Al-Azhar University Civil Engineering Research Magazine (CERM)
Vol. (42) No. (3) October . 2020

Towards a National Strategy for C&D Waste Management in Egypt

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نحو استراتيجية وطنية لإدارة مخلفات البناء والهدم في مصر

ملخص البحث

تسعى الحكومة المصرية الى تنفيذ أجندة طموحة للتنمية الاقتصادية والاجتماعية من خلال المشاريع القومية والكبرى لتحديث البنية التحتية والنقل والإسكان والاتصالات والمرافق الصناعية والتجارية. وقد أدت أنشطة البناء المتسارعة إلى زيادة الكميات المتولدة من مخلفات البناء والهدم في حين أن البنية التحتية لجمع المخلفات ونقلها وإعادة تدويرها وطمرها ضعيفة نسبيًا عن أفضل الممارسات أو غير موجودة على الإطلاق. وتهدف هذه الدراسة الى تحديد الاتجاهات الاستراتيجية الرئيسية لإعداد استراتيجية وطنية لإدارة مخلفات البناء والهدم في مصر. وقد تم الانتهاء من هذه الدراسة في عام 2019 مع مشاركين من القطاعين الحكومى والخاص يمثلون أصحاب المصلحة الرئيسيين في قطاع ادارة مخلفات البناء والهدم في مصر. وتبين الدراسة استخدام أداة التحليل الاستراتيجى المعروفة باسم "بستل" ، وهو أداة لتقييم العوامل الخارجية المؤثرة على المنظومة ، لتقييم العوامل التي تؤثر على ممارسات إدارة مخلفات البناء والهدم في مصر. وتعرض الورقة نتائج تحديد أصحاب المصلحة ، وتحليل بستل الاستراتيجى ، وصياغة ستة (6) اتجاهات استراتيجية رئيسية لإدارة مخلفات البناء والهدم في مصر. وتشير نتائج تقييم اتفاق أصحاب المصلحة مع التوجهات الاستراتيجية إلى تأييد قوي للتوجهات المقترحة كأساس نحو صياغة استراتيجية وطنية لإدارة مخلفات البناء والهدم فى مصر.

Abstract

The Egyptian government has an ambitious agenda for economic and social development through mega construction projects to upgrade infrastructure, transportation, housing, telecommunications, industrial and commercial facilities. The accelerated construction activities have led to increasing generation of C&D waste while the infrastructure for waste collection, transportation, recycling, and dumping is relatively falling behind average best practices or non-existing. The objective of this study is to identify key strategic directions to establish a national strategy for C&D waste management in Egypt. The study was completed in 2019 with public and private sectors participants representing key stakeholders for C&D waste sector in Egypt. PESTEL analysis, a tool for environmental screening, has been used to assess factors affecting C&D waste management practices in Egypt. The paper presents stakeholder identification, PESTEL analysis, and the development of six (6) key strategic directions for C&D waste management in Egypt. Evaluation of stakeholder's agreement with the strategic directions

indicate strong agreement as a basis towards a national C&D waste management strategy for Egypt.

Key Words:
Sustainability, C&D Waste, Strategy, Waste Management, Construction, Egypt

1. Introduction

The construction industry in Egypt is one of the fastest growing sectors of the economy and a major contributor to the Gross Domestic Product (GDP). The industry has added 25 billion US$ (equal to 8.3 %) to the national GDP of 303 billion US$ in 2019. The construction industry in Egypt is growing at a rate much higher than the overall national growth rate (9% for construction compared to 5.5% for all economic sectors in 2019). The growth of the construction industry in MENA is estimated to be the fastest worldwide in 2019, with a rate of 7.5% in 2018 compared to a 5.7% global growth rate (Deloitte, 2019). This is also an indicator of the sharp growth rate of construction sector in Egypt. This rapid growth construction activities have led to increased generation of C&D waste in absence of waste management strategy/infrastructure/regulation. The visitor to Egypt will easily spot numerous accumulations of Construction & Demolition Waste (C&D Waste) covering roadsides, open areas, and land lots.

C&D Waste is generated when constructing new buildings or civil installations such as roads, bridges, public works projects, utilities, dams, etc., or when renewing, re-finishing, rehabilitating or demolishing existing buildings and structures. Construction contractors generate C&D Waste as a by-product of construction/demolition activities. C&D Waste is often composed of a mixture of the following components: excavated soil and rocks, concrete, bricks of various types, gypsum (the main component of drywall), ceramic, marble and other natural stones, metals, heat insulation and moisture insulation materials, asphalt, glass, plastics, chemicals and paints, extracted building components (doors, windows and plumbing fixtures), trees and trunks. Excavated soil represents large portion of C&D waste, which have a low environmental impact upon disposal, however, "C&D waste is characterized by its high volume and weight but with probably the lowest environmental burden and the highest inert fraction per Mg of all waste streams" (J. G. álvez-Martosa, et.al., 2018).

The random accumulation of C&D Waste on sides of roads and open land areas in most cities and towns is a common phenomenon in Egypt. This leads to environmental degradation and considerable economic losses. Non-recycling of C&D waste is depleting raw materials, lead to energy losses, and consumes large areas of land for burial of C&D wastes.

The Government of Egypt, represented by the Ministry of Environment, aims to develop a national strategy for C&D waste management in Egypt. The amount of C&D Waste generated annually increases as a result of the increase in the activities of construction,

demolition, rehabilitation of housing, infrastructure, and other projects. Currently, Egypt lacks an integrated system for managing the generation, transportation, sorting and recycling, or burial of C&D waste with several negative consequences on the environment, economy, and urban sight. To develop a successful strategy for C&D waste management, all key stakeholders need to be identified and incorporated during the strategy development and action plans development and implementation.

C&D waste represents one of the largest waste streams according to statistics from different countries. Statistics from the European Union 27 states indicate that C&D waste represents 49% of the total solid waste (Sáez, Río Merino, Amores, San Antonio, González, 2011), with an estimated amount of 700 million tons in 2017 (Iacoboaea C., Aldea M., Petrescu F., 2019), (J. G. álvez-Martosa, et.al., 2018). According to the Environmental Protection Agency (EPA), the United States has generated 569 million tons of C&D waste in 2017 (EPA, 2017). In China, C&D waste represents 30-40% of total waste with a weight of up to 2 billion tons in 2011, it is generally estimated that C&D waste takes up around 30%–40% of total MSW in China (Ramzy, 2013). The amount of C&D waste in the United Kingdom reached 77.4 million tons in 2010 (Vivian Tam and Weisheng Lu, 2016). In Egypt, data available from the Ministry of Environment (MOE, WMRA, 2018) indicate that the total volume of solid waste in Egypt is 90.22 million tons in 2016, of which about 21 million tons are municipal solid waste and 5.8 million tons are C&D waste. It is worth noting that the mentioned percentage of C&D waste in the 2016 report, which represents only 6% of the total waste, is much lower than the global average that ranges between (30-50%) of the total waste and reflects the absence of reliable and accurate C&D waste quantification statistics in Egypt.

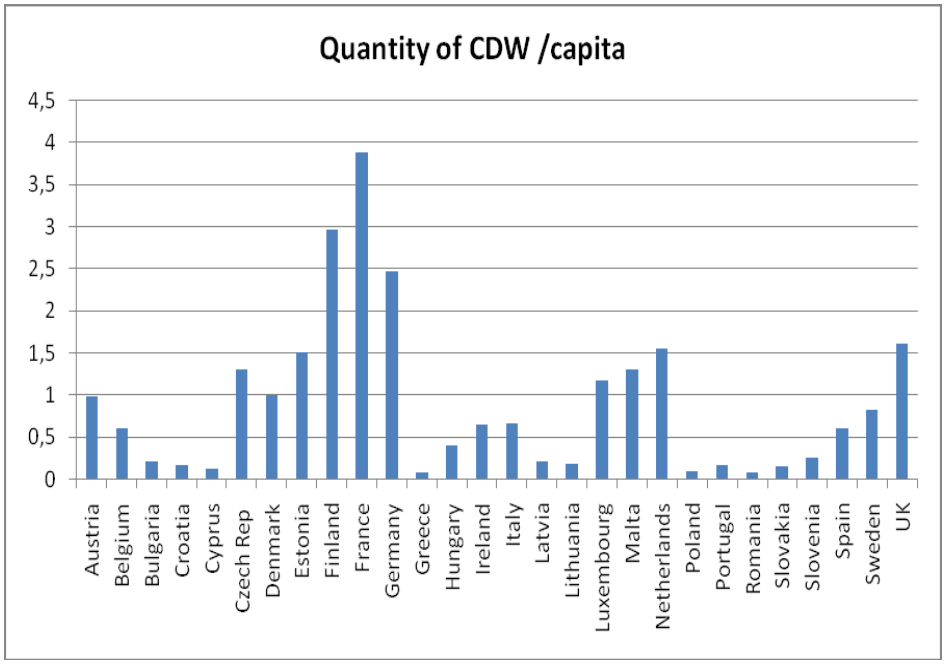
C&D Waste Recovery

Many countries have succeeded in C&D waste recovery through re-use and recycling of waste materials. C&D waste can be used to produce building materials such as gravel, tiles, bricks, and road construction base materials. In 2008, the EU has established a mandatory recovery target of (70% by year 2020), (J. G. álvez-Martosa, et.al., 2018). This simple indicator compares the percentage of recovered materials (reused & recycled) to the total generated C&D waste. This indicator supports the measurement of progress and effectiveness of C&D waste management efforts within and across cities and countries. This mandatory target is part of the EU "Waste Framework Directive (2008/98/EC) taking 2008 as a base year (Prabir Ganguly, 2012). According to (OECD, 2013); "effective waste management strategies include a mix of complementary measures such as regulatory, economic, educational and informative instruments. Thus "economic instruments are designed to motivate waste producers to divert waste from landfills, recycle more waste and optimize the use of resources, so waste is (i) prevented, (ii) well managed, and (iii) optimally treated" (OECD, 2013 ; J. G. álvez-Martosa, et.al., 2018).

Methods for Reporting Quantities of C&D Waste

Countries report the generated C&D waste quantities using different methods. Total generated quantities per year, percentage of C&D waste to total solid waste, quantities of C&D waste per meter square of constructed/demolished facilities, and annual quantities "per capita per year. The latter measure is the simplest one that enables comparisons among nations. Fig. (1), depicts generated C&D waste per capita per year for EU countries. Sixteen (16) out of (28) EU countries has a C&D waste rate of more than (0.5 tone /capita/year), (Iacoboaea C., Aldea M., Petrescu F. 2019). Applying this average figure for Egypt leads to an estimated 50 million tons of C&D waste per year. A figure much higher and realistic than the official reported quantities.

Figure (1): The Quantity of C&D waste per capita (Tones/ Year) generated as reported by EU member States in 2012.



Source: (Iacoboaea C., Aldea M., Petrescu F. 2019)

Key Policies in support for C&D Waste Strategy

Most developed countries have created an integrated system for C&D Waste management to reduce generation of waste, encourage waste classification at the source, and recovering the maximum amount of materials through recycling and reuse. The management also aims to minimize the quantities directed to landfills. The recycling alternative helps to achieve sustainability by conserving natural resources of building materials and the reduction of energy used to mine, manufacture, transport building materials and components. The quantities of C&D Waste are estimated at 1-10% of the total materials used in the construction industry, the bulk of which (70-80%) can be recovered through

recycling. The typical C&D waste management system includes the following components:

- Legislative and regulatory instruments that supports governance over the whole waste life cycle from generation (to reduce the waste quantities), classification and separation at the source, regulations on collection, transportation, recycling, and disposal.
- Regulation to impose relatively high tipping fees for waste dumping in landfills to encourage waste reduction and recycling.
- Rules and mechanisms for calculating quantities generated from construction activities.
- Control tools to ensure that parties responsible for collection, transportation and recycling comply with the agreed requirements and mechanisms.
- Legislation encouraging investors to invest in the establishment of an integrated industry for the management of C&D waste and achieve economic feasibility of waste recycling and production.
- Stimulating partnership between cities administrations and private sector through long-term contracts for integrated management of waste.
- Regulations and technical specifications that encourage reuse of materials and products resulting from the recycling of C&D Waste.
- Identifying the targets at the national level for the recovery rate from recycling of C&D Waste within a specified time frame and mobilizing national efforts among the stakeholders to achieve the target (e.g., European Union: the recovery rate from waste was determined at least 70% of the weight of generated waste by 2020 for all EU countries (J. G. álvez-Martosa, et.al., 2018).

2. Research Methodology

The research team held several meetings during February and March 2019 with the team of the Waste Management Regulatory Authority, Ministry of Environment (WMRA) and the German Agency for International Cooperation team (giz), to set a general framework for preparing the strategy and the expected outputs. The methodology, timeline and identification of key stakeholders were discussed during these meetings and can be summarized in the following points.

- Governing strategies such as the sustainable development strategy (Egypt 2030), the solid waste sector management strategy and the WMRA strategy as a general framework to guide the development of the national C&D waste strategy.

- A review of local and international experiences for C&D waste management and the most appropriate strategies and policies were identified.
- Interviews with main C&D waste management stakeholders in Egypt have been conducted. A SWOT analysis that revealed the weaknesses, strengths, opportunities, and threats was compiled from stakeholders' interviews. PESTEL analysis; a comprehensive environmental screening approach (Turkyilmaz et. Al., 2019) was utilized to screen main (Political, Economic, Social, Technological, Environmental, and Legal) factors affecting C&D waste management in Egypt.
- Based on the previous steps, the strategic directions were drafted focusing on the establishment of an integrated C&D waste management system for Egypt. The directions build on existing strengths in Egypt and potential opportunities for improvement, it also mitigates weaknesses in the current system and possible threats. The strategic directions are in line with the national strategies for waste management and also in line with the global trends in C&D waste management.
- The strategic directions were verified through three workshops held during the period Sept.to Dec. 2019 attended by (143 participants) representing main stakeholders, government agencies, and private sector. The participants evaluated the six directions and the results have indicated strong consensus.

3. Identification of C&D Waste Key Stakeholders

The Waste Management Regulatory Authority (WMRA) was established in 2015 through the "Cabinet of Ministers Resolution No. 3005" as an independent authority under the Ministry of Environment. WMRA aims at regulating and monitoring all processes related to waste management at the central and local levels, as well as attracting and encouraging investments in the areas of collection, transportation, recycling, and disposal of waste.

Currently, WMRA is in the phase of institutional formation and preparation of strategies and operational tools to achieve integrated management of solid waste in Egypt. According to the new draft law regulating the management of solid waste, WMRA is the policy-making, supervision and guidance entity for solid waste of various types in cooperation with the executive agencies of other ministries. Twelve (12) key C&D Waste stakeholders have been identified through interviews and discussions with the team of the Waste Management Regulation Authority (WMRA), the SWM team of German Corporation for International Cooperation GmbH (giz), and construction industry experts. Table 1., presents the role of each participant in C&D waste management activities.

Table: 1. Key Stakeholders and their roles in C&D waste management

	Key Stakeholder	Role
	Waste Management Regulation Authority (WMRA), Ministry of Environment, Egypt	▪ Regulate C&D waste practices ▪ Monitor performance of waste management by municipalities
	Construction Contractors	▪ Generate C&D waste ▪ Transport C&D waste ▪ Pay for waste management/disposal
	Waste Transportation Entities	▪ Transport C&D waste ▪ Potential investors for a new C&D waste management system (Collection, transportation, recycling, dumping)
	Private Sector/Investors	▪ Potential participants in a new integrated C&D waste management system (Collection, transportation, recycling, dumping)
	Ministry of Housing, Utilities and Urban Communities, New Urban Communities Authority (NUCA)	▪ Operator of major new cities and communities in Egypt ▪ Issue & monitor construction permits in new cities.
	Ministry of Local Development (MLD), Governorates, Local Governance	▪ Operator of old cities and localities. ▪ Issue & monitor construction permits in old cities and villages.
	Central Unit for Partnership with the Private Sector (PPP), Ministry of Finance.	▪ Regulate/Facilitate PPP projects necessary for establishing C&D waste management infrastructure.
	Ministry of Investment and International Cooperation.	▪ Regulate/Promote foreign and local investors for establishing C&D waste management infrastructure.
	Engineering Authority of the Armed Forces.	▪ Major implementation body (management & construction) of mega and national construction projects.
	Housing and Building National Research Center (HBRC).	▪ Major governmental (R&D) Organization with long track record of C&D Waste recycling pilot projects ▪ Sole Developer of engineering codes in Egypt including SWM code.
	Egyptian Organization for Standards and Quality (EOS).	▪ Sole developer of national standards and specifications in Egypt
	Construction materials manufacturers/Suppliers	▪ Manufacture/Supply building materials and products (concrete, bricks, aggregates, tiles, ….). ▪ Potential supplier of products made of recycled C&D Waste.

As for the procedures currently applied in the new cities for the issuance of excavation permits and the transportation of construction waste, they include the following:

- The owner/contractor will apply for an excavation permit after the city authority has issued the construction permit of the building. The customer will pay the inspection fees and insurance fees to guarantee the "transportation of the excavation waste" to landfills. The representative of the authority will conduct a site inspection to estimate the existing quantities of waste at the site and estimate quantities of excavation.
- The waste department of the city authority will issue the excavation permit and give the customer the "vouchers" of the transportation and delivery of the excavation waste to the public landfills, where such vouchers are the means to ensure the customer's transportation and delivery of waste in a formal manner.
- The customer shall deliver the waste to the public dumps specified by the authority and seal the delivery vouchers at the landfill gate. The customer shall then submit the vouchers sealed by the landfill to refund his payment.

4. SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats)

A SWOT analysis was carried out through discussions with stakeholders' representatives. The current management system of the C&D Waste in Egypt, as well as the governmental and private bodies involved in the planning and implementation of the C&D waste management.

Strengths

- The objectives of Egypt 2030 Strategy for Sustainable Development is in line with global sustainability agreements.
- The leadership at higher government levels is committed to achieving sustainability through supporting the Ministry of Environment and city administrations in the development of an integrated solid waste management structures and regulations.
- The establishment of the Waste Management Authority (WMRA) and the issuance of a comprehensive waste management law that includes the necessary legislation, through which the following will be conducted:
    - Regulate the companies working in the field of integrated management of the C&D Waste and regulate the issuance of licenses according to specific requirements.
    - Increase the penalties imposed and actions taken against the waste generator or the party responsible for the waste transportation in case of violation.

    - Develop a system of incentives for projects of the recycling and treatment of excavation waste and the C&D Waste.
    - Encourage investment in reuse and recycling of excavation waste and the C&D Waste and encourage partnership between the government and the private sector to work in this field.
- The Housing, Building National Research Center (HBRC) of Egypt had issued a series of engineering codes to help achieve sustainability, green buildings and smart cities, including:
    - Egyptian System for Building Sustainability Assessment (Green Pyramid Rating System - GPRS)
    - Egyptian Code of Design Principles and Implementation Conditions for solid waste management organization
    - Egyptian Code for Recycling of the C&D Waste.
    - Egyptian Code of Smart Cities.

Weaknesses

- There is no model for an Egyptian city that recycles any percentage of C&D Waste.
- Poor governance/control from city authorities and local governments over the transportation of C&D waste that leads to illegal dumping.
- Lack of guidelines in new and old cities to direct the processes of C&D waste collection, transportation, and disposal.
- Lack/absence of accurate data in city administrations regarding the generated and accumulated C&D waste quantities.
- Lack of a national system, databases, and tools to monitor C&D waste generated in construction sites.
- Lack of technical requirements for companies practicing transportation of soil excavation and waste disposal.
- Lack of incentives to attract investors to work in the field of integrated C&D waste management.
- The current standard specifications of building materials and products (aggregate for concrete, bricks, tiles, road construction materials) do not allow the use of recycled stones.
- There is no study to determine the appropriate fees for disposal of the C&D Waste.

Threats

- The continuation of the illegal disposal of the C&D waste and the negative environmental, economic, and health impacts from random accumulations.
- The negative cultural appearance of accumulations of the C&D Waste.
- As C&D waste is occupying more areas of land leads to increase of development costs due to transportation of C&D Waste more than once.
- The excavation waste are mixed with the C&D Waste in addition to household waste, which leads to health and environmental threats and the difficulty of classifying or utilizing them through recycling.
- Increased accumulations on the highways, thus posing a risk to traffic.
- Investors are concerned about the futility of investing in long-term projects for the management of the C&D Waste and recycling, and the low possibility of marketing recycled products due to the low awareness and reservations set by national specifications on recycled materials.

Opportunities

- There are models and previous initiatives carried out in other countries to deal with the problem of management of the C&D Waste, which provides the opportunity to use available information on the policies that can be followed to make the construction industry a sustainable industry in which the recycled product is used regularly, create a stable market for the recycled product and thus attract investments in this field.
- There are promising investment opportunities and high return on capital in the projects of recycling of the C&D Waste if proper disposal fees are imposed.
- Accelerated construction of modern new cities in Egypt planned under the premise of "smart cities" or fifth generation cities implicates policy makers understanding of sustainability principles and inclination to modern solid waste management practices.
- Many private sector developers have set out to build "green" cities and communities and implement the principles of sustainability in the construction and operation of these communities.

5. PESTEL analysis of C&D Waste Management

PESTEL analysis is known as a comprehensive environmental screening approach (Turkyilmaz et. Al., 2019). Through interviews with stakeholders, factors affecting C&D waste management in Egypt were identified. These factors can be classified into six dimensions (Political, Economic, Social, Technological, Environmental, and Legal). This analysis enables the understanding of

existing environment surrounding C&D waste and supports the creation of strategic measures to establish an integrated C&D waste management strategy. Tables (2) & (3) summarize the results of PESTEL analysis.

Table 2: Political, Economic, and Social Factors

1	**Political Factors**	2	**Economic Factors**	3	**Socio-Cultural Factors**
1.1	The adoption of "Egypt Vision 2030" by most governmental sectors motivates conservation of Environment in decision making.	2.1	No incentives for investors to establish companies for C&D waste collection, transportation, and recycling.	3.1	Th rapid population growth increase the scale of C&D waste illegal dumping due to increasing poverty and illegal construction.
1.2	Government spending on several "National and Mega Projects" accelerates generation of C&D waste and raise attention to the critical need for proper C&D waste management system.	2.2	Low expectations for sales of recycled construction materials in Egypt due to highly conservative construction industry practices.	3.2	There is a lack of cultural awareness on C&D waste recycling benefits among city officials, contractors, and citizens.
1.3	On 2014, Egypt has established a new authority for SWM () to regulate and monitor SWM Sector.	2.3	Lack of governmental programs to motivate investment in C&D waste management.	3.3	Using recycled construction products may not be easily accepted without strong campaigns to demonstrate the quality of those products and the overall benefits to the society.
1.4	Egypt is preparing a new legislation to regulate all activities related to solid waste management and disposal fees including C&D waste.	2.4	Relatively low landfill tipping fees discourage reuse/recycling.		

Table 3: Technological, Environmental, and Legal Factors

4	Technological Factors	5	Environmental Factors	6	Legal Factors
4.1	Technology and expertise for C&D waste reduction, reuse, and recycling is available in Egypt at the experimental research and pilot implementation levels.	5.1	Illegal dumping of C&D waste is common in Egypt and is considered a threat to the environment due to dust and possible hazardous materials (such as Gypsum) within C&D waste.	6.1	City administrations (new cities and local governments) have a policy to ban illegal dumping, however, the implementation is weak and illegal dumping is the cheapest alternative.
4.2	Lack of C&D waste recycling plants in Egypt.	5.2	Current practices of dumping C&D waste in landfills and mixing of municipal waste with C&D waste complicates the environmental problems and contaminations facing Egyptian cities.	6.2	Lack of governmental regulation/policies for C&D waste generation, collection, transportation, recycling, dumping.
4.3	Lack of construction materials and products manufactured from recycled materials in Egypt.	5.3	The large amount of construction materials used in construction with zero recycling adds to the problem of consuming natural resources, CO^2 emissions, and embodied energy consumption for material manufacture and transportation.	6.3	The Egyptian standard specification does not consider recycled C&D waste as an accepted source of materials for Construction materials/products.

6. C&D Waste Management Strategic Directions

Based on SWOT & PESTEL analysis, review of international best practices, the author has developed six major strategic directions for C&D waste management in Egypt. The following paragraphs illustrate each of the strategic direction in detail.

6.1 Establish policies to reduce generation of C&D waste at construction sites

Reduction of generated quantities of C&D waste from construction activities should be the first option. Adoption of compulsory and voluntary programs at construction sites to reduce waste generation and separate components. Contracting companies seek to implement these programs to reduce the high costs of waste disposal in developed countries.

The mechanisms required to achieve this direction include providing technical guidance to contractors on waste reduction & separation, mandate to quantify C&D waste generated at construction projects, and to equip city authority to monitor transportation of C&D waste from all construction sites using GPS devices on all trucks.

In order to implement this strategic direction, the following measures should be adopted:

- Construction contractors to document C&D waste quantities generation, collection, and transportation to landfills.
- City Authority to document actual C&D waste reaching landfills or diverted for reuse/recycling.

6.2 Establish institutional and regulative structure in support of an integrated C&D waste management activities.

As evidenced by SWOT/PESTEL analysis, Egypt lacks a comprehensive legal/institutional structure to support integrated C&D waste management activities (generation, separation, collection, transportation, recycling, disposal). On 2015, the Ministry of the Environment has created a new specialized entity for waste regulation (WMRA - Waste Management Regulation Authority). This agency is currently in the process of institutional and capacity building. The role of WMRA will be mainly regulative/monitoring. On the other hand, the implementation of C&D waste management activities still has to be handled by city authorities across the nation (NUCA, Governorates). City authorities are in control of construction permits and have oversight over transportation and landfill of C&D waste. These cities are lacking the institutional/legislative structure and mandates to direct/monitor/implement C&D waste management activities.

On the legislation side, the Ministry of Environment has drafted a new law to regulate all activities related to SWM in Egypt. It is essential to conduct a study to determine the appropriate C&D waste disposal fees in each geographic locality. Disposal fees are critical tool to inhibit the increase in waste generation and a main economic motivator for recycling options. The increase of disposal fees at landfills is an economic incentive to stimulate investment in the creation of the infrastructure for C&D Waste management activities including the establishment and operation of recycling stations. City authorities and administrations still need to develop organizational procedures and technical manuals to direct the collection, transportation, recycling and burial of the C&D Waste.

In order to implement this strategic direction, the following measures should be adopted:

- Define the responsibilities of the actors in the system (WMRA, NUCA, Municipalities, waste collection and transportation companies, recycling companies, ...).
- Encourage collaboration and coordination among the main actors.
- Provide flexible contracting alternatives between city authorities and investors.
- Stimulate/motivate investors to the establishment of an infrastructure for the integrated management of the C&D Waste.

6.3 Establish infrastructure for: reduction, collection, separation, transportation, and recycling, and disposal of C&D waste,

The success of the establishment of an integrated management system of the C&D Waste relies on the establishment of an infrastructure for the reduction, collection, separation, transportation, recycling, and disposal of C&D waste (e.g. containers, modern trucks, GPS monitoring and tracking systems, central control rooms, databases, procedures manuals, trained personnel). The infrastructure also includes recycling means of the C&D waste (sorting stations and crushers, and production lines of building materials and products made from recycled waste, landfills). The infrastructure also includes the knowledge, modern management systems, performance monitoring, trained personnel in C&D waste management. Measures for C&D waste quantification at construction sites, during transit, at recycling stations, and landfills are also part of the required infrastructure.

In order to implement this strategic direction, the following measures should be adopted:

- Build the capacity of city authorities and local administrations to plan and implement a system for integrated management of the C&D Waste.
- Eliminate the phenomenon of random disposal of the C&D Waste.
- Document the capacity and efficiency of C&D Waste infrastructure elements (containers, waste trucks, crushers, production lines of construction products manufactured from recycling) in each geographical area or each city.
- Document C&D Waste governance and procedures in each city.
- Document the generated and accumulated C&D Waste quantities in each city and formal landfills.
    - Track and document the illegal C&D waste dumping activities and locations.

6.4 Stimulate private sector participation in C&D waste management investment projects

The participation of the sector is critical to establish waste management infrastructure. Financial feasibility studies on integrated C&D waste management indicated that investors in C&D waste recycling should be compensated through the disposal fees in order for their production to compete with products manufactured from natural resources. Different measures could be used to motivate investors to C&D waste management sector. Such measures include:

- Public private partnerships between investors and city authorities
- Green public procurement measures that commit government agencies to use certain percentage of recycled products in their projects.

- Application of circular economy principles, through which recycled products are considered a major stream parallel to natural resources.
- Conduct detailed feasibility studies for C7D waste recycling at each city to take into account generated C&D waste quantities, cost of transportation and recycling facilities, and marketing recycled products.
- Monitor and document the public expenditures for the collection and transportation of C&D waste and disposal fees/fines in each city.
- Monitor the value of investments provided by the private sector through long-term partnership contracts.
- Monitor the technologies and human resources in the C&D waste sector.

6.5 Set a national target of 40% by 2030; for C&D waste recovery

Most of the developed countries have adopted a national target for the diversion of C&D waste. Setting a national target for Egypt during the next 10 years will encourage all stakeholders to integrate their efforts, monitor progress in each locality/city towards the target. Annual progress towards the target will reflect the success in planning and implementation of all strategic objectives and action plans; and helps to benchmark activities throughout Egypt. Recycling ratio of 40% is a realistic target especially that Egypt has all the requirements to start the implementation of the integrated solid waste management system starting in 2020.

To monitor progress towards achieving the specified target, accurate mechanisms for documenting the quantities of the generated and recycled C&D waste should be established. This measurement must take place at all construction projects, at the level of neighborhoods, cities and governorates, both contractors and city officials need to abide by the measurement system.

The determination of the quantities collected, and the recycling ratio requires the establishment of an "Operations & Monitoring Center" in each city that reports to a national center that could be established at WMRA. Which should be able to audit the reported quantities and recycling activities across Egypt.

In order to implement this strategic direction, the following measures should be adopted:

- Oblige the authorities and administrations of cities to establish the necessary infrastructure to meet the national target.
- Develop the capacity of the authorities and administrations of cities to monitor and document the quantities of waste collected, transported, recycled, reused, or buried.

6.6 Establish a quality management and accreditation System to ensure and certify the quality of construction products manufactured from C&D waste recycling.

Successful recycling of the C&D waste requires a local construction market that accepts the use of recycled materials and products (bricks, tiles, interlock, ordinary concrete, subgrade and subbase layers for road construction, etc.). It also requires giving confidence to the owner, the consultant engineer, and the contractor that the recycled products satisfy the requirements of the national standards and technical specifications.

It is essential to stablish a quality & accreditation system according to the requirements of national Egyptian standards and Building Codes. The current Egyptian Standard specification does not consider recycled C&D waste as one of the resources for manufacturing building materials and products. EOS and HBRC are currently modifying (10) standard specifications to allow the use of recycled C&D waste materials in manufacturing of building materials. The creation of a certification/accreditation system to certify materials/products made from C&D waste will lay the foundation for a new industry and market for construction in Egypt.

In order to implement this strategic direction, the following measures should be adopted:

- Develop and amend the current standard specifications of building materials to allow the use of materials resulting from C&D waste recycling in the manufacture of building products.
- Develop a national system to certify the quality of building products resulting from C&D waste recycling.
- Develop technical manuals for construction materials and products manufactured from C&D waste materials to certify final product quality.
- Develop a labeling system for C&D waste recycled products.

7. Analysis of Stakeholders Feedback

The stakeholders' identification and the six strategic directions have been introduced to C&D waste stakeholders and industry experts through three workshops (143 participants) during the period of September to December 2019. Agreement of participants on stakeholders' identification and the developed strategic directions was measured through a questionnaire survey.

Degree of agreement on selected key stakeholders

Workshop participants degree of agreement with the selection of stakeholders is illustrated in Figure 1. It is measured based on a Likert scale (1-5), where 1 refers to "don't agree" and 5 refers to "strongly agree". The highest degree of agreement (i.e., >

4.5) includes WMRA, NUCA, LDM, ESQA, and HBRC. These stakeholders represent the main authority on C&D waste regulation implementation (i.e., WMRA, NUCA, and LDM). They also include two key players in the area of mandating construction materials specifications (i.e., ESQA) and engineering codes development (i.e., HBRC). All identified participants received an agreement of greater than 4.2. Additional stakeholders suggested by workshop participants include roads and bridges authority, governorates representatives, ministry of investment, and ministry of housing.

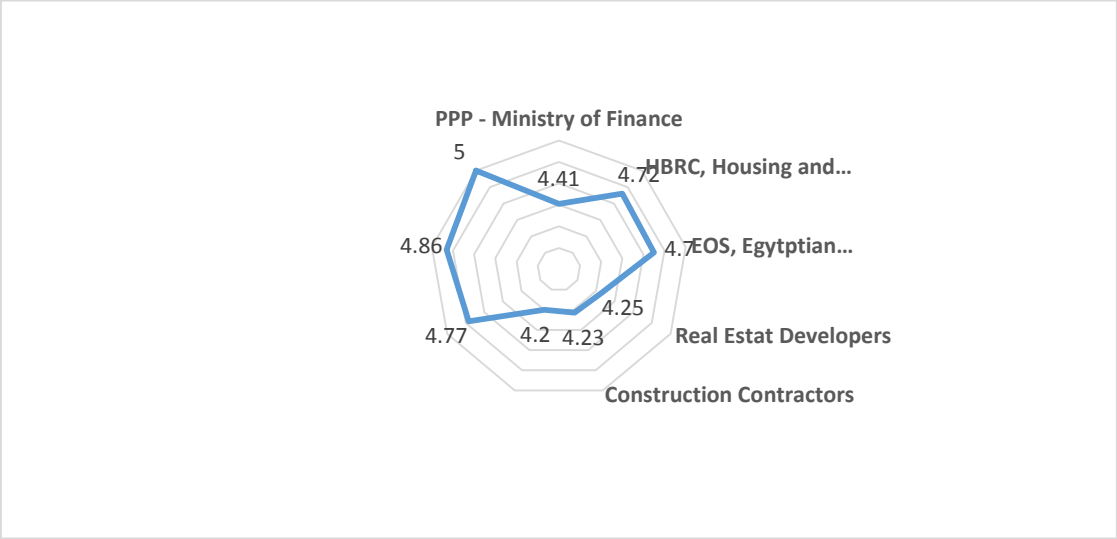


Figure 1: Degree of agreement on stakeholders' identification

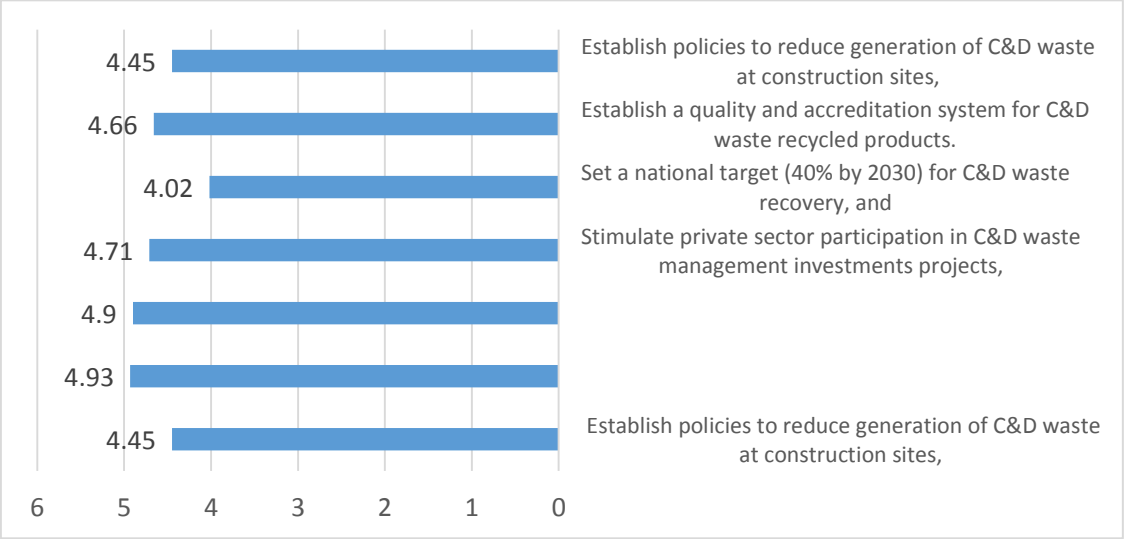


Figure 2: Degree of agreement on C&D waste strategy directions

8. Conclusions

Egypt lacks a national strategy and infrastructure to manage C&D waste properly. The public authorities also lack reliable data on generated and accumulated quantities for

C&D waste across Egyptian cities and towns. This study managed to identify and interact with C&D waste key stakeholders to create C&D waste management strategic directions. Six (6) major strategic directions have been created as a basis for a national C&D waste management strategy in Egypt. The strategic directions cover the major aspects of a modern C&D waste management system, follow international best practices, and take into account local conditions and limitations. The strategic directions include: 1) Establish policies to reduce generation of C&D waste at construction sites, 2) Establish institutional and regulative structure in support of an integrated C&D waste management activities, 3) Establish infrastructure for: reduction, collection, separation, transportation, and recycling of C&D waste, 4) Stimulate private sector participation in C&D waste management projects, 5) Set a national target (40% by 2030) for C&D waste recovery, and 6) Establish a quality and accreditation system for C&D waste recycled products. Evaluation of stakeholders' identification and proposed strategic directions indicates strong agreement by major stakeholders and industry experts. There is an urgent need to establish a mechanism to monitor and quantify generated C&D waste quantities at Egyptian cities. WMRA in coordination with city authorities should start creating a "National C&D Waste Action Plan" to laydown detailed steps, budgets, time frame towards infrastructure creation and gearing public and private sectors efforts towards C&D waste strategy implementation.

Acknowledgements

This study was funded and coordinated by the "German Corporation for International Cooperation GmbH (GIZ)" in Egypt. The study was requested and supervised by The Egyptian Ministry of Environment represented by (WMRA); Waste Management Regulatory Authority & and the National Solid Waste Management Program.

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