

**THE CHALLENGES OF INTRODUCING A NEW GREEN BUILDING
MATERIAL IN ENVIRONMENTALLY EMERGING COUNTRIES; A
STAKEHOLDERS' PERCEPTIONS STUDY IN CYPRUS**

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ABSTRACT

While comprehensive legislative frameworks may exist, the sustainable management of construction and demolition waste has proven challenging, especially for countries where environmental maturity may be still lacking. Recognizing the great potential for recycling and reusing CDW materials, Cypriot researchers are developing a new green building facade material using recycled materials. However, the market success of such a material is highly dependent on sound management and on stakeholders' acceptance, hence the undertaking of a survey aiming to explore the attitudes and perceptions of Cypriot construction stakeholders. A total of 187 individuals participated in a survey, which used a 20-question questionnaire, that collected data through live interviews. Analysis of data indicated a strong support for CDW management, but also the belief that the existing legislative framework is somewhat lacking and not adequately implemented. In parallel, a confusion on existing management efforts was identified, suggesting the need for better education of stakeholders. The reduction of operational costs was identified as the strongest incentive for companies to adopt actions towards proper CDW management, while the improvement of their public image was not considered as adequate motivation. Despite the fact that respondents strongly support CDW recycling and the idea of green materials, they are not very trusting towards using building materials that are newly-introduced in the market.

Keywords: CDW Management, Perceptions, Recycled Material, Survey, Construction

INTRODUCTION

According to latest data (for the year 2020) from Eurostat [1], the mineral waste produced from the construction sector in the European Union (EU) was around 300 million tonnes (excluding excavated materials) of construction and demolition waste (CDW), which is around 15% of the quantity of the total solid waste generated in the Union. CDW comprises of primarily concrete, ceramics and masonry (amounting to approximately 85% of the total), although CDW can be more heterogeneous, depending on its origin, and may contain large amounts of wood and plasterboard [2].

The EU has identified CDW as a priority waste stream not only due to the large quantities being generated but also due to its high potential for reuse and recycling (i.e. the embodied energy of these materials). Proper management of this waste stream can largely contribute to a more effective use of natural resources and hence the mitigation

of environmental impacts; a rationale that has been reflected in the European Waste Framework Directive ((2008/98/EC) [3].

In the case of Cyprus, and although the quantities of CDW produced in 2020 were 420000 tonnes (a small quantity when compared to the EU totals; primarily due to the small size of the country), the waste stream has witnessed an increase of more than 250% between the years of 2010 and 2020 [1]. At the same time, CDW management practices are assumed to vary greatly from a Member State to another, within the EU [2]. For instance, while the CDW recycling rates for the EU averaged to around 80% in 2020, for Cyprus they did not exceed 50% and more than 10% still ended up in landfills [1]. In parallel to the challenges created in Cyprus due to the increasingly hard to come by space for new landfills, the country faces dwindling natural aggregate resources and a pressure to quarry in environmental sensitive areas.

In Cyprus, and despite the fact that a comprehensive legislative framework has been in place since 2011 (Cyprus Waste Law of 2011 - N. 185(I)/2011), CDW management appears to be underperforming [4]. This deficiency can be attributed to a number of reasons, some of which may be of a more technical nature, while others may be more related to the perceptions and attitudes of some of the main stakeholders of the construction industry. Specific examples of technical limitations, may include 1) the fact that the cost of recovery activities is currently higher than the selling prices of recycled end-products, 2) the absence of significant recycling technologies that can be applied to construction waste other than plastic, metal and paper, 3) the complexity presented by the heterogeneous nature of CDW that often dictates manual waste sorting practices, while often leaving such materials as concrete and ceramics full of impurities. On the other hand, some limitations mentioned in a pertinent report [4] include such factors as 1) lack of political will, 2) the general mentality of the construction sector, and 3) lack of incentives for recycling.

Within this challenging environment, a team of scientists embarked on a research effort that envisions to develop a pilot scale of an innovative separation method for CDW, develop a composite material also generated from CDW that will be characterized by low thermal conductivity, satisfactory mechanical properties, and fire resistance properties. The produced material will be able to be applied as a façade, either on existing or new construction projects [5].

However, besides from the technical challenges that any such team of researchers may be facing, there seem to be several drivers and barriers that affect the degree to which CDW recycling and reuse rates may be achieved or not, as well as the degree to which any new construction material can be accepted by a market in more environmentally immature countries. Some studies indicated that the lack of engagement and education and training of key construction stakeholders (i.e. architects and clients) is a main problem for the implementation of designing out waste techniques [6]. Some researchers support that education is the key to the successful implementation of a management program; however, others support that the factors governing the public's attitude are more complex than what an education campaign could address [7]. It remains that the extent to which a community embraces sound CDW management measures, or the use of a newly developed green construction material, is its own

decision. If a sustainable CDW management scheme is to be successfully implemented, it is necessary that a careful assessment of the stakeholder community's perceptions and attitudes is conducted. Our work seeks to record and analyse such perceptions and attitudes among stakeholder groups in Cyprus, and suggest mechanisms that can promote a sustainable CDW management program on the island. This is achieved, in part, through a survey that examines the awareness, ideas, and concerns of different construction sector stakeholder groups in the country.

METHODOLOGY

The methodology involved a series of actions, such as a thorough literature review, the drafting of a survey tool (questionnaire), an experts' workshop, and interviews, many of which are commonly used when developing a perceptions study [9]. However, the main method employed in obtaining information was a specially-designed questionnaire, which was used by field workers in personal interviews of participants. The survey was conducted among main stakeholder groups in the CDW management field.

Specifically, a questionnaire was prepared, through which the perceptions and attitudes of important stakeholders of a CDW reuse program were solicited. It comprised of 20 questions plus the demographic items. The questions covered such elements as levels of awareness on the topic, perceptions and attitudes concerning the use of new construction material produced from recycled CDW. The questions were structured so that the resulting analysis could follow standard statistical approaches. To allow for the necessary variability in responses, only two questions were formulated to reflect an agreement versus disagreement dichotomy, while nine questions were formulated to measure the level of agreement with specific statements by using a five-point Likert-scale, where number 1 represents least agreement and number 5 represents most agreement [8], and another nine questions called for respondents to rank options provided.

Two variants of the questionnaire were prepared. While the first variant targeted all participant groups, the second variant concerned respondents who are actively involved in the design, construction, or the maintenance of buildings.

A pilot test was carried out, taking the form of an experts' workshop, which assessed the suitability and clarity of the questionnaire. Individuals from 15 different stakeholder organizations were invited, and 20 individuals from 12 of those organizations participated in the workshop. Prior to the workshop, a copy of the draft questionnaire was emailed to invited organizations. The participants were asked to review its content, design and structure. During the workshop, individual survey items were discussed and comments provided were incorporated in a second draft of the questionnaire, which was sent for final agreement, before distribution to the targeted population.

The final questionnaire was used to survey CDW management stakeholders from all areas of Cyprus, according to census population data. The population of stakeholders (obtained from such sources as the Chamber of Engineers in Cyprus and the Federation of the Building Contractors Associations of Cyprus) is estimated at around 2675 civil engineers, 2135 architects, 2300 building contractors, and materials suppliers. The size of the sample for each population group under study was determined using precision

analysis (i.e. restricting the margin of error in parameter estimates to 10% or less across all groups) and confirmed in terms of its statistical power to detect differences in the responses between the three groups under study using power analysis. Different sampling methods were adopted in order to sample study participants from each of the groups under investigation. Specifically, purposive and snowballing was used in the case of architects and civil engineers, and convenience and snowballing was used in the case of building contractors and materials suppliers. The questionnaire was distributed to a total of 500 individuals, in proportion to the stakeholders' group populations. Several means of data collection were utilized, primarily 1) face-to-face interviews, and 2) electronic responses to the structured questionnaire that were shared via electronic mail. 187 individuals responded to the survey, representing a response rate of 37.4%. The sample size allows for a statistical confidence level of 99% with a confidence interval of 9 for the results.

RESULTS AND DISCUSSION

The select results presented are limited to the items that show statistical significance, according to the methodology described above. Also, we are presenting results that better guide us in suggesting appropriate action / policy measures for a successful waste management scheme to be implemented in Cyprus.

The identity of our survey sample is provided in Table 1. The percentages shown are in relation to the total number of respondents. The category named "other" includes such participants as representatives of non-governmental organizations that do not identify themselves as any other category of professionals.

Table 1. Socio-demographic identity of the respondents
(percentages shown are in relation to the total number of respondents)

	Architect	Civil Engineer	Building Contractor	Materials Supplier	Academic	Other
Gender						
Men	12%	27%	23%	3%	6%	1%
Women	17%	7%		2%	1%	2%
Age group						
18-30	7%	5%	1%	2%	1%	
31-40	10%	18%	5%	2%	2%	2%
41-50	7%	5%	5%	1%	3%	1%
51-60	4%	3%	8%	1%		
>60	1%	2%	4%	1%		
Education level						
High School			16%	3%		1%
BSc Degree	16%	18%	7%	3%		1%
MSc Degree	11%	13%		1%	3%	2%
PhD Degree	1%	3%			3%	

85% of the respondents belong to the categories of civil engineers, architects and building contractors. The distribution of the professional profile of the sample follows suit with the population statistics that we obtained from such sources as the Scientific Technical Chamber of Cyprus and from the Federation of the Building Contractors Associations of Cyprus. Considering the large gender gap in the representation of women in the general field of construction, the opinions of women were adequately represented in this survey (29% of the sample). Most of the women participants identified themselves as architects, which category was the only one dominated by women versus men. No women identified themselves as building contractors. 55% of our sample were professionals 40 years old or younger, while only 25% were over 50 years of age. These distributions may be explained by the fact that younger people are more willing to participate in this type of surveys, especially when electronic response is required. At the same time, this skewness in age distribution may have introduced error in our results and therefore it needs to be considered when suggesting policy measures for better CDW management. Only 20% of our respondents hold only a high school diploma and they belong, exclusively, to the categories of building contractors and construction materials suppliers. 37% of the respondents hold a graduate or doctoral degree. Governmental officials were somewhat underrepresented in the sample, with only 5% of the respondents identifying themselves as public servants.

Results obtained show that all respondents (with the exception of one) support the necessity of CDW management in Cyprus. 91% of respondents are aware of the existence of legislation pertaining to CDW management in Cyprus. Although a high percentage, the remaining 9% is deemed as important, especially since the survey was conducted among direct stakeholders and not among laypeople. At the same time, a significant percentage (40%) of respondents stated that the pertinent legislation in Cyprus is not adequate, as it currently stands. Only 16% of respondents find the existing legislation very adequate. An even higher percentage of respondents (57%) believe that the existing CDW legislation is not adequately implemented in Cyprus. Only 8% of respondents feel that the legislation is implemented to a high degree. The reason most commonly quoted reason that leads to an inadequate implementation of legislation was “Inadequacy of the implementability of the pertinent legislation” (half of the participants who responded to this question selected this reason), followed by “Absence of an appropriate mechanism for monitoring the implementation of legislation” (almost 40% of participants who responded to this question stated this reason). A close third reason quoted (34% of participants who responded to this question stated this reason) is that “The existing legislation is not financially sound”. A surprisingly high percentage of respondents (23%) stated that there was “lack of awareness among stakeholders”.

In one of the survey questions, a total of nine authorities (i.e. Governmental Ministries and Departments, pertinent bodies and professional organizations) were listed, and participants were asked to say as to which ones they thought are involved in the decision-making regarding the management of CDW in Cyprus. Despite the fact that all of the listed authorities have an active involvement in decision making (to varying degrees of course) regarding CDW management in Cyprus, most respondents (67%) identified the Ministry of Agriculture, Rural Development and Environment as the

entity that is relevant, followed by a distant second (39%) the Federation of Environmental Organizations of Cyprus. At the same time, only 30% listed the Ministry of Interior, even though it plays a very important role in CDW management decision-making. Similar trends were identified when participants were asked as to which of the same authorities play a role in the actual management of CDW in Cyprus. No distinction was identified by respondents between decision-making and actual management implementation for pertinent authorities.

Respondents were asked to identify which (from a list) the CDW management approaches/measures/models that they think to exist in Cyprus. Half of the respondents identified “financial measures” as being present in Cyprus, followed by another 37% who identified “CDW management plans of construction companies”, and 34% who identified “CDW recycling” as being among the implemented measures in Cyprus. On the other hand, only 9% feel that “reduction in CDW quantities” and only 4% feel that “production of pre-fabricated buildings” are practices that are in existence in Cyprus.

In a subsequent question, respondents were asked to identify the efficiency (i.e. the degree of ease of implementation) of CDW management measures (from a list provided). Despite the fact that no single management measure stood out, it seems that more respondents (47%) seem to think that the production of pre-fabricated buildings would not be an efficient management strategy/measure. On the opposite side of the spectrum, 48% of respondents think that “positive economic measures” may be a more efficient management approach for Cyprus, which is the measure that seems to produce the most “polarization” among respondents as well (i.e. lower percentage of mid-range responses – response options included the 5-point Likert scale of “not at all” to “extremely”). Similar to the responses received for the question related to the efficiency of measures, responses to the question concerning the effectiveness (i.e. the degree to which they may produce results) of management measures for Cyprus, respondents did not exhibit extreme views of any of the listed management measures. However, the “production of pre-fabricated buildings” was not viewed as a very “promising” approach. On the other hand, “economic measures” seem to be the approach that 50% of the participants thought as being the most effective, closely followed by 47% who thought of “CDW recycling program” and another 47% who thought of “disposal of CDW in sanitary landfills” as being the more effective CDW management approaches for Cyprus.

From a list of options, respondents were asked to define the extent to which they each option could be an incentive for a construction company to adopt actions for the proper management of CDW in Cyprus. 69% of respondents feel that “the reduction of operational costs of companies” would be the strongest incentive for companies to adopt actions towards proper CDW management in Cyprus. On the other hand, respondents do not strongly feel that companies in Cyprus will be motivated by “the improvement of their public image (when it comes to using proper CDW management measures for that improvement)”. Similar responses were received with regards to “the improvement of a company’s environmental responsibility and sustainability”.

61% of respondents strongly feel that measures should be taken against construction companies that do not prepare and implement CDW management plans, while another

23% of respondents also agree that measures should be taken. Only the remaining 16% feel otherwise. In addition, the overwhelming majority of respondents (66%) think that the use of recycle materials in construction in Cyprus should become mandatory. The same emphasis that respondents place on the value of recycling approaches seems to be a recurring theme in several of the questions included in the survey, possibly due to the possibility that recycling schemes may be more familiar to respondents as part of their professional reality.

83% of the respondents identified themselves as practicing engineers, architects, contractors, or materials suppliers. The remaining respondents are either public servants or academics. From those practicing professionals, a significant percentage (35%) tends to use buildings materials that are not the norm in Cyprus (“Masonry with plaster and coatings” as the most commonly used façade material in Cyprus, followed by a distant “Plasterboard or cement board masonry with spatula and coatings” and a tie in third place between “Panel cladding” and “Exposed concrete”). “Thermal Insulation” (24% of responses) and “Aesthetics” (20% of responses) are the dominating qualities that govern the choice of building façade materials by our participants. “Durability” and “Low Cost” are listed as third and fourth choices (with percentage responses of 13% and 9%, respectively). The fact that the cost was a distance fourth was not expected by the research team. Also, the fact that “thermal insulation” was listed higher than “waterproofing” as the quality of a façade material may also come under scrutiny. However, the percentage differences among those responses are statistically insignificant.

Finally, responding to a pertinent question, it appears that the large majority of respondents are more reserved towards adopting the use of new construction materials in their practice. Only a modest 17% of respondents are prepared to readily accept to new material in the market. Despite the fact that “the product’s technical characteristics” are the most important criterion for the choice of a new construction material (29% of respondents), the “brand name” of a company also plays an important role in practitioners using a new material (25% of respondents), indicating that the company’s name inspires trust in a product. The “environmental certification” of a product is listed as a third reason (17%) for the choice of a new material.

CONCLUSIONS

In this paper we tried to identify the perceptions and attitudes of construction industry stakeholders on the topic of construction and demolition waste management in Cyprus. This effort was instigated by the need to effectively develop and introduce new green construction materials in the market, something that would much depend on a sound national CDW management scheme being in place. Towards this end, a survey was conducted among construction industry stakeholders in Cyprus, which, although an EU member state, still lacks with respect to its environmental maturity.

Our findings indicate that an important portion of the country’s stakeholders may need an update of their knowledge on issues of CDW management, including legal and procedural items, as well as newer and more sustainable technical approaches that are being used in other countries. Therefore, the development of a professional continuing-education program should be examined.

At the same time, our findings indicate that there seems to be a lack of trust towards governmental mechanisms and procedures, especially with regards to the implementation of existing legislation. An approach that could be examined by governmental authorities would be to find ways to better project their work and also to improve their public image. Also, governmental authorities should revisit the national legislation so that it not only remains in tune with EU legislation but that it also becomes more pragmatic for the country's realities.

Further, construction professionals in Cyprus, although supportive of the idea of new and green construction materials, they tend to be cautious towards actually partaking into such new approaches in their own practices. This relative conservatism of construction professionals may be reflecting the views of an environmentally immature society (and hence their concern of not being professionally competitive in such), instead of being pioneering leaders that will drive society towards a more sustainable future.

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REFERENCES

- [1] Eurostat (2022). Generation of waste by waste category, hazardousness and NACE Rev. 2 activity, Retrieved October 24, 2022 from https://ec.europa.eu/eurostat/databrowser/view/env_wasgen/default/table?lang=en
- [2] Monier, V., Mudgal, S., Hestin, M., Trarieux, M., Mimid, S. (2011). *Management of Construction and Demolition Waste* [WWW Document]. URL. (Retrieved October 24, 2022). http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf.
- [3] Joint Research Centre-European Commission. (2012). *Best Environmental Management Practice in the Building and Construction Sector, Final Draft*.
- [4] Deloitte SA. (2015). *Construction and Demolition Waste management in Cyprus*, Retrieved October 24, 2022, from https://ec.europa.eu/environment/waste/studies/deliverables/CDW_Cyprus_Factsheet_Final.pdf
- [5] Luhar, S., Nicolaides, D. and Luhar, I., (2021). *Fire resistance behaviour of geopolymer concrete: An overview*. Buildings, 11, 82.
- [6] Osmani, M., Glass, J., Price, A.D.F., (2008). *Architects' perspectives on construction waste reduction by design*. Waste Management 28, 1147-1158
- [7] Sjoberg, L. (2001). *Limits of knowledge and the limited importance of trust*. Risk Analysis, 21(1),189-198.
- [8] Likert, R. (1932). *A technique for the measurement of attitudes*. Archives of Psychology, 22 140, 55.
- [9] Saris, W. E., & Gallhofer, I. N. (2014). *Design, Evaluation, and Analysis of Questionnaires for Survey Research* (2nd ed.). John Wiley & Sons, Inc.