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Construction And Demolition Waste Management In Civil Engineering Projects

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Abstract

Environment sustainable improvement has turned into a critical objective of construction progress and waste management is one of the key connectionsin construction. Based on the domestic and foreign pertinentexperiences, this paper proposes a new system to evaluate waste management performance in an architectural engineering project. Through research, primary impact factors of construction waste management in our country are affirmed, to be specific: "collecting packed materials back by suppliers; commitment of contractor's representative on site;appointment of laborers solely for waste disposal; design and construction utilizing standardized materials and minimizing rework in the construction phase.A model of waste management in architectural engineering projects, it is demonstrated that the model can successfully gauge the waste management performance in construction site, with clearer tasks and higher performance.Also , this paper proposes to distinguish the critical success factors (CSF) for organizing Construction & Demolition (C&D) waste: (1) Waste Management System (WMS), (2) WM regulations, (3) vocational training in WM, (4) awareness of C&D WM, (5) fewer design changes, (6) low-waste building technologies and (7) research and development in WM. These CSFs can provide as important references for stakeholders to to create viable C&D WM strategies. Lastly, it is recommended that our government ought to survey waste management performance in construction site relevantly, create market evaluation software effectively and advance the natural supportable improvement of the architectural industry.

Keywords: Construction&Demolition, Waste Management System, Critical Success Factor.

Introduction

Resource depletion, serious environmental pollution, global warming is compelling various countries to focuson environmental issues in the architectural industry, to invest a great deal of time and capital to build up environmentallymaintainable building systemsand in addition to have an exceptional craving to environmental assessment methods andtechnology for practical development in construction. There are four main negative impacts on the environmentfrom the design phase to the construction phase of an architectural engineering project, they are: construction noise,air pollution, on-site dust, construction waste. Among these impacts, the construction waste is perceived by researchers as the most naturally destructive throughout the whole engineering project the most solutions by decreasing material waste or recycling [1-2].

In practice, construction planning and control draws on asubstantial-scale project and corporate data repositories, which are frequentlyamorphous. Thissurvey exhibited a large number of conceptual object models, which were created to recognize attributes and relationshipsbetween product and planning information thoroughly, using bridges as a representative product.The models were utilizedto build up a vastinformation repository executed in a database management system to encourage real world project information collation management and organization to replicate the large-scale nature of construction projects in practice. The database behaves as a source of cases andsub-cases that are recovered and mapped in a case-book. These cases are considered independently for matching, validation purposes and retrieval, encouraging the re-utilization of parts of different cases to build new project plans. A prototype software model, Case-Based Reasoning (CBR)Planner, which was produced and tried with real world project casesto exhibit the methodology waspresented [6].

The objective of this survey is to gather the information aboutadvancements,achievements, problems and solutions most illustrative of the different countries.Accordingly, every country can gain from illustrations and support a teaching method for the successful usage ofrecycling. A short survey of the history of recycling ofconstruction and demolition waste is exhibited.As indicated by theISPRA's estimates, distributed on Italian Waste Report 2008, around52 million tons have been created in Italy.Concerning the qualitative characteristics, in 2008 almost the 100% of thewastes sent to the recycling plants were construction and demolition ones, includingtainted soil.

Among the above-mentioned, primary classifications are:

–Other than that 17 09 01, 17 09 02 and 17 09 03 , EWC 17 09 04 consists of mixed construction and demolition waste;

–Other than that 17 01 06, EWC 17 01 07 consists of mixture of concrete, bricks, tiles and ceramics;

–Other than that 17 05 03, EWC 17 05 04 consists of soil and stones.

Regarding the quantitative aspects, despite this year the plants' involvement hasbeen restricted because the economic situation, so the study can't thoroughly be viewed as illustrativethe Italian circumstance is emphatically rearward if contrasted and that of other comparable European Countries [7].

This surveydescribes about the major issues in theestimation of Construction Waste (CW), with the end goal of advancingwasterecuperation inside of the system ofsustainable construction. Bothterritorially and on a smaller scale and in diverse sorts ofbuildingsare givenby a few studies and quantization tables which acessessing the Construction & Demolition (C&D) waste. The challenges and significance of getting a more prominent learning of CW initial commencement of the project are discussed. Seventeen examples and casestudies highlight the variables influencing the estimation of C&D waste, the change accomplished in themanagement scenarios and the advantages of usage in accomplishing manageable buildings [8].

2. Establishment of waste management performance assessment model

In the research, the main thought of waste management performance assessment model is as below Figure 2.1.

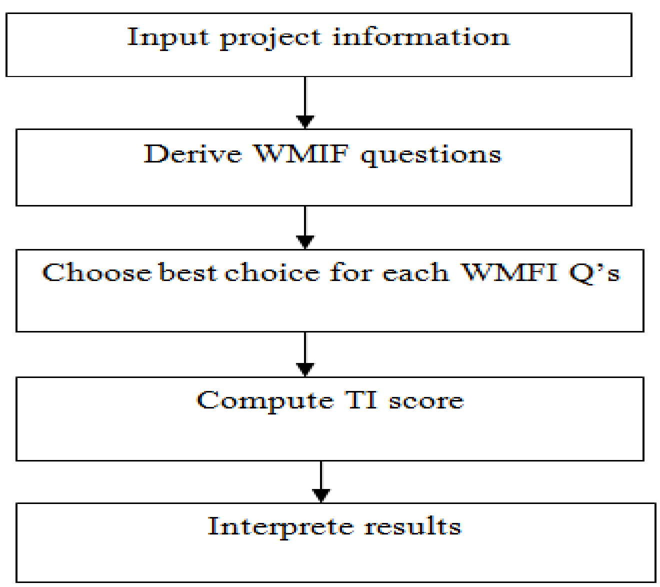

Figure .2.1. Waste Management Performance Assessment-Logic flowchart

Firstly, the client is obliged to input project information, including project name, location, evaluator and date ofassessment. In the next step, In the following step, the members addressed inquiries of "questions of waste management influencefactors" of the questionnaire or by e-mail. After finishing the response selection process, the framework naturally figures the total score, the level of waste management performance for thesubject project is known as "Total Index (TI)". The following equation was used in developing this tool:

$$\text{Total index} = \sum_{k=1}^{4}(\sum_{l=1}^{i}(\sum_{m=1}^{j} PQ_{klm} \times PV_{klm}) \times GV_{kl}) \times DV_k \qquad (2.1)$$

Total index alludes to the total score,PQ_{klm} = score of mth response for lth factor in kth category; PV_{klm} = weight of mthresponse for lth factor in kth category ($0 < DV_k \leq 10$);DV_k= weight of kth category ($0 < DV_k \leq 10$); GV_{kl}= weightof lth factor in kth category ($0 < GV_{kl} \leq 10$); i= number of factors in kth category; and j=number of responses for lthfactor in kth category.

This evaluation model uses three unique sorts of weights, factor , category and including response. Thecomputation for these weights is at present in view of the surveyof project managers and technicians, expertexperience and knowledge. In this way, the evaluation results are subjective to some degree. To reduce thisdisadvantage, in the research, data collection must be thorough and recognize impact variables. By increasing the alternative scores for every waste management impact element with the three sorts of weightings, the total index effectively acquired and ranges from 0 to 1000. The score coulddemonstrated the present level of waste management practice inarchitectural engineering projects, mainly for high-rise residential projects. In order to give some guidance for thewaste management practice, this survey classified the total scores into four levels, including excellent, good, fairand poor.For example, to be classified as an excellent project, the TI score should be over 800, whereas in poor projects, thescore is below 400.

3. Establishment of assessment model of waste management performance in construction project

3.1. Identifying waste management influence factors(WMIF)

"Waste Management Influence Factors(WMIF)" is defined as amanagement performance assessment of building construction, the management factors influential on the reductionof construction waste and promoting recycling of waste management". Based on the above definition, with thereference on a wide range of national literature, as well as by interviewing project managers and visitingconstruction sites of high-rise office buildings in the Pearl River Delta region, we define "waste managementinfluence factors" as "in the construction site management, the factors influencing on the reduction of constructionwaste, harmlessness and materialization" and they preliminary design factors that may affect waste management.Factors were finalized and categorized into five areas, including manpower, Construction method, materials andequipment, Management practice, and architectural industry policy.The complete set of 56 factors identified in this study is shown in Fig. 1. These factors can be regarded aspotential indicators that relate to improving construction waste management performance. In the "Manpower"category, there are three factors in relation with participants' commitment, management, organizational structureand education program of the staff. In "Material and equipment" category, cyclic utilization of waste is emphasized.In the "Construction method" category, there are 12 factors related with disposal of construction wastes, includinghow to provide waste recycling bins and how to classify mixed construction waste. In the "Management practice"category, 15 factors are listed in relation to the contractor's waste management plan and execution approach,contractual conditions for waste treatment, and the contractor's supervision of waste control. Finally, in the"Architectural industry policy" category, regulations and laws related to waste treatment are included.By investigating the important roles of 56 factors in waste management practice, the results show the average ofrelative importance of factors is greater than 5.0 (where the maximum is 10). If give these factors some weight and transform them into measurable indicators, they can be used in the waste management assessment on buildingconstruction site, and can effectively assess the waste management performance of project participants (mainlycontractors).They also suggested that the Questionnaire Survey for weight values of waste management influence factors.

Manpower	**Construction method**
A1 Commitment of contractor's representative on site.	C1 Setting up separated bins by waste by type from mixed materials
A2 Appointment of labours solely for wastes disposal	C2 Sorting out individual waste by type from mixed materials
A3 Coooperation of subcontractors	C3 Designate a place for sorting wastes in an early stage of construction
A4 Organization breakdown structure involved in waste management	C4 Setting up temporary bins at each building zone
A5 Education of project managers,technicians	C5 Sorting wastes at an easily accessible area

A6 Education of labours	C6 Providing bins for collecting wastes for each subcontractor
A7 Preventing waste of materials by labours	C7 Noticing engineers the responsibility on reusing wastes
Materials and equipment	C8 Noticing staff to reuse recycled materials
B1 Collecting packed materials back by suppliers	C9 Preventing mixing wastes with soil
B2 Minimize rework on a construction phase	C10 Prohibiting use of pipes for dumping down mixed wastes
B3 Design and construction using standard materials	C11 Installing an information broad to notice categories for separating wastes
B4 Prefabrication of materials	C12 Informing methods to deal with rest of the wastes after recycling
B5 Use of recycled materials	**Management practice**
B6 Preventing easily fragile materials from being used	D1 Rules on dealing with waste-generators
B7 Collecting recycled materials back	D2 Contractual clauses for a subcontractor in dealing with wastes
B8 Collecting left construction materials	D3 Positive incentive for decreasing or recycling by subcontractors
B9 Minimizing loss of materials during carrying and storing	D4 Keeping a record about waste management (amounts,kinds etc.)

Architectural industry policy	D5 Shortening a period of collecting wastes in a site
E1 Obligatory cost estimation for quantityof waste treatment in a bill	D6 Contractual clauses about the method for a waste disposal agency to traet wastes
E2 Enhancing punishment for illegal treatment of wastes	D7 Establishing an waste management plan in an early stage of construction
E3 Incentive in bidding for a contractor having a plan about decreasing waste and increasing recycle	D8 Checklist on executing detailed waste management plan
E4 Supervising waste management by a residential officer	D9 Confirming capability of a firm which treats wastes
E5 Issuing waste management levels from owners to contractors	D10 Deciding an objective rate for recycling wastes
E6 Simplifying legal procedure to install waste treatment equipment	D11 Keeping a record about recycling wastes
E7 Activating development of technique to treat and recycle wastes	D12 Shortening a period of taking waste out of a site
E8 Establishing criteria for quality and safety of recycled materials	D13 Informing recycling methods and uses in a site
E9 Constructing marketing structure for recycled materials	D14 Checking the route periodically for a waste agency to carry wastes
E10 Raising fees for mixed wastes	D15 Checking and submitting the documents of

	waste disposal
E11 Reducing fees for separated wastes	
E12 Tax free for waste treatment equipment	
E13 Database management for construction wastes	

Table 3.1. Cause-and-effect diagram for waste management performance improvement

4. Construction and demolition waste management

The construction industry has a negative impact on the naturalenvironment. Construction by its nature is not environmentally friendly as the various activities involved, such as excavation, buildingand civil works, site clearance, demolition activities, road worksand building renovation, generates a tremendous amount of C&Dwaste. C&Dwaste is typically in the form of building debris, rubble, earth, concrete,steel, timber and mixed site clearance material; it is often amixture of inert and organic materials. The research and practice of C&D WM can be best understoodby putting it into a spectrum ranging from hard technologies to soft management. For example, low level technologies can be introducedto reduce C&D waste, such as using prefabrication insteadof in situ. Also, new technologies have been developed to reuse and recycle, for example, using recycled aggregates for differentconcrete applications.

5. Research methodology

The critical success factors (CSFs) approach has been a populartechnique in construction research. the two key words of the CSF approach . The CSFs is an effective method in the following twosituations:

(1) when the task is to make a complex system manageableby reducing the number of factors; and

(2) when a largenumber of success factors are competing for limited resources andit is necessary to identify the vital ones that should be given moreattention.

This paper proposed the procedures for identifying CSFs into five steps:

(1)identify a full set of selected success factors (SSFs);

(2) conduct asurvey to investigate each SSF's importance by referring to a givengoal;

(3) calculate each factor's importance index value based onthe survey data;

(4) extract CSFs from the pool of SSFs accordingto the value of importance index;

(5) interpret and analyze theextracted CSFs. This research followed those steps for identificationof CSFs for C&D WM.

5.1 Selected success factors for C&D WM

With eight constructionprofessionals in order to ensure the suitability and comprehensivenessof the factors for China's construction industry. Three of theprofessionals were from contractors (including oneC&Dwaste contractor),one was from a building developer, two were from on-sitesupervision companies, one from a government department andone from a construction research institute. They were all carefullyselected to ensure that they would reflect the views of differentstakeholders and professionals involved in managing C&D waste.

In addition to the 13 factors identified from the literature review, 5additional factors were recommended by pilot study respondents.The resulting 18 factors along with their sources are shown inTable 5.1.

No.	Factors for C&D WM
S-1	Material usage and storage system
S-2	Fewer design changes
S-3	Improving communication amongst project participants
S-4	Lifecycle waste management
S-5	WM regulations
S-6	C&D waste recycling and reuse
S-7	On-site C&D waste supervision system
S-8	On-site C&D waste sorting
S-9	Low-waste construction technologies
S-10	Awareness of C&D WM
S-11	Improving conventional construction process
S-12	Environmental management system
S-13	Waste management syatem (WMS)
S-14	Housing industrialization programme
S-15	Research and development in WM
S-16	Vocational training in WM
S-17	Measuring C&D WM

S-18	Taking WM into consideration in bidding and tendering

Table.5.1.Tentative success factors for C&D WM.

6. Conclusion

This paper demonstrated the combination of two methods.Firstly, Environmental sustainability has become an important driving force promoting the continuous grow ofarchitectural industry. To follow up on this trend, many countries tried to establish sustainable construction systemand develop the effective tool of assessment performance. They not only research and develop building environmentassessment tool in the planning and design phase, but also develop waste management software in constructionphase and take waste management as an important component of construction management. At present, China hasnot targeted to assess the performance of waste management on construction site; the assessment model presented inthis study can provide guidance for the improvement of the construction site with the total score. Secondly,Managing C&D waste is high on the agenda for reducing thenegative impact of construction on China's environment. Througha series of analytical processes, this research identified 7 CSFs forconducting C&D WM in Shenzhen, China. They are:

(1) Waste Management System (WMS),(2) WM regulations

(3) vocational training (4) R&D

(5) awareness of C&D WM

(6) low-waste building technologies

(7) fewer design changes

The recognitionof CSFs reduces the complex nature of C&D WM into manageable,but vital factors that need to be taken into consideration whendevising successful C&DWMstrategies. The dilemma in relation to C&DWM in Shenzhen is caused by the requirements of fast economicdevelopment and the need to pay more attention to C&D waste thatis perceived to negatively impact such development. Discoveries fromthis research suggest that in order to foster greater acceptance ofC&D WM, it will be essential to demonstrate that it does not necessarilyundermine economic development. It was also found that activitiesthat are conducted in haste, such as fast-track design and insufficienttraining for labor do not necessarily help companies to keepup with the fast pace of development.Onthe converse, they can leadto budget and time overruns, low quality, and bad environmentalperformance.

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