR is itself a major contributor to ensuring that the building does not have a short life time. When a structure is built in a permanent location, it is less likeable to abandonment than the buildings built in a temporary location and subject to move. LEED® Minimum program requirements determine the eligibility of the projects for LEED® certification and are not intended to set exhaustive requirements that makes it difficult for projects to be eligible for certification. Therefore, the author does not think that adding another requirement that is pro blight removal such as "locating the building where blight is prevalent" would be accepted by U.S. Green Building Council as it can disqualify a range of new constructions that intends to apply for LEED® certification.

Credit Categories

Referring to the U.S. Green Building Council LEED® V4 Reference Guide for Building Design and Construction, author finds that Location and Transportation (LT) specifically the LEED for Neighborhood Development under this credit category, and Material and Resources (MR) are the two credit categories that directly and indirectly encourages blight removal and material re-use. The relevant credits to the blight removal and material re-use are highlighted with red rectangles in Figure 3 for clarity.

Credit Categories with Potential to Minimize Blight

Location and Transportation (LT) - LEED for Neighborhood Development (16 points)

As an alternative to the pursuit of Location and Transportation (LT) credits, LEED® ND intends to avoid development on an inappropriate site, and enhances livability (USGBC, 2016). A building under this credit category can achieve up to 16 points, which makes 16% of the total standard available points in LEED® certification.

Although this credit category primarily seeks auto reliance for commuting, and reducing the transporting impacts associated with buildings (Cottrell, 2014), a building developed in a certified ND reflects principles of new urbanism, smart growth, green building design, and construction to promote healthy, sustainable, and equitable places for neighborhood workers, residents, and visitors; it provides access to transit systems, facilitates walkability, connectivity, and shared infrastructure (Chen, 2014).

Locating a project within the boundary of a development certified under LEED for Neighborhood Development helps to avoid developing on inappropriate sites. Although the aim of this credit category is to reduce the vehicle distance traveled and to enhance the livability and improve human health with daily physical activity, it can indirectly help a structure from becoming blighted in the future.

Location and Transportation – Sensitive Land Protection

The intent of this credit is to avoid the development of environmentally sensitive lands and reduce the environmental impact from the location of a building on a site (USGBC, 2016). There are up to two points available in this credit category for which the candidate LEED® projects can achieve.

There are two options available to comply with the requirements of this credit category. In the first option, the development should be located on a land that has been previously developed (USGBC, 2016). This will encourage developers to not abandon already developed areas, and discourages the development on new undeveloped areas, which helps to minimize blight. In Option-2, the development should not be in a sensitive land (USGBC, 2016) which is not directly relevant to blight removal.

Location and Transportation – High Priority Site

The intent of this credit is to encourage project location in areas with development constraints and promote the health of the surroundings (USGBC, 2016). There are up to three points (3% of total available credits) available in this credit for which the candidate LEED® project may achieve.

There are three options available to comply with the requirements of this credit. In option one, the project needs to be in an infill location in a historic district (USGBC, 2016). This will encourage the developer to preserve historic district and will help to avoid abandoning the conservation areas.

The second option requires that the project be in the designated priority sites as following (USGBC, 2016):

- a site listed by Environmental Protection Agency (EPA) National Priorities List;
- a Federal Empowerment Zone site;
- a Federal Enterprise Community site;
- a Federal Renewal Community site;
- a Department of the Treasury Community Development Financial Institutions Fund Qualified Low-Income Community (a subset of the New Markets Tax Credit Program);
- a site in a U.S. Department of Housing and Urban Development's Qualified Census Tract (QCT) or Difficult Development Area (DDA)

Developing on the abovementioned locations directly or indirectly minimizes the structure abandonment.

The third option requires that a brownfield site is remediated (USGBC, 2016). A brownfield is where soil or groundwater contamination has been identified (USGBC, 2016). Surveys have shown that some numerous abandoned areas are in brownfields. Locating project in a brownfield, and remediating the contamination directly help to remove blight.

Credit Categories with Potential to Material Re-use

As buildings are a large consumer of natural resources, the Material and Resources category deals with how to assess and select materials and what to do with them after their useful life, which are two critical elements for environment and building industry (Cottrell, 2014). With the idea to eliminate the need for new materials, this credit category focus on material re-use (Cottrell, 2014). USGBC provides five strategies to conserve material throughout a project's life cycle. Out of the five strategies, the re-use of existing buildings and salvaged materials relates to the topic of this study. Certified projects encourage the re-use of existing buildings and re-use of salvaged material. The aim of the credit category is to reduce new material extraction, and maximize the use of existing facilities and materials which help prevent buildings from being abandoned and/or if abandoned their material is salvaged.

Material and Resources (MR) Prerequisite: Construction and Demolition Waste Management Planning

The intent of this prerequisite is to reduce construction and demolition waste disposed in landfills and incinerated by recovering, reusing, and recycling (USGBC, 2016). This is a prerequisite under the Material and Resources (MR) credit categories, which means that any project candidate for LEED® certification must comply with this requirement. By requiring the developer to plan for reusing and recycling of waste created because of construction and demolition, this prerequisite will help material re-use.

Moreover, a credit is also available under the same name - Construction and Demolition Waste Management for which the developers may go beyond the prerequisite and score up to 2 more points (2% of available credits) under this category.

Material and Resources (MR) Credit: Building Life-Cycle Impact Reduction

Projects can obtain up to 6 points (6% of available credits) in the Building Life-Cycle Impact Reduction credit under Material and Resources category. This credit requires that the project either re-use a historic building, renovate an abandoned or blighted building, or re-use and salvage up to 75 percent of project surface area of building material such as floors, roof decking, framing, walls, doors, and ceiling systems from off-site or onsite (USGBC, 2016). This will not only encourage material re-use but also help minimize blight.

Material and Resources (MR) Credit: Building Product Disclosure and Optimization – Environmental Product Declarations

The intent of this credit is to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts (USBGC, 2016). There are up to two points available (2% of the available credits) in this credit. Material re-use is a fundamental part of the life-cycle approach. By encouraging the use of material that have cradle to gate scope, this credit motivates the use of re-use materials. Cradle-to-gate is an assessment of a partial product life cycle from resource extraction (cradle) to the factory gate.

Material and Resources (MR) Credit: Building Product Disclosure and Optimization – Sourcing of Raw Material

Projects can obtain up to 2 points (2% of the available credits) in the Building Product Disclosure and Optimization – Sourcing of Raw Material credit category. Pursing the first option, the project can choose to pursue a Leadership Extraction Practice by using products that meet the responsible extraction criteria for at least 25%, by cost, of the total value of permanently installed building products in the project. Out of the six practices proposed by USGBC in this option, two practices, Material Re-use and Recycled Content, encourage the project to use salvaged, refurbished, and recycled contents (USGBC, 2016).

Material and Resource (MR) Credit: Building Product Disclosure and Optimization – Material Ingredients

This credit can achieve up to 2 points (2%) in the Building Product Disclosure and Optimization credit category. The intent of this credit is to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts (USGBC, 2016). In addition to the other requirements of the first option to achieve points in this credit, the developer can report Cradle to Cradle certification of the product end use.

SUMMARY

Summing up the available credits that directly encourage material re-use and minimize blight is shown in the following Table.

Credit	Available Points	Percentage of Total Available Points
Location and Transportation (LT) - LEED for Neighborhood Development	16	16%
Location and Transportation – Sensitive Land Protection	2	2%
Location and Transportation – High Priority Site	3	3%
Material and Resources (MR) Prerequisite: Construction and Demolition Waste Management Planning	Prerequisite	
Construction and Demolition Waste Management Credit	2	2%
MR Credit: Building Life-Cycle Impact Reduction	6	6%
MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations	2	2%
MR Credit: Building Product Disclosure and Optimization – Material Ingredients	2	2%
MR Credit: Building Product Disclosure and Optimization – Sourcing of Raw Material	2	2%
Subtotal Blight Removal Related Points (No. 1+2+3)		21%
Subtotal Material Re-Use Related Points (No. 4+5+6+7+8+9)		14%
Total (No. 11+12)		35%

Table 3: Summary of the total available credits that encourage material re-use and blight removal

DATA COLLECTION

INTERVIEW WITH EXPERTS

The professionals who participated in short interview were Dr. Matt Syal, who is a professor at Michigan State University and a LEED Accredited Professional. Kris Jolley, Re-Use and Recycling Manager at Michigan State University Surplus Store and Recycling Center was the other professional who participated in this study and provided his feedback on how LEED is being practiced, maintained, and discussed the room for proposed changes in the existing LEED rating system. Kristine Hartel, from U.S. Green Building Council also participated via email conversation, and provided her feedback on potentials to maximize material re-use within existing LEED rating system.

INNOVATION CREDITS

The suggestions collected during an interview with Dr. Matt Syal of Michigan State University indicated innovation credits in the existing LEED point system, and proposed credits in Energy and Atmosphere category. Moreover, the Design for Deconstruction (DfD) and the position of demolition in the LEED rating system was discussed (Syal, 2017).

A revisit of the Figure 3 with Syal (2017) has indicated that there are still credits in the existing LEED® rating system. Syal (2017) believes that the available 5 Points under Innovation credit category is one of the easier ways to achieve material re-use and blight removal related credits. The innovation credits can be achieved in one of the following three ways (USGBC, 2016):

- Exemplary performance,
- Pilot credit, or
- Innovative strategy

A project that can exceed the required threshold in certain credits, can get innovation credits through exemplary performance (USGBC, 2016). However, the exemplary performance is not available for all credits. Credits highlighted in Figure 3 that can achieve innovation credits via exemplary performance are as following:

- Location and Transportation (LT) – High Priority Site
- Material and Resources (MR) – Building Product Disclosure and Optimization - Environmental Product Declarations
- Material and Resources (MR) – Building Product Disclosure and Optimization - Sourcing of Raw Materials
- Material and Resources (MR) – Building Product Disclosure and Optimization - Material Ingredients
- Material and Resources (MR) – Construction and Demolition Waste Management

The second option to achieve innovation credits is through gaining pilot credits. The pilot credits are intended to facilitate the introduction of new credits to LEED and it is a mechanism that allows projects to evaluate more innovative credits (LEED User, 2017). The pilot credit library is dynamic and users can apply to register pilot credits with USGBC (USGBC, 2016). Currently, the open pilot credits related to the highlighted credit categories in Figure 3, are as following:

- Pilot credit – Verified Construction & Demolition Recycling Rates
- Pilot credit – Integrative Analysis of Building Materials
- Pilot credit – Certified Multi-Attribute Products and Materials

The third option to pursue innovation credits, is to come up with an innovative strategy not mentioned by USGBC.

Energy and Atmosphere Credits – Save Embodied Energy

Energy and Atmosphere is the credit category in the LEED rating system that has the highest weight (30 points) when compared to other credit categories (USGBC, 2016). One definition of embodied energy by Australia's guide to environmentally sustainable homes states:

"Embodied energy is the energy consumed by all the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery." (Milne & Reardon, 2013).

Although the existing LEED credits in the Material and Resources (MR) credit category focus on the embodied energy impact through life-cycle approach, the specific credits for material embodied energy in the energy and atmosphere credit category is missing (Syal, 2017). Thus, under Energy and Atmosphere (ER) credit category, "save material embodied energy" credit can be proposed and at least 10 points can be allocated to it (Syal, 2017). Material re-using and recycling provides the opportunity to reduce the embodied energy (Thormark, 2002).

Also, LaMore (2017) suggests LEED buildings may provide the opportunity to increase the market demand for structural deconstruction by creating a special market for material re-use by requiring more re-used material in LEED building.

LEED for Demolition/Deconstruction and Blight Removal

As discussed in the previous section, the only credit that directly has an option to develop a blighted area is in Material and Resources (MR) Credit: Building Life-Cycle Impact Reduction. The weight of this credit is only 6 points, and the development of a blighted area is one option, not a requirement under this credit category. Moreover, the concept of developing a blighted area is also relevant to LEED for Neighborhood Development (ND) (Syal, 2017, and LaMore, 2017). Also, if the entire blighted areas are not feasible to re-develop, future LEED buildings can focus on high vacancy or abandoned areas (LaMore, 2017). This may hasten the deconstruction of abandoned structure and stimulate redevelopment of distressed areas (LaMore, 2017).

Jolley (2017) proposed that there should be a mechanism for material re-use and material re-sale like material recycle in the MR Construction and Demolition Waste Management Credit. If the projects can report where the construction waste goes, they should report where the material is re-used and or resold (Jolley, 2017).

LEED FOR DECONSTRUCTION

If the buildings and structures are built in such a way that after their useful life their material can be re-used and salvaged, this would help to prevent buildings from becoming blighted. A building can become blighted due to various reasons such as economic, and social reasons. A blighted structure can be removed by adopting new design approaches such as Design for Deconstruction (DfD).

While strategies such as design for deconstruction (DfD) seems to be more expensive than conventional demolition, studies have shown that they can be competitive to conventional non-machinery demolition (EPA, 2008). Currently, LEED® program lack credit points for encouraging DfD. It is recommended that a certification sub category can be added for LEED DC (LEED for Deconstruction) which basically means a Deconstructed Project can also be LEED certified by using *Sustainable Deconstruction Techniques* as following:

- Credit for lowering the number of landfills (maybe to zero)
- More credit for salvage, refurbish, and re-use building material and make them ready for market to buy
- Credit for repurposing or selling the salvaged material or entrepreneurship (Jolley, 2017)
- Prerequisite for pollution and dust control which discourages or prohibits conventional demolition and encourages deconstruction

Other options under suggested LEED DC can include credits for use of material sourced specifically from blighted structures such as:

- First skim e.g., metal scraps
- Second skim e.g., architecturally valuable such as wood flooring
- Third skim material e.g., exterior/interior walls, shingles, roof

To restore blighted structures, LEED DC may possibly can assign credit points for rehabilitating structures that are blighted or have signs and potential to become blighted.

CHALLENGES TO DECONSTRUCTION

Jolley (2017) believes that people are not interested in material re-use, because of the cost issues. Not only that, most of the re-used material are special architectural features, such as doors, and windows, etc., and are not structural material (Jolley, 2017).

Also, the LEED buildings need to be maintained, and if the owner of the project intends to make alterations to the existing certification level, and intend to apply for a higher certification level, LEED needs to cost-effective, and flexible (Jolley, 2017).

CONCLUSION

SUMMARY OF THE FINDINGS

United States, and specifically mid-western states, has been experiencing structural abandonment for decades. Highly vacant areas cause public and attractive nuisance and has detrimental social, environmental, and economic effects on the communities.

The purpose of this study was to seek how LEED® green building rating system can address blight removal and maximize material re-use. Leadership in Energy and Environmental Design (LEED) is one of the pioneer green building certification programs in the United States and has gained great market in the path toward greener construction methods.

This study investigated the existing LEED rating system under Building Design and Construction (BD+C) group, and found that the following minimum program requirement (MPR), prerequisites, and credit categories directly and indirectly address blight removal and encourage material re-use:

- Blight removal
    - Minimum program requirement (MPR1) – The project needs to be in a permanent location in an existing land,
    - Location and Transportation (LT) - LEED for Neighborhood Development,
    - Location and Transportation – Sensitive Land Protection; and
    - Location and Transportation – High Priority Site.
- Material re-use
    - Material and Resources (MR) Prerequisite: Construction and Demolition Waste Management Planning,
    - Construction and Demolition Waste Management Credit,
    - Material and Resources (MR) Credit: Building Life-Cycle Impact Reduction,
    - Material and Resources (MR) Credit: Building Product Disclosure and Optimization – Environmental Product Declarations,
    - Material and Resources (MR) Credit: Building Product Disclosure and Optimization – Material Ingredients; and
    - Material and Resources (MR) Credit: Building Product Disclosure and Optimization – Sourcing of Raw Material.

As shown in above items, most of the Location and Transportation (LT) credits relate to blight removal, and most of the Material and Resources (MR) credits relate to the material re-use.

This study further sought suggestions from professionals in the green construction industry, academia, and U.S. Green Building Council, to propose new credits that address these two issues. The findings of the professional interviews with Dr. Matt Syal of Michigan State University, and Kris Jolley of MSU Surplus and Recycling Center revealed the following:

- Blight removal
    - Innovation credits under LT – High Priority Site (Max. 5 Points),
    - LEED for Deconstruction/Demolition and Blight Removal under LEED for; and Neighborhood Development (20 Points).
- Material re-use
    - Innovation credits under MR credit categories (Max. 5 Points),
    - LEED for demolition of existing building and obtain credits for reporting material re-use and re-sale,
    - Save embodied energy under Energy and Atmosphere (EA) credit category; and
    - LEED for Deconstruction

OUTCOMES OF THE CHANGES

The triple bottom line of social, economic, and environmental aspects of the built environment can be addressed by the changes proposed in previous section. A sustainable and green building lessens the probability of a structure to become blighted, encourages the re-use of material and existing buildings. This will in turn help the economy and health.

LIMITATIONS OF THE STUDY

The purpose of this paper is not to conduct an exhaustive literature review, and collect widespread data. The intent is limited to a study primer on the topic of Domicology – study of structure lifecycle. Due to time limitations, this study did not include in-depth interviews with U.S. Green Building Council members. One UGBC professional member showed positive feedback on the proposed suggestions, however she could not provide further comments on how these changes can be applied. The assumption is that demand for LEED buildings is on the rise, and this can be a potential way to address some of the blight removal and material re-use challenges through this certification process. However, this study does not have clear data and findings on how the existing certified LEED buildings have performed so far in addressing blight removal and material re-use.

RECOMMENDATION FOR FUTURE WORK

Future work may include a thorough survey of existing certified LEED buildings, and conduct an interview with building facility managers, and the building project manager to collect empirical data on how much material have been re-used in the existing certified LEED buildings, and how many blighted areas are developed through LEED rating systems. Moreover, in-depth interviews may need to be conducted with U.S. Green Building Council on the newly proposed credits mentioned in this study, and collect their opinion on how these credits may fit under existing LEED rating system.

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