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Analysis of the Opportunities and Challenges of Construction and Demolition Waste Management Methods Using PESTEL Analytical Tool

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Abstract

The aim of this study is to analyse the construction and demolition waste (C&DW) management strategies using a management analytical tool. The literature study was carried out to identify the various C&DW techniques. This was followed by the administration of a questionnaire survey completed based on a five-point Likert scale and the results were assessed and analyzed using IBM SPSS version 26 software. The outcome demonstrated that the stakeholders in the construction industry are more concerned about the final cost of the project, quality of work and completion time than the management of C&DW. The use of site waste management plan, legislation on implementation of waste sorting, and development of a waste stream market were identified as the most effective waste management strategies which should be adopted by the construction stakeholders. The PESTEL (political, economic, social, technological, environmental and legal) analysis was used to analyze the external risks to be considered in the management of the construction waste while the SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was used to identify the various strengths, weaknesses, opportunities and threat that can arise in the management of construction waste.

Keywords: Construction and demolition waste; PESTEL analysis; reduction; reuse; recycling; stakeholders; strategies; waste.

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1. Introduction

The construction sector is an important aspect of the socio-economic enlargement of any country. Several countries have experienced growth in their economic because of this sector; In Poland, the employment rate within the construction sector grew by 20.9% between 2010 to 2020 [1]. The Jordanian construction sector recorded a compound annual growth rate of 24.4% in 2010 [2]. 5.95% of the gross domestic product (GDP) is attributed to the Canadian construction industry through the employment of millions of people [3]. The sector contributed 4 percent to the GDP of Malaysia in 2014, with a predicted increase of 5.5% in 2020 [4]. In 2019, the construction industry in Peru is anticipated to see a growth rate of 9.5%, which will lead to increased waste generation [5]. Construction is essential to all of our needs, but it also generates waste. The Waste Act of 14 December 2012 defines waste as any solid item or thing that the holder discards, wants to discard, or is obligated to trash. This concept conforms to the 2008/98/EC Waste Framework Directive (WFD). Symonds defined waste in his study as materials obtained when a building or civil engineering infrastructure is demolished (although not always obtained directly as a result of the demolition) [6]. Objects or materials which are thrashed or intended to be thrashed or are required to be thrashed according to the provisions of the state law are referred to as waste [7]. Wastes from C&DW are produced during the building, maintenance and disposal phases. The market for construction waste comprises garbage from demolished buildings, such as large panel systems [8] as well as projects involving renovations in the real estate industry and other types of civil engineering. The lack of implementation of waste reduction controls has further reduced landfill life. Numerous industrialized nations have recognized the need to adjust the tendering, contracting, and building site procedures in order to prioritize waste avoidance and treatment on-site.

The major approach to construction waste management has been the combination of public fill areas and sorting facilities. Currently in Ukraine, landfills for construction waste only existed in few cities with 90% of them filled [9]. In order to achieve sustainable development, overreliance on reclamation of the inert construction waste must end. These days, the reclamation sites are gradually decreasing. With the current trend, the landfills will be full, and public fill capacity will be depleted soon. Recently, the building sector has realized not only the need to be environmentally responsible but also the benefits of green construction. Life cycle evaluation and pricing of developed infrastructures is the subject of an ongoing endeavor. To internalize the externalities of construction-related activities, there is also a push to quantify the environmental costs of building. Several programs have been initiated by different countries to increase the efficiency in construction in terms of manpower, machinery, and material use. There is growing support for the purchase and use of building materials and products containing recycled content. Newer strategies focusing on the prevention, reduction, re-use, and recycling of waste from construction sites have been proposed with great effort. In addition, governments have increasingly implemented legislative and incentive measures that make it more difficult for wasteful job site practices to continue. The large volume of project site waste contributes to the C&DW that result from the construction industry on a yearly basis. Based on a 2012 estimate by the World Bank, urban areas create 1.3 billion tonnes of solid waste on a yearly basis [10]. According to [11], material constitute half of the solid waste generated worldwide on a yearly basis. An average of 19,000 tonnes of C&DW were generated on a daily basis in Peru [5]. In the United States, over 600 million tonnes of construction-related waste were generated in 2018 [12] while the C&DW generation in the U.S. increased by 342% from 1990 to 2018. The effects of the C&DW

generated on the environment on a yearly basis is huge, and therefore, its management has to be taken seriously. Effective planning and quantities of waste prediction should be included as a pre-requisite for the management of waste. There is a need for a better understanding of the C&DW management strategies available in the construction sector and the challenges that could pose a threat to the opportunities of harnessing these strategies. For the purpose of this research, the following questions would be addressed:

1. What are the various site waste management strategies available in the construction industry?
2. What is the main contractors' goal with respect to investment cost, realization time, quality of work and C&DW management?

The aim of this thesis is to analyse the C&DW management strategies using the strategic management tool; the PESTEL analysis. The objectives of the research are; to provide a comprehensive review of literature, identify the waste management strategies available, examine the main contractors' goal on investment cost, completion time, quality of work and site waste management methods in the building construction projects. The novelty of the study will show the perspectives of the stakeholders with respect to cost, completion time, quality and site waste management strategies. The use of PESTEL analysis for the evaluation of the external factors that affect the C&DW management would be analysed. The findings will be significant to professionals, contractors, investors and government. The research scope is limited to contractors and sub-contractors registered under the heading of Polish Association of Construction Employers (Polski Zwiazek Pracodawcow Budownictwa). The quality of data from the stakeholders for this survey is high because these organizations engage professionals with a good knowledge of the subject.

2. Literature reviews

2.1 Construction demolition and site waste

2.1.1 Composition and sources of site waste

The differences in the activities carried out in the construction industry along with the accumulation pattern makes it almost unrealistic to define the composition of the C&DW. The European Union (EU) list of wastes include the C&DW in Category 17 with concrete and masonry making up of 50% of the waste generated in the construction industry [13]. Others are gypsum-based materials, timber, metal, glass, plastics, and insulation materials. The absence of knowledge of construction participants on the features and compositions of the waste, results in the large volume of waste dumped in the landfill [14].The rate of involvement and ranking of the waste sources will determine the level of attention drawn to the waste source. Design, procurement, material handling, operations, residual and others are the six (6) subdivision of waste sources identified by [15]. Reference [16] grouped the causes of C&DW under the following; design, management, workers, procurement, construction operation, site condition, handling and external factor. In the proceedings of the second Southern African Conference on Sustainable Development in the Built Environment, Reference [17] classified the source of construction waste into four (4) categories: design, procurement, material handling, and operational.

2.1.2 Waste generation in construction activities

Studies have shown that the volume of construction waste generation is huge notwithstanding the location. Reference [18] presented the percentage of the waste generated from different sectors ranging from commercial and industrial waste, C&DW, special and domestic waste. In their study, 38% of the waste generated was attributed to C&DW. In 2009, 23% of the total waste generated in Hong Kong are construction and demolition (C&D) related [12]. In Australia, the percentage of material waste is between 2.5-22% [19]. The wastes obtained from the materials bought in Netherland is between 1-10% [20]. The construction type, technology, procedure and regulations enforced by the government (local, regional and federal) can affect the waste in construction site differently. Other factors that impact waste generation are attitude and behaviour of the workers (supervisors, tradesmen, labourers etc.). Reference [21] identified material storage, movement and construction processes as some of the factors that determine waste generation. Rework different from design and specifications, revision of designs and uneconomical waste shapes were identified as the three major factors of waste generation in his research on evaluating factors affecting the waste generation in Rivers State, Nigeria [22]. Reference [23]classified the identified C&DW generation factors into two; human and non-human factors using drywall as a case study for the waste quantity prediction.

2.1.3 Waste hierarchy

The establishment of the waste hierarchy in figure 1 was in accordance with Article 4(1) of the EU WFD (2008/98/EC). This is a guiding principle for the waste management system. The Hong Kong Environmental Protection Department in 2013 summarized construction waste management strategy as a cone that is turned in the opposite direction, which is to avoid, minimize, reuse, recycle and dispose of waste with the benefits reducing in this manner. The deliberate use and implementation of this hierarchy should result in resource efficiency, environmentally improved locality.

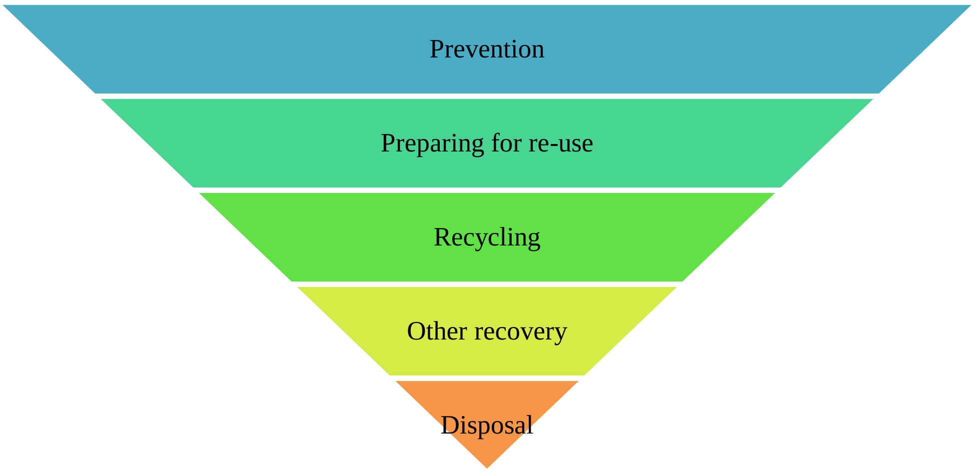

Figure 1: Waste hierarchy, by the Waste Framework Directive (2008/98/EC)

2.2 Management of construction demolition and site waste

Several research have shown that the construction activities are not environmental friendly [24]. Land depletion, waste accumulation and pollution are some of the effects of the construction works [25]. The least attention and priority placed on the waste minimization and management was identified as the main cause of huge waste generation in Iraq [26]. [27], described that the negative impact of demolishing structure were lowered by replacing natural fine aggregate with recycled fine aggregate from industrial wastes. [8] evaluate the properties of recycled coarse aggregate obtained from C&DW of large panel system; the answer allow for the possibility of reducing waste as well as transportation of waste.

2.2.1 Strategies for the management of the construction demolition and site waste

Waste disposal ordinance, waste reduction framework plan, green managers scheme, concrete recycling plan, promotion of public landfill charging scheme are some of the initiatives developed by the government of Hong Kong as a waste control measure [12]. Reference [28] explains that the establishment and promotion of the legislature on recycling, certifications and economic rewards as useful tools for the C&DW management. Reference [29] proposed the acceptance of the waste management model as the solution for the industry to achieve greener construction and sustainability through the application of the 3R (reduce, recycle and reuse). Reference [30] discussed the systematic methodology for the C&DW management using a closed-loop method. The loop were grouped into objectives, planning-design-procurement, construction, occupancy, operation-maintenance, and renovation and demolition. The design for flexibility and deconstruction is regarded as one of the strategy for the C&DW management. Deconstruction is the process of careful removal of the building components in order to allow for recycling and reuse. The C&DW strategy in Malta uses four (4) interconnected factors as the main point in waste management [31]. This was represented in a diagram as shown in figure 2. Priority levels were assigned to the set in the diagram with planning and design, waste management, quality management, policy and regulatory frameworks occurring at different levels. The waste management methods and the frequency of use in the construction industry in relation to some selected materials e.g. concrete, blocks, steel, concrete, stone tiles and wood depend on the size of the construction company [32].

Figure 2: Diagram showing the overlapping and interconnected relationships between the four priority levels [31].

2.2.2 Implementation and difficulties of the waste management strategies

Reference [18,25] identified pollution prevention, allocation of materials, compliance, risk evaluation and plans for averting problems as some of the benefits of implementing the waste management strategies. The prevention and reduction of C&DW helps to take charge of the socio-economic, environmental impacts and achievement of sustainability in construction [33].

Reference [34] discussed the impacts of construction waste management practices by identifying Twenty-Five (25) negative socio-economic and environmental factors that affect waste management in Ethiopia. Reference [35] identified the lack of deliberate focus on waste management in recent regulations; lack of focus on design to meet the requirement of waste management; awareness of C&DW management practices; incentives from regulatory authorities. Lack of cooperation and communication between the participants within the construction industry are recognized as the main obstacle to the execution of C&DW management.

2.3 Current state and challenges

Waste reduction has the greatest priority among the waste management alternatives but the effective reduction is not possible without the knowledge of the waste sources. Reference [36] present a study that carried out the contribution rates of nine identified sources of construction waste. The establishment and the contribution of various waste sources will facilitate knowledge-based decision-making in developing an appropriate strategy for mitigating construction waste. Reference [37] estimated that around 33% of on-site waste is associated with project design. Therefore, waste reduction should not only fall on the shoulders of the building firm, since the client and designer are able to make eco-friendly choices in the program of requirements and designs.

In their study on techniques for successful waste reduction and management of construction project in densely populated cities, Reference [38] conducted a desktop study on construction proper waste management to gain a preliminary grasp of the current situation in Hong Kong. Five major strategies were identified and these are financial values to participants, public legislation in implementation of waste sorting, the government encouragement for the green building, development of a waste stream market, and education and research in construction waste minimization and management.

A framework for managing C&DW economic determinants of recycling was proposed by [39]. The research suggests a framework for the proper operation of C&DW in countries suffering from lack of national C&DW management procedures and facilities. The result shows that the possibility of commencing a new recycling facility is greatly dependent on the interrelationship between the landfill-tipping cost and the price of the recycling gate fee coupled with the ability to market the byproduct as well as enforcement to control illegal dumping and properly manage engineered landfills. Reference [40] proposes a framework for the maximization of the construction and waste management 3R and minimization of the disposal process using a unique sustainable strategy throughout the duration of the building project. In research evaluation of waste management practices in the Hong Kong construction sector using spectrum and bi-spectral methodologies, Reference [18] found that enhancing safety performance is as significant as reducing construction costs for building projects.

The improvement of environmental performance is considered as the lowest project scope in the construction industry. Organizations experience the greatest challenge in establishing waste management systems due to the absence of well-known, effective waste management strategies.

The major problem of the recycling and re-use of the C&DW in the EU is the problem of confidence in the quality of produced recycled materials, possibilities of undetermined health risk for workers. The Protocol for the EU C&DW management agrees with the Construction 2020 strategy [41] together with the Communication on Resource Efficiency Opportunities in the Building Sector [42]; this also includes the newly presented Circular Economy Package by the European Commission. These proposals will help in the stimulation and accomplishment of the WFD goal of 70% recycled C&DW. The goal of the Protocol is to expand the level of trust of C&D produced materials by:

- Improving waste identification, source separation and collection;
- Improved waste logistics
- Improved waste processing
- Quality management
- Policy and framework conditions

The Protocol recognize market-based competitiveness, ownership by practitioner, transparency, traceability, certification, audit, location, respect for environmental and health and safety rules, data collection and generation throughout the C&DW management process. The environmental impacts assessment position a greater opportunities for the participations of stakeholders as spelt out in the Act. In the quest for the achievement of the National Waste Management Plan [43], environmental awareness and campaigns, sorting of waste collected, inspection, and supporting of the recycle and reuse of construction materials were identified.

3 Methodology

There is a growth pattern in the rate of construction works in Poland, and the waste generated from these activities will require effective C&DW management strategies. This research is centred on reviewing the C&DW management methods using strategic management tool. Figure 3 depicts the approach employed for this study.

3.1 Data collection

The beginning of the research was a detailed review of the literature to identify the C&DW management practices. The reviews comprises journals articles, and proceedings that discuss the issue of construction waste management methods and its current state. During the literature review, Twenty-Three (23) waste management strategies were noted. These were the inputs for the formation of the questionnaire to show if these identified strategies are relevant to Poland. The respondents are Engineers, Architects, Construction Managers, Project Managers, Foremen, client representatives, etc. The data collected were evaluated using IBM SPSS version 26 and the relative importance index to determine the impact observed by the identified methods. According to

[44], the use of a pilot survey for conducting research is to obtain a level of certainty that the research meets the defined criteria in terms of reliability and quality. This was the approach used to obtain correct information from the construction sector stakeholders, including the literature review [45].

3.2 Questionnaire design

The questions were collated modified, and designed in a questionnaire. The refined questionnaire was sent to stakeholders in the Polish construction industry using a careful sampling technique. The questionnaire was divided into three (3) sections; section A contains general information, and the respondents were asked to provide some information about their background (profession, years of professional practice, level of academic qualifications, and professional membership). Section B outlined site waste management strategies used in the construction sector. The respondents are required to rate their level of disagreement or agreement with the listed strategies. In section C, the stakeholders' goals were asked concerning cost, quality, time, health and safety, environmental impact, and waste management impacts.

Figure 3: Flowchart of the research methodology.

3.3 Data analysis

The collected data from the construction professionals were analyzed using the descriptive statistics methods in IBM SPSS version 26. The relative importance index (RII) was calculated using equation 1 on the five-point scale consisting of,

1 – Strongly disagree

2 – Disagree

3 – Neither disagree nor agree

4 - Agree

5 – Strongly agree

$$RII = \frac{5b_5+4b_4+3b_3+2b_2+1b_1}{A \times N} \qquad (1)$$

Where:

1, 2, 3, 4, 5, – Rating scale,

b_5 – The number of respondents for strongly agree.

b_4 – The number of respondents for agree.

b_3 – The number of respondents for neither agree nor disagree.

b_2 – The number of respondents for disagree.

b_1 – The number of respondents for strongly disagree.

A– Highest weight

N– Total number of respondents

The relative importance index of each response is shown to give a clearer overview of the level of agreement reached by the study respondents and to show the main results from the research.

3.3.1 Reliability Test

According to [46], reliability testing is the first important step to be carried out in statistical analysis. As stated in Equation 2, Cronbach's alpha was used to evaluate the internal consistency of the questionnaire's measurement [47].

$$\propto = \frac{K}{K-1}\left(1 - \frac{\sum \delta i^2}{\delta x}\right) \qquad (2)$$

Where:

α - Cronbach alpha

K- Number of items

δ_i^2- Variance of the scores for each item

$\sum \delta i^2$- Variance of the total variance of the observed test.

δx - Scores for each element

The Cronbach's alpha coefficient was used to determine the internal consistency of the questionnaires' assessments and the suitability of the data for analysis, particularly when utilizing a Likert scale on a questionnaire [48,49]. Cronbach's alpha statistics, ranging from 0 to 1, were determined by analyzing the internal consistency of the respondents' responses [44]. Table 1 shows that the Cronbach's alpha for this research is 0.894. This reveals the high dependability and internal consistency of the study's outputs. However, any item with a Cronbach's alpha more than the confirmed value of 0.894 should be eliminated from the list of variables as it is a poor construction. This proves that 89.40% of the answers given by the respondents on the waste management strategies are reliable.

3.3.2 Test for normality

According to [49], a p-value less than 0.05 in the normality analysis showed a significant difference between the groups of participants for the specified procedures with a 95% level of confidence. When the p-value is more than 0.05, there is no significant difference between the groups, according to [50]. The normality test for the collected data from study participants is shown in table 1. The significant value of all items for the Kolmogorov–Smirnov test is 0.000, which is less than the needed normality requirement of 0.05 ($p < 0.05$), indicating that the participants' responses to the itemized C&DW management techniques in the construction industry are not normally distributed.

Table 1: Descriptive statistics and normality test for the collected data

						Kolmogorov-Smirnov[a]		
Codes	Strategies	Mean	Std. Deviation	Variance	Cronbach alpha	Statistic	df	Sig.
WMS1	Waste disposal ordinance	3.62	0.878	0.771	0.798	0.227	50	0.000
WMS2	Waste reduction framework plan, Green managers' scheme	3.84	0.650	0.423	0.874	0.297	50	0.000
WMS3	Concrete recycling plan	3.86	0.700	0.490	0.839	0.299	50	0.000
WMS4	Promotion of public landfill charging scheme	3.92	0.778	0.606	0.805	0.241	50	0.000
WMS5	Legislature on recycling	3.96	0.781	0.611	0.856	0.240	50	0.000
WMS6	Certifications and economic rewards as useful tools for the construction demolition & waste management	4.00	0.990	0.980	0.832	0.260	50	0.000
WMS7	The application of the 3R (Reuse, Recycle and Recovery)	3.92	0.986	0.973	0.879	0.252	50	0.000
WMS8	Design for flexibility and deconstruction	3.84	0.866	0.749	0.842	0.233	50	0.000
WMS9	Planning-design-procurement	4.00	0.782	0.612	0.887	0.240	50	0.000
WMS10	Voluntary agreement	3.70	0.931	0.867	0.829	0.234	50	0.000
WMS11	Awareness campaigns	4.02	0.937	0.877	0.874	0.232	50	0.000
WMS12	Waste designing out	3.94	0.978	0.956	0.811	0.221	50	0.000
WMS13	Site Remediation	3.72	0.784	0.614	0.879	0.240	50	0.000
WMS14	Recycling facilities	3.92	0.829	0.687	0.874	0.238	50	0.000
WMS15	Take back policy	3.96	0.832	0.692	0.860	0.239	50	0.000
WMS16	Aggregate levy	3.66	0.772	0.596	0.798	0.284	50	0.000
WMS17	Site waste management plan	4.08	0.804	0.647	0.847	0.220	50	0.000
WMS18	Green procurement	3.90	0.763	0.582	0.860	0.252	50	0.000

WMS19	Financial values to participants	3.84	1.017	1.035	0.856	0.262	50	0.000
WMS20	Legislation on implementation of waste sorting	4.06	0.767	0.588	0.858	0.211	50	0.000
WMS21	Government encouragement for the green building	3.86	0.833	0.694	0.878	0.227	50	0.000
WMS22	Development of a waste stream market	4.06	0.913	0.833	0.844	0.228	50	0.000
WMS23	Education and research in construction waste minimization and management	4.02	0.685	0.469	0.869	0.272	50	0.000
	a**; Overall Cronbach's alpha coefficient is 0.894							

4 Results and discussion

4.1 Description of respondents

Evaluating and analyzing the characteristics of the respondents who gave information for the study according to their profession, Construction managers and Project managers have a high proportion of 26% and 28% of all respondents respectively. Additionally, Structural engineers placed third with 20% of the overall respondents. The Architects, Mechanical/electrical engineers, Construction cost estimators and Waste managers represented 26% of all respondents as shown in figure 4. The average years of experience of the respondents is within 10 years in construction projects as shown in figure 5.

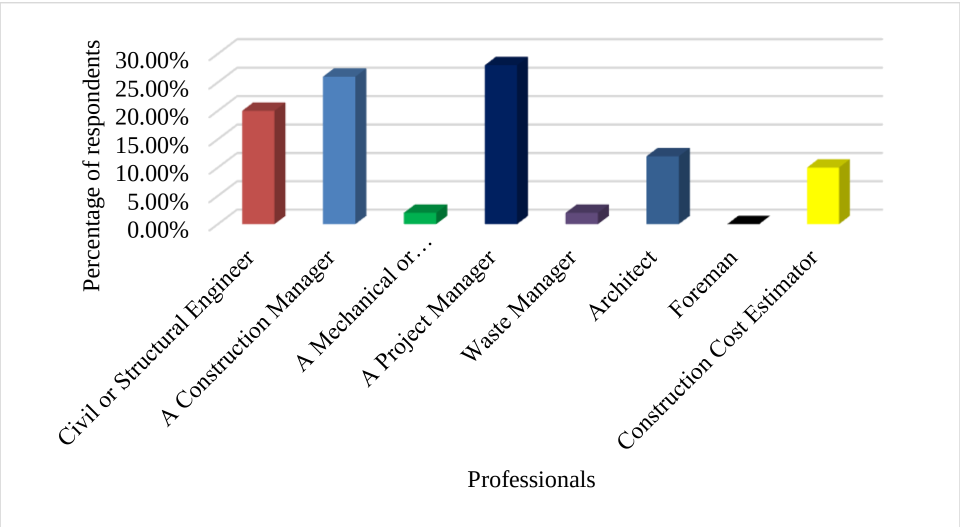

Figure 4: Professions of the respondents.

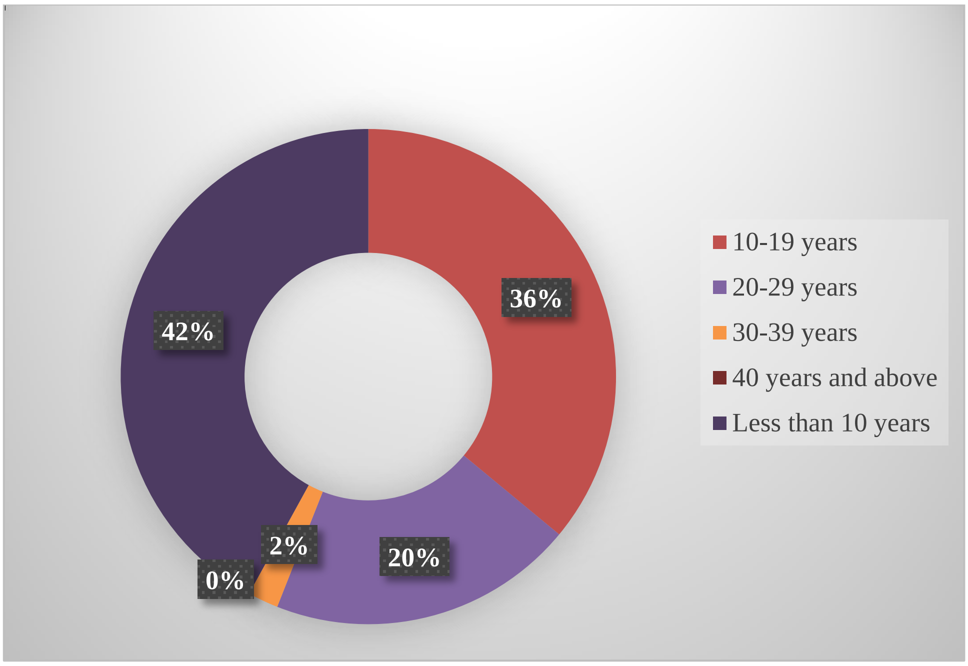

Figure 5: Years of experience of the respondents.

4.2 The most economical site waste management strategies

The evaluation of the identified site waste management strategies in the building projects were carried out as shown in table 1. It was discovered that the site waste management plan (SWMP), legislation on implementation of waste sorting, and development of a waste stream market are the most important among the waste management strategies examined. Hence, the need for the incorporation of the SWMP into the building tendering and contract documents. The government should promulgate legislation regarding the implementation of the on-site waste sorting as this will help in further managing the waste and thereby ease of taking this generated waste to the market. Provision of the waste stream market is of great importance as the waste sorted can be marketed for various recycling, and reuse. Awareness campaigns, education and research in construction waste minimization and management are also rated high, showing the great need for the construction professionals and workers to be aware of the various waste management strategies. The construction sector need to participate in research and development (R&D) of tools that will foster increased usage of the waste materials and develop several other methodologies that will aid the waste management. Certifications and economic rewards as useful tools for the C&DW management, Planning-design-procurement should also be considered.

Government's encouragement for the green building, green procurement and waste reduction framework plan, and green managers' scheme will also help in the economical management of the C&DW. The voluntary agreement, aggregate levy, and waste disposal ordinance were rated lowest with mean value of 3.70, 3.66 and 3.62 respectively. Hence, the need for a more rigorous approach to be adopted in the management of the strategies as shown in figure 6.

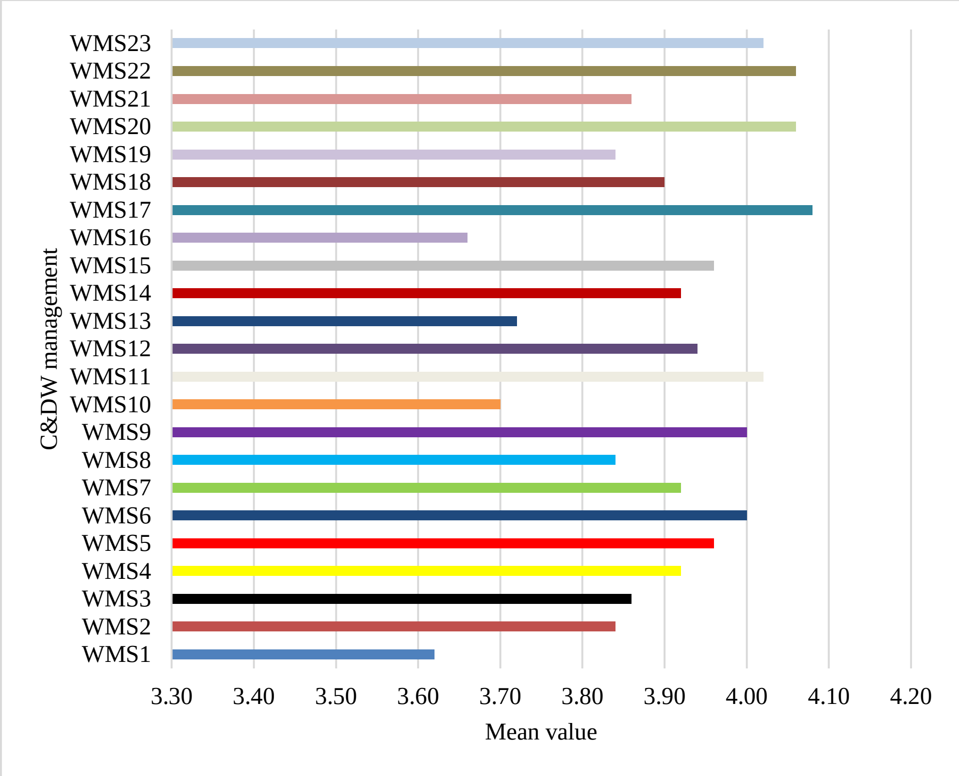

Figure 6: C&DW management strategies with mean values.

4.3 Stakeholders waste management target on the investment cost calculation, realization time and the natural environment.

The on-site waste management implementation programs gains are not shown. These are been given little attention by the contractors when compared to other targets and schedule of works [51]. The top management of the construction companies and the investors have been identified as the major stakeholders in the building projects. The major goal of these stakeholders were evaluated with respect to the investment cost, realization time, quality of workdone and the environment. It was observed that the stakeholders placed high priority on the investment cost of the project by proposing ways to lower the cost rather than increasing the cost by adding the cost from the implementing waste management strategies as shown in figure 7. The quality of work, health and safety were rated higher than the preservation of the environment according to the respondents from this research. The RII of the objectives of the waste management stakeholders is 0.4520. Figure 7 illustrates the minimum value.

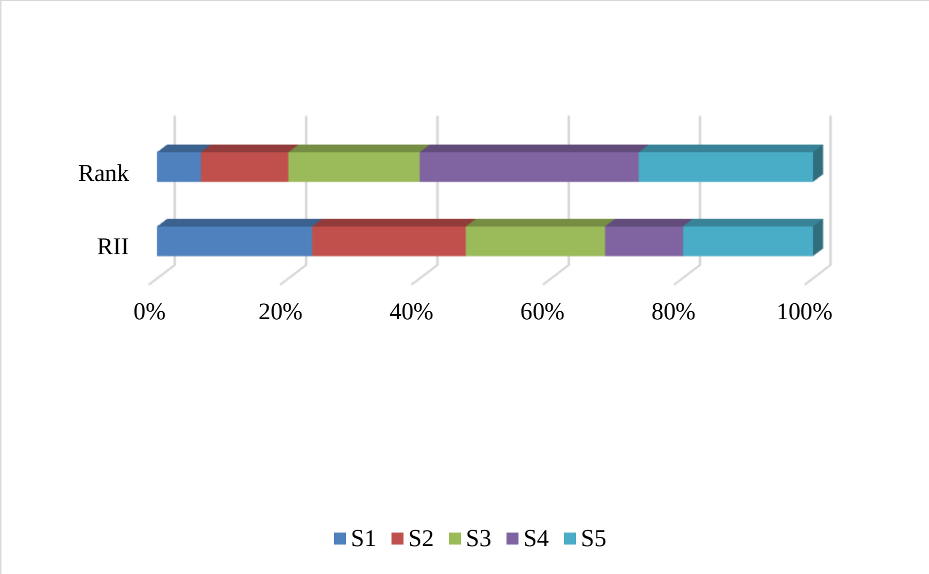

Figure 7: The stakeholders' goal on projects with respect to investment cost, quality, environment and C&DW management.

4.4 PESTEL Analysis

The huge investment outlay in the construction sector has called for the effective identification and analysis of the external factors that affect C&DW management methods. The use of PESTEL analysis together with the SWOT analysis helps to identify the risks associated with the C&DW. The volume of C&DW generated differs. Thus, it is necessary to identify the risks that affect the construction waste management. Risks are basically categorized into two (2) types-

- Internal risk
- External risk

The internal risks are specific to companies or project's past database which is readily available in the company and thus can be identified easily using techniques like Risk Breakdown Structure (RBS), Program Evaluation Review Technique (PERT), risk register etc. External risks are dangers about which little is known, which are not easily available in the database, and for which there is no planned technique to identify them. These hazards are beyond the organization's control. Consequently, they are challenging to recognize.

PESTEL analysis is a unique approach for strategic planning that evaluates the potential consequences of political, economic, social, technical, environmental, and legal elements on a project. The PESTEL framework is an excellent analytical technique for analyzing the externalities on a project. The tool, together with SWOT analysis should consistently be used in an organisation to enable the identification of the external risks pattern [52]. Figure 8 gives a general overview of the PESTEL analysis for the C&DW management strategies.

PESTEL stands for –

P- POLITICAL

E- ECONOMIC

S- SOCIAL

T-TECHNOLOGICAL

E-ENVIRONMENTAL

L- LEGAL

4.4.1 Political

These elements determine a government's ability to affect the economy or the building sector. Implementation of new landfill fees, or a government may levy a new tax due to the organizations' complete revenue-generating mechanisms. Political variables, such as tax laws, fiscal policy, trade tariffs, etc., that a government may impose during the fiscal year can significantly alter the economic climate. The Nepal waste management Act 2068 levies a service fee on solid waste management, offers technical assistance to local bodies, and provides locals with clear guidelines for the operation and management of wastes [53]. The National Waste Management Plan (NWMP) 2022 has fees imposed if the organisation does not meet the recovery target for the volume of its products packaging for recycling.

4.4.2 Economic

These are factors, which determine the economic performance of the organization and the sector as a whole. Such factors directly affects a company and have reverberating effects. A rise in the inflation rate in any country would affect how businesses price their goods and services. The purchasing power of the consumer would change, and the change in demand/supply models for that economy will be eminent. The implementation of a waste management plan will necessitate expenditures from sorting through disposal. Hence, Public, private partnership will be required in its implementation. The C&DW generated in the construction site will require more funds and time for sorting. It will necessitate increased operational and human resource costs. The sorting, storage facility, and disposal will need funding. To implement a waste management strategy, a budget will be required. Therefore, at the initiation phase, a waste management strategy needs more cash. However, once the system is created, it begins to generate cash and provides locals with work. Various economic elements, such as the inflation rate, interest rates, foreign currency rates, economic growth patterns, and foreign direct investment, must be examined.

4.4.3 Social

These elements take into account all social and economic developments affecting the market and the society. Therefore, the pros and demerits to the residents of the neighborhood in which the project is taking place also need to be considered. Some of these factors are cultural expectations, norms, population dynamics, healthy behaviour, career altitudes, global warming, etc. These elements investigate the market's social environment and assess determinants such as cultural trends, demographics, and population analytics, among others. The construction site should be made to sort its generated waste, as this will help to determine the volume of waste to be re-use, recycled and disposed.

4.4.4 Technological

These elements include technological advancements that may have positive or negative effects on the building sector and the market. Automation, R&D, and the extent of a market's technical practical understanding. These criteria take into account all technologically relevant occurrences. In addition, it might take into account all market entrance restrictions and changes in financial decisions. The marketability of the construction and demolition (C&D) recycled product is considered as one of the major challenges of waste management. Lack of data recording waste volume, skilled manpower, limited transportation for staff and waste. The building site will require containers of various hues for segregating its rubbish

4.4.5 Environmental

The environmental factors that influence the management of C&DW include foul odor, contaminated air, climate, weather, geographical position, global climate change, environmental offsets, ground conditions, ground contamination, and adjacent water sources, among others. These variables are those that are influenced or determined by the surroundings.

4.4.6 Legal

This component takes into account several aspects of legal acts, including employment, quotas, taxation, resources, imports and exports, etc. Certain laws govern the business climate in a country, while corporations and economic sectors keep their own regulations and policies. Legal evaluation consider both angles and then provide the strategies in the direction of these regulations. Consumer laws, safety regulations, and labor laws are examples. The introduction of various waste acts, directives and regulations by EU and various member states are to help in the attainment of the WFD target of 70% recycled waste.

Figure 8: PESTEL analysis for the C&DW management strategies

4.5 SWOT analysis

The SWOT analysis is a strategic planning process tools that aid organization subdue difficulty and decide the new focus area to adopt. The goal of the analysis is to guide organization to create a full awareness of all factors required in the decision-making. The SWOT analysis provides information regarding the construction waste management sector. The industry would be able to use the information provided and compare the advantages and disadvantages.

Finally, it would direct the decision-making process based on the information and implementation of the plan, according to [54], PESTEL analysis is used to highlight the various external factors that could influence the successful implementation of the C&DW management strategies, after the creation of the SWOT analysis. Figure 9 highlight the SWOT analysis for the C&DW management strategies.

4.5.1 Strength

The construction industry produces a large quantity of waste resources, which are collected and disposed. However, it has enough sources to operate the organization. Employment opportunities can emerge in the sorting of the waste generated, manufacturing process of the recycled products will lead to improvement in the construction materials, lower cost of materials. Government involvement in the current waste management strategies means that political and government support will be instrumental and beneficial.

4.5.2 Weakness

The successful implementation of the C&DW management strategies are affected by some constraints. The waste generated by the construction sector is combined with various waste types. The time required for the sorting out of the waste is longer than required, government regulations, policies and directives affect the generation, recycling, reuse, recovery and disposal of the C&DW. The culture of waste management system, awareness and education, transportation and storage facilities affect these strategies.

4.5.3 Opportunity

Creation of employment for the locals, public private partnership will boost the economy, various business opportunities will emerge from the waste management strategies. This will aid the growth of the economy and increase the GDP. The environmental impact include low carbon emission, reduction of pollution and contamination that occurs from the C&DW. The community's health and safety are also affected.

4.5.4 Threats

The acceptance of the new waste management culture will be difficult for the community and the industry at the initial phase. Several awareness and education will be required for the acculturation of the waste management culture. The fund required for the implementation of the waste management strategies is a major factor to the organization as they feel that this will increase the cost of construction. Political instability, lack of support from the government and top management of the organization will result in unsuccessful implementation. Lack of landfill, non-imposing of fees for disposals at landfill, technological input, R&D, and undeveloped market for the recycled building products, health risk resulting from the usage of the recycled products are other threats that could result from the waste management strategies.

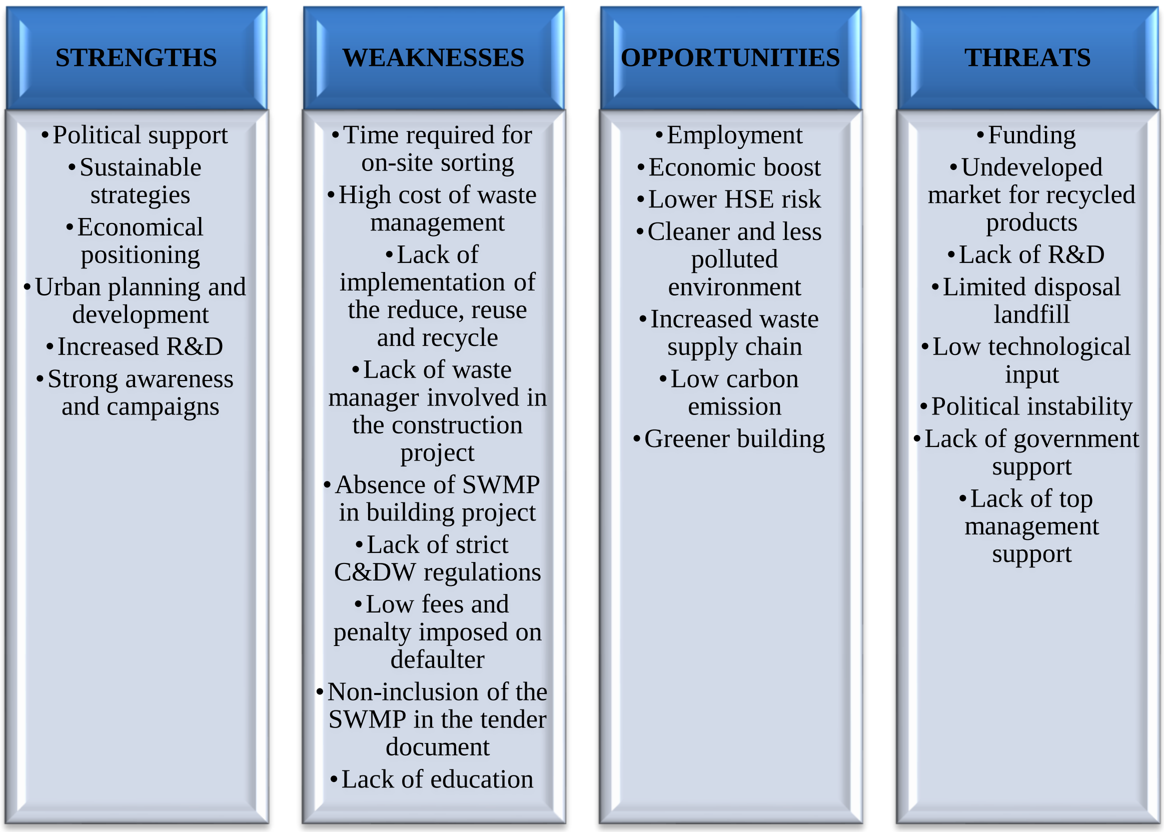

Figure 1: SWOT analysis for the construction waste management strategies.

5 Conclusion

The motivation for this research was to evaluate the main goal of construction stakeholders with respect to project cost, completion time, quality of work done over C&DW management in the construction projects. The review of literature were carried out to identify, assess and analyzed the various C&DW management strategies using descriptive statistics. From the outcome of the extensive analysis, it can be concluded that the stakeholders' goals with respect to investment cost, realization time, quality and the environment indicates; that they are interested in reducing the cost of the projects, improvement of quality of work done, reduction in the duration of construction project while waste management does not rank as top priority to the organizations. Certification of the SWMP by the government officials should be done before the commencement of the building project. Stakeholders should endeavor to include the management of waste into the company's goal as this could help in the recovery, reuse and recycling of waste materials.

The PESTEL analysis; a strategic management analysis tool was used to show the various external risks that are inherent in the construction waste management strategies. This analytic tool shows the political, environmental, social, technological, economic and legal risk that can be observed in the management of waste in the construction industry. This analytical tool is used in conjunction with the SWOT analysis to show the diverse strengths, weaknesses, opportunities, and threats arising from the identified risk in the PESTEL analysis. These tools will enable the organizations to plan their methodologies in the management of waste during the construction activities while outlining their strategies based on the identified risk factors. Further research should be carried out to assess and compare the economic and environmental benefits of the various C&DW management methods and an evaluation of the impacts of these methods on the overall construction cost, completion time and quality of work should be analyzed in relation to the C&DW methods adopted.

6. Conflict of interest

The authors declare no conflict of interest.

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