Emerging Challenges in Urban Development: Construction or Demolition?

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Abstract: With the rapid urbanisation worldwide, the transitions of old residential regions inside or close to the urban districts have been challenging both governments and professionals. The sustainable maintenance, innovation and construction of these regions incorporate the history, culture, environment and policy factors into the economic objectives. Over the long and complex process of a transition project, the dedicated project management crew are frequently confronted with diversified novel issues and obliged to contribute appropriate solutions urgently. In this paper, the author first analyses the state of the art of transition projects of old residential regions. Furthermore, the author explores the sustainable alternatives of transition projects from the reservation and development perspectives of culture, environment, society and infrastructure. The research outcomes will contribute to knowledge about emerging challenges in urban development and regeneration worldwide.

Keywords: construction, demolition, economics, management, sustainability, urbanisation

1. INTRODUCTION

From a lifecycle viewpoint, the demolition stage for buildings is achieved after the sequential stages of planning, design, construction and maintenance. The demolition process of a building is normally regarded as an unavoidable annoyance in its lifecycle and demolition contractors frequently undertake demolition practice with tight time constraints with little up front demolition planning. The history of building demolition may be tracked back to several thousand years, including effects from various ancient wars. Until the 1950s, buildings were mostly dismantled by hand at the ends of their lives due to structural or functional obsolescence[1]. For several decades now, urban redevelopment worldwide has led to the demolition of buildings that are still structurally and functionally acceptable. Only in the last few years, however, has the emphasis on demolition arisen, mainly due to increasing environmental pressure, particularly the disposal of demolition waste.

The importance of demolition is also learned from previous demolition failures and disasters brought about by the lack of sufficient awareness and knowledge on demolition. For example, demolition waste containing chemicals hazardous to human health and the environment may be sent to landfills and the leachate from landfills poses a potential risk to groundwater quality[2]. Landfill creation is therefore an outcome that communities should aim to avoid due to the significant environmental issues involved. One disastrous example in Australia concerns the demolition of the Royal Canberra Hospital building in 1997. A girl was killed and at least nine others were sent to the hospital with serious injuries by flying debris when they stood in a designated viewing area 300 metres away[3].

Although a lifecycle approach has been considered to play an important role in project management by integrating all above-mentioned stages, the last lifecycle stage of demolition was rarely given full consideration. The demolition of an old building is normally dependent on the development of a new project. Some old buildings and structures that serve no function at all may stand there for years until the redevelopment is conceived and approved. With the increase of density of constructed facilities in a city, its development starts no longer with construction of new project, but demolition of an existing one. The future of building demolition will be predicated by the availability and cost of new resources and by the scarcity of energy for machine operation as well as by heightened environmental awareness. However, previous efforts in both research and practice such as setting up advanced recycling technologies for demolition wastes and improving landfill disposal technology were mainly focused on the disposal of demolition waste, not the demolition process itself. As further improvements in demolition waste disposal are technically limited, emphasis needs to be moved ahead toward demolition in the hope that an evolution of practice may one day provide an essential solution to radically lessen the waste disposal issue. In this research, the authors seek to develop a series of strategies to promote building demolition evolution. The authors first describe the current circumstance of building demolition from various aspects. Furthermore, the authors explore the sustainable alternatives of transition projects from the reservation and development perspectives of culture, environment, society and infrastructure. The research conclusions are stated in the final section.

2. THE STATE OF THE ART OF DEMOLITION

Waste disposal from building demolition has become a challenging issue worldwide. In all states of Australia, construction and demolition of buildings contribute up to 30-40% of solid waste that goes to landfills according to Australian Bureau of Statistics[4]. Waste can therefore be reduced drastically if supply from the construction and demolition industries is limited. A major proportion of construction waste materials are collected for recycling rather than sent straight to landfills as they are normally new and segregated. On the contrary, the indiscriminate demolition of buildings produces an enormous amount of mixed and heavily used materials that result in significant waste streams to landfills. It may hence be stated that demolition generates more waste sent to landfills than construction although accurate data for their division from landfills or projects are unavailable. Current building demolition is severely restricted by numerous factors, and its evolution by necessity must involve the demolition industry, regulations, economics, new technology, management and so on. The reduction of demolition waste will be achieved and benefit from a better understanding of demolition elements and the further establishment of an enhanced platform for demolition management.

It is apparent that the construction and demolition of a building functions oppositely. Construction and demolition are also interactive. Frequently, the construction of a new building requests the demolition of an old one or more on the site. There are also some examples in which the construction of a new structure is linked to the demolition of a historical one. However, the demolition industry is just a decentralised and diverse segment of the large and fragmented construction industry. Only in large cities are there a few companies dedicated solely to demolition. One possible reason is that there are only a small number of independent demolition projects. In most cases, building demolition is immediately followed by new construction, and kept as brief and uncomplicated as possible. The importance of demolition is completely underestimated because the materials and energy consumed in constructing a building dominate. In fact, manufactures and supplies of building materials are only the intermediate sources for construction, as the original source is nature, despite being largely invisible in the modern construction industry[5].

In Australia, several demolition regulations have been documented by government departments and professional authorities such as Standards Australia[6] and Victorian WorkCover Authority[7]. In the Geelong region of Australia, the demolition work procedure includes a demolition permit granted by a municipal building surveyor. However, compared to the construction regulations, demolition regulations are still rather separated, roughly-outlined and dated. For example, those demolition regulations given above were constituted from the occupational health and safety provisions with little concern on environment protection. There are no standards for demolition contractors. Anyone with a backhoe can bid for a demolition project. Furthermore, environmental considerations need to assume more importance in the process, particularly to the building owner, designer and contractor. Research and development on building demolition have not drawn much interest from project managers or engineers, and no robust demolition code system has been published by any authoritative governments or associations. Some current legal regulations, moreover, do not even promote environmentally-friendly demolition implementation. For instance, in the Victorian landfills in Australia, the difference of disposal costs per tonne between municipal solid waste and construction and demolition waste is only one Australian dollar based on the Industry Research and Strategy Report[8]. The certification procedure for the quality of used building materials and components has not been well established and widely understood. Therefore, the salvaged materials and products are not easy to be approved and reused in the construction of a new project.

The abovementioned small number of demolition companies also implies low economic benefits of demolition projects. Current demolition cost factors retard the boom of demolition business[9]. These factors consist of the present low acceptance of recycled and reused components and materials, high labour costs, low tipping fees of demolition waste and so on. The salvaged materials market is currently struggling due to a secure economic climate, where the average home handyman, enterprise manager and urban developer will source new material from a hardware store rather than even considering second-hand materials. The general consensus is that further education on environmental protection is required to drastically change this behaviour in society. The economics of demolition performance also drives demolition waste disposal decision-making. Any change in hauling costs, tipping fees and virgin material prices may induce the adoption of substitutive demolition and disposal methods.

Before the advent of mechanised demolition in the 1950s, demolition contractors brought very little materials to landfill sites and reused materials were widely applied in new projects as the hands-based "deconstruction" was commonplace as a demolition method[10]. Then achine-based dismantling became more common. The key reason to induce this shift was that the labour cost had increased faster than the equipment costs, despite the fact that greater recycling of used material will significantly contribute to lower resource usage in new facilities. Due to the time restriction to prepare the ground for the construction of a new project, the demolition contractor frequently undertakes a demolition project with tight time constraints. Recycling is also out of the question due to the high labour content required and the difficulties to sort different materials unless it is specifically requested in the contract. So far, most buildings have been designed and constructed with no consideration of what will happen to them after their service lives, which also enlarges the difficulty in implementing careful demolition for recycling. Recent research projects have attempted to promote design for demolition[11]. As a result, a new generation of deconstruction based on the utilisation of machinery might be achieved in the near future so that a larger proportion of demolished materials can be reused and recycled.

As an independent project, building demolition involves planning, design and implementation as well as its unique issues such as decision-making on alternatives to conventional building demolition, and handling and disposal of demolition waste. With regard to the long term ecological influences of demolition actions, the conventional machine demolition approach may be replaced by one of its substitutes. Technical development and research may enable those substitutes to become viable economically. The planning of a demolition project is generally based on the permission of demolition approved by a government department or authority. The design phase of a demolition project focuses on the physical procedure of the demolition activities. The demolition implementation phase mainly relies on demolition technologies and project management principles. The following three sections of this paper will introduce a series of proposed management strategies on decision-making for alternatives to conventional demolition, optimal demolition procedure with consideration to demolition planning and design, and a conceptual demolition implementation management framework. For simplicity, the disposal stage after the demolition waste generation is not elaborated on in this paper.

Figure 1 highlights the basic subjects required to be developed for promoting building demolition, including the development of demolition techniques and management, the enhancement of demolition awareness with owners, designers and construction teams, the development of environmental regulations on material consumption and disposal, and the quality certificates and market for reused materials and products to uplift demolition economics. The development of these practical subjects is interrelated and mutually promotional, and the developments in demolition management resulting from related research have direct effects on them. It is forecast that the improvement of these demolition-related subjects are also of a high benefit to the construction industry and the natural environment.

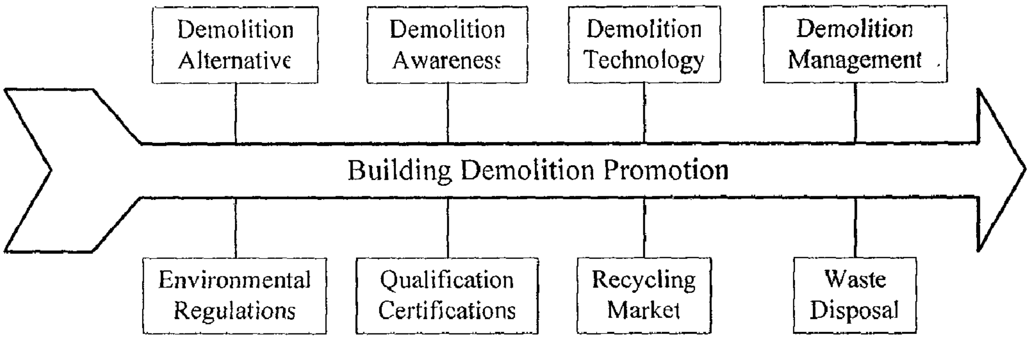

Figure 1. Building demolition promotion strategies

3. ALTERNATIVE DEMOLITION

3.1 Alternative demolition options

Buildings account for one quarter of the world's wood harvest and two-thirds of its material and energy flows[1]. From the viewpoint of natural resource reservation, the construction and demolition industries can use materials much more sustainable than they are doing now. Construction materials extracted from natural resources are sent to landfills after only one or two usages. As any natural resource is within limits after which irreversible or serious depletion and damage can occur, the resource extraction activities have to be undertaken with a view to the carrying capacity of the relevant ecosystem to absorb its varied effects[12].

To be more conscious of natural resources and more innovative in building demolition, there is a desperate need to find new ways of using no longer occupied or unwanted buildings. An example is that, in 2001, a design competition to extend the service life of a building to one hundred years, over three times the existing design life of thirty years, was launched by the Architectural Institute of Japan[13]. Although the currently widely-used machine demolition may be a quick, cheap and easy solution to remove buildings, other options under a systematic approach now more than ever need to be explored for the purpose of minimising construction and demolition waste.

Figure 2 represents the construction-demolition chain from the raw materials extracted from the earth to landfill after one or more usages through construction and demolition activities. Building demolition alternatives decide the proportions of materials going back to construction through each of the loops from top to bottom as shown by the dashed lines. An ideal solution for an abandoned constructed facility, which cannot be used as it is from a structural or functional standpoint, is to refurbish or relocate it. In this case the life of a building is extended, and the majority of a building is retained. In other words, demolition of a building may certainly be avoided, or the third solution do exist after construction and demolition. For many years, renovation and rehabilitation of buildings in Australia has been developed under requirements for building heritage preservation.

An example is the Geelong Waterfront Campus of Deakin University, in which the whole building originally built in the 19th century underwent extensive redesign and refurbishment in the 1990s.

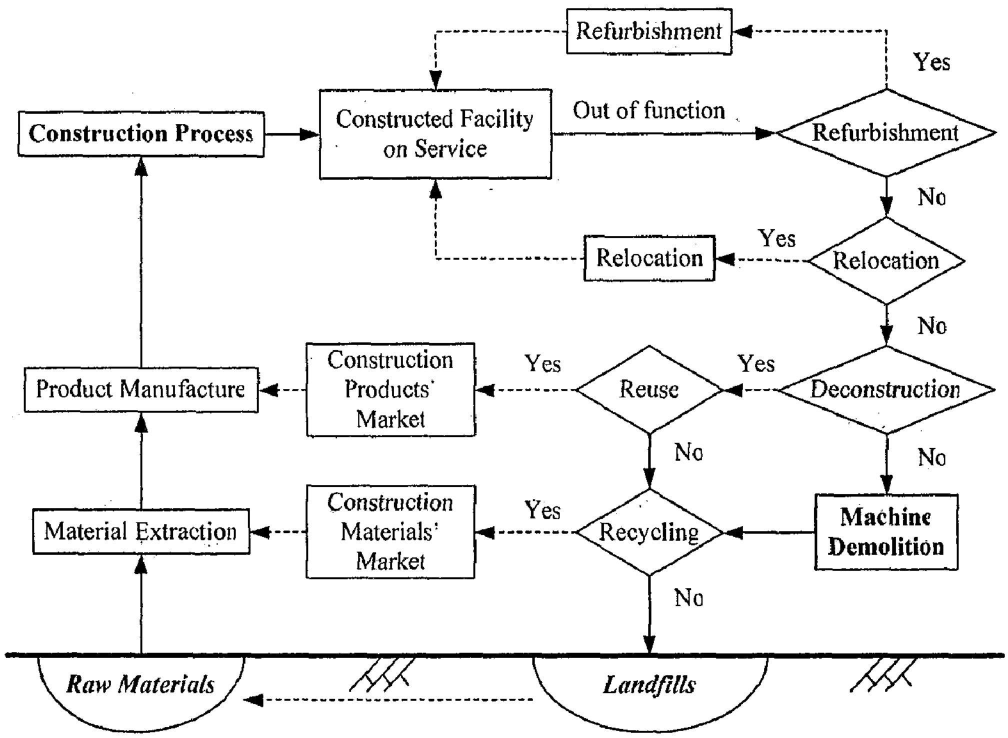

Figure 2. Decision-making process on building demolition

Relocation has widely been applied on residential houses, particularly with post and beam, weatherboard cladding and timber frame. In the Victorian region of Australia, more than one thousand buildings are relocated each year[14]. Worldwide, successful relocation has occurred for bridges, churches, odeums and stations, and other structures. After refurbishment or relocation, as shown in Figure 2, a building may be on service again with the original or a modified function.

In addition, buildings that are optimally designed with environmentally sustainable materials and with deconstruction in mind are of extreme value for reducing waste, although most buildings currently being refurbished or totally demolished are not of this nature. Deconstruction is the first consideration from an ecological viewpoint if demolition has to be carried out.

By deconstructing the building, the reuse of materials would provide the next best result following refurbishment or relocation in terms of waste minimization. Destruction, which represents machine-based dismantling, may still allow a major portion of the material to be recycled and reprocessed into building elements. The last process in order of preference is the disposal of the demolished waste to landfill, which should only occur after all other options have been fully explored and investigated.

3.2 Evaluation of alternative demolition options

This optimal decision-making process on alternative approaches implies maximisation of resources conservation by preventing demolition waste in the first place, such as by extending the building's life or optimal design of the building for reuse. Minimum waste oriented demolition processes also provide a systematic approach to reduce landfill pressure from the construction industry. The economic performance of each demolition method may be analysed and compared.

Based on a real case study, research was carried out to depict both the economic advantages and disadvantages of three demolition strategies, which are machine demolition; machine demolition for recycling; and deconstruction[9].

The base case for comparison was traditional machine-based demolition. The main cost factors considered were labour costs, materials benefits, plant costs, environmental costs, and administrative costs. This previous study may be extended to define and model all demolition and alternative scenarios with an emphasis on refurbishment and relocation. Each scenario may further be evaluated holistically using a combination of multiple criteria such as financial return, functional performance, energy usage, and environment impact criteria.

4. CONCLUSIONS

Serious attention has been drawn to the demolition of buildings due to the enormous amount in landfill disposal being generated globally. The current demolition approach gives little time to demolition participants from the occurrence of a demolition concept to the implementation of demolition activities. This paper presents the promotion strategies for demolition from the viewpoint of systematic demolition management. The demolition stage in the lifecycle of a building is of the same importance as planning, design, construction and maintenance stages. The demolition waste dominates the waste stream to landfills and hence minimizing the demolition waste is a crucial strategy to develop environmentally friendly building techniques. A series of alternative demolition strategies was set up for reducing demolition waste sent to landfills and their evaluation methods are also discussed in this paper.

REFERENCES

[1] Roodman, D. and Lenssen, N. (1995). A Building Revolution: How Ecology and Health Concerns are Transforming Construction. Worldwatch Institute, Washington, USA.

[2] Weber, W. J., Jang, Y. C., Townsend, T. G, and Laux, S. (2002). Leachate from land disposed residential construction waste. Journal of Environmental Engineering, ASCE, 128(3): 237-245.

[3] Tabloid News Service (1997). Rain of Horror Pounds Aussies, http://www.tabloid.net/97/07/14/B1.html (accessed on 15/2/2007).

[4] Australian Bureau of Statistics (2003). Australian Year Book, Canberra, Canada.

[5] Birkeland, J. (2002). Design for Sustainability: A Sourcebook of Integrated Eco-logical Solutions. Earthscan Publications Limited, London, UK.

[6] Standards Australian (2001). AS 2601-2001: The Demolition of Structures, Sydney, Australia.

[7] Victorian WorkCover Authority (1998). Code of Practice - (No. 21) - Demolition – Amendment, Melbourne, Australia.

[8] Industry Research and Strategy Report (2000). Understanding the Waste Stream, Statistical Overview, EcoRecycle Victoria, Melbourne, Australia.

[9] Liu, C., Lyle, B. and Langston, C. (2003). Estimating demolition costs for single residential buildings. Australian Journal of Construction Economics and Building, 3(2): 33-42.

[10] Liu, C., Pun, S., and Itoh, Y. (2003). Technical development for deconstruction management. Proceedings of the 11th Rinker International Conference on Deconstruction and Materials Reuse, pp. 186-203, Gainesville, USA.

[11] Chini, A. (2002). Design for Deconstruction and Materials Reuse, CIB Publication 272. International Council for Research and Innovation in Building Construction, Gainesville, USA.

[12] Trusty, W. B. and Paehlke, R. (1994). Assessing the Relative Ecological Carrying Capacity Impacts of Resource Extraction, Forintek Canada Corp., Vancouver, Canada.

[13] Architectural Institute of Japan (2003). Architectural Design for Reduction of 30% $LCCO_2$ and Extension of Three Times of Service Life (100 Years). http://www.aij.or.jp/aijhome.htm (accessed on 15/2/2007).

[14] Kibert, C. J. and Chini, A. R. (2000). Overview of Deconstruction in Selected Countries, CIB Publication 252. International Councill for Research and Innovation in Building Construction, Gainesville, USA.