
JST-JICA SATREPS Report on Construction and Demolition Waste Management in Da Nang, Vietnam

November 2021

SATREPS

Science and Technology Research Partnership
for Sustainable Development Program



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Preface

Based on the agreement between the Socialist Republic of Vietnam and Japan, a JST-JICA SATREPS (Science and Technology Research Partnership for Sustainable Development) project began in February 2018. The SATREPS project targets the establishment of environmentally sound management of construction and demolition waste and its wise utilization for control of environmental pollution and production of new recycled construction materials; it will continue until March 2023.

This publication is the Report on Construction and Demolition Waste (CDW) Management in Da Nang, Vietnam. The survey was carried out as a part of SATREPS project activities during February and March 2021 in collaboration with Da Nang Environmental Protection Agency and The University of Da Nang - University of Science and Technology (DUT). The objective of the survey was to identify the current situation of CDW management in Da Nang by using data and information collection, interviews to local authorities, and survey at CDW disposal sites.

We would like to acknowledge Department of Natural Resources and Environment (DONRE) and Department of Construction (DOC) of Da Nang City, Da Nang People's Committee, JICA Vietnam Office and the respective coordinators from JICA Headquarter and JST for their continuous support on the SATREPS project.

Prof. Phan Quang Minh, Hanoi University of Civil Engineering: Project Director of SATREPS in Vietnam
Assoc. Prof. Nguyen Hoang Giang, Hanoi University of Civil Engineering: Project Manager of SATREPS
in Vietnam

Dr. Tong Ton Kien, Hanoi University of Civil Engineering: Project Vice-Manager of SATREPS in Vietnam

Assoc. Prof. Tran Thi Viet Nga, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Assoc. Prof. Nguyen Duc Luong, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Dr. Nguyen Tien Dung, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Dr. Nguyen Lan Huong, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Dr. Nguyen Ngoc Tan, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Mr. Nghiem Ha Tan, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Mr. Ngo Kim Tuan, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Mr. Tran Viet Cuong, Hanoi University of Civil Engineering: SATREPS member in Vietnam

Mrs. Nguyen Thi Kim Ha, Vice-Director, Da Nang Environmental Protection Agency

Mr. Tran Trieu, Specialist, Pollution Control Bureau, Da Nang Environmental Protection Agency

Mr. Tran Duc Tu, Specialist, Waste Management Bureau, Da Nang Environmental Protection Agency

Mr. Thai Ba Anh, Specialist, Waste Management Bureau, Da Nang Environmental Protection Agency

Assoc. Prof. Tran Quang Hung, Faculty of Civil & Industrial Buildings, The University of Da Nang -
University of Science and Technology

Mr. Le Xuan Dung, Faculty of Civil & Industrial Buildings, The University of Da Nang - University of
Science and Technology

Mr. Nguyen Quang Hoa, Faculty of Civil & Industrial Buildings, The University of Da Nang - University
of Science and Technology

Prof. Ken Kawamoto, Saitama University: Project Manager of SATREPS in Japan

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1. Introduction

1.1. Da Nang City

Da Nang City, a Class-1 municipality with the third largest population in Vietnam, is a commercial and educational center of Central Vietnam. The city is located at the coastal area of South China Sea at the mouth of the Han River and is one of the important port cities in Vietnam. The city has a well-sheltered and easy accessible port and is connected to National Highway 1A and the North–South Railway, making the city a transport hub in Central Vietnam. Additionally, the city is located within 100 km of several UNESCO World Heritage Sites such as the Imperial City of Hue, the Old Town of Hoi An, and the My Son Ruins.

Before 1997, the city was part of Quang Nam-Da Nang Province. On January 1st, 1997, Da Nang was separated from Quang Nam Province to become one of five centrally-controlled municipalities in Vietnam under the administration of the central government (Da Nang EPA, 2021). Da Nang is designated a Class-1 city and has a higher urbanization than any of the other Vietnamese provinces and centrally governed cities and its population growth is at an average of 2.54% per year (Sakae Corporate Advisory and Surbana Jurong Consulting Company, 2020). The city is surrounded by mountains to the west, and the South China Sea to the east. Da Nang borders Thua Thien-Hue Province across the Hai Van Pass to the north, along with the Quang Nam Province to the south and west. It is 764 km south of Hanoi, and 964 km north of Ho Chi Minh City. The city has a total land area of 1,259.6 km², of which 247.1 km² are urban districts, and 1,012.5 km² are rural districts (Da Nang EPA, 2021).

Da Nang Port is located in Da Nang Bay with an area of 100 km² and a convenient transportation system. Currently, the port is an important gate in the logistics service chain of the Central Vietnam. The port was selected as the terminus of the East–West Economic Corridor, linking four countries including Myanmar, Thailand, Laos, and Vietnam, as well as the main gateway to the East Sea for the entire region. Founded in 1901 with a history of over 115 years of establishment and development, Da Nang Port has played an important role in the economic and social development of the region. Nowadays, it has stature as the largest seaport in the Central Vietnam.

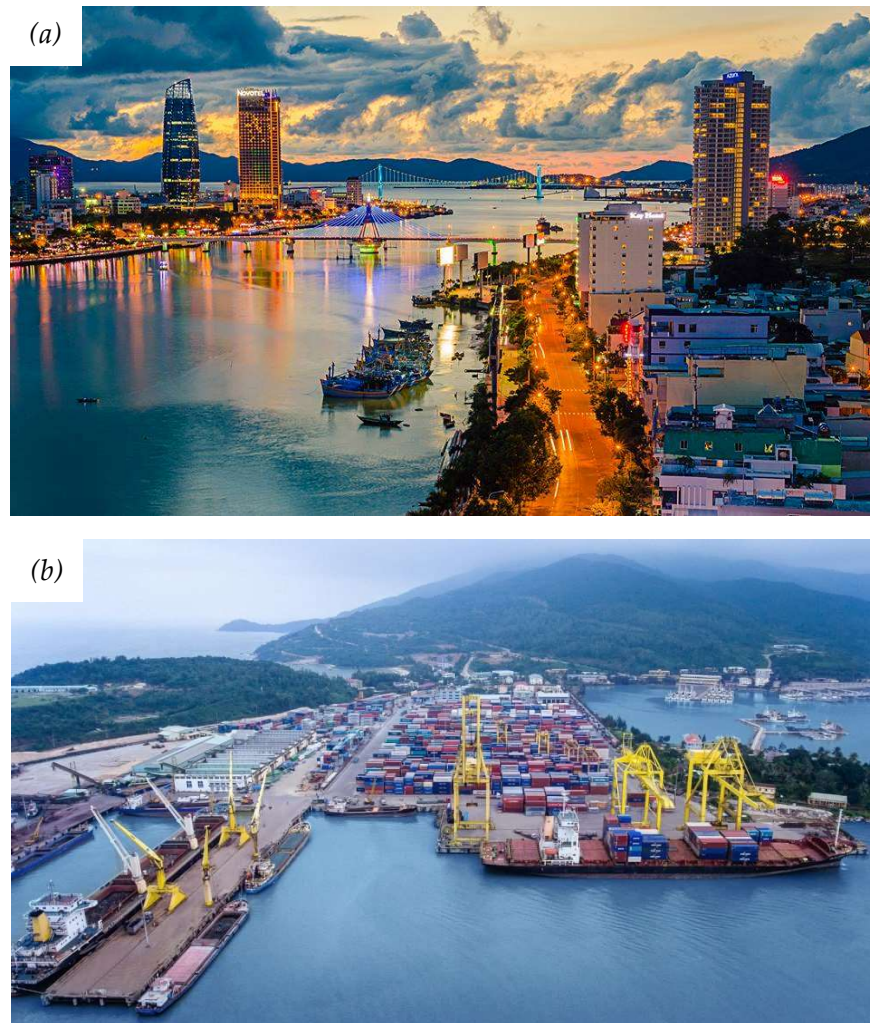


Figure 1: (a) Overall view of Da Nang City and (b) Da Nang Port, one of the city's distinctive features
(Source: Da Nang City Portal, 2021)

Da Nang City is officially divided into eight district-level sub-divisions, including six urban districts and two rural districts as listed in Table 1 and illustrated in the district map in Fig. 2. The city is the sixth most populous city in Vietnam as of 2019, and 87% of the population of Da Nang resides in urban districts. The city also has the highest urbanization ratio among provinces and municipalities in Vietnam because it contains only 11 rural communes (which is the fewest among all other province-level units in Vietnam).

Table 1: List of local government districts in Da Nang (Source: General statistics office of Danang and Da Nang City Portal, 2021)

S/N	Urban District	Number of Wards	Area (km ²)	Population in 2019	Density (people/km ²)
1	Hai Chau	13	24.1	201,522	8,362
2	Cam Le	06	33.3	159,295	4,720
3	Thanh Khe	10	9.3	185,064	20,563
4	Son Tra	07	60.8	157,415	2,654
5	Ngu Hanh Son	04	36.5	90,352	2,310
6	Lien Chieu	05	83.1	194,913	2,616
Sub-Total		45	247.1	988,561	4,001
S/N	Rural District	Number of Communes	Area (km ²)	Population in 2019	Density (people/km ²)
7	Hoa Vang	11	707.5	145,749	206
8	Hoang Sa (Paracel Islands)	-	305.0	-	-
Sub-Total		11	1,012.5	145,749	206
Total		45 wards, 11 communes	1,259.6	1,134,310	901



Figure 2: District map of Da Nang (Source: Da Nang City Portal, 2021)

1.2. Background and Objectives

Vietnam is a developing country with high rate of economic growth annually, which results in a rapid trend toward urbanization. The need for infrastructure and housing leads to the appearance of construction sites all over the country, and especially in large cities such as Da Nang. According to official statistics in 2009, these sites generate approximately 500–600 tons/day of construction and demolition waste (CDW) in Da Nang, which makes up 10–15% the total amount of solid waste produced in Vietnam (MONRE, 2011).

In recent years, the Vietnamese government has enforced strong measures through the Ministry of Construction (MOC) and Ministry of Natural Resources and Environment (MONRE) in order to realize the National Strategy for Management of Solid Waste up to 2025, and Vision Towards 2050. Within the mentioned strategy, issued pursuant to Decision No. 2149/QD-TTg on 17 December 2009 by the Prime Minister, it is stated that “In 2025, we aim towards recovering 90% of the amount of CDW, and recycling 60% of it”. The most recent legal document attempting to enforce proper management of CDW is Circular No. 08/2017/TT-BXD on the Regulation of Construction Solid Waste Management.

The JICA-JST Science and Technology Research Partnership for Sustainable Development (SATREPS) project on “Establishment of Environmentally Sound Management of Construction and Demolition Waste and its Wise Utilization for Environmental Pollution Control and for New Recycled Construction Materials in Vietnam” aims to achieve sound CDW management and to promote CDW recycling in Vietnam. In order to reach such goals, first it is crucial to study the current status of CDW in large cities, including Da Nang, to sketch an overall picture of the current status of CDW management and treatment, difficulties in recycling CDW, as well as CDW generation rate and composition.

The objectives of this report are i) to investigate the current status of the management of CDW in Da Nang and to reveal attitudes of governmental agencies towards CDW recycling and management, and recycled products, and ii) to collect information and data on new buildings in Da Nang to assist in the management of solid waste in general and forecast the amount of CDW in the future when these new constructions are demolished, and iii) to conduct basic information survey of current CDW landfills in Da Nang and organize site visits to gather actual data.

2. Methodologies

2.1. Data Collection and Interviews to Government Agencies on CDW Management

Data collection on solid waste management in Da Nang City and interviews of government agencies were conducted. To carry out the investigation survey by the SATREPS team, an official announcement from the Department of Natural Resources and Environment (DONRE) and Environmental Protection Agency (EPA) of Da Nang City was issued as Announcement No. 799/STNMT-CCMT on 5th March 2021 to 7 targeted Districts of the city (Fig. 3). The interview form for authorities (see, Appendix) was sent via email together with the official introduction at least five working days in prior to the interview so that interviewees of appointed agencies were able to study the content of the interview beforehand. Next, face-to-face interviews were set up with all districts (Fig. 4), and a total of 14 interview forms were collected. The contacted governmental agencies in the interviews are listed in Table 3. It is noted that the two basic codes of conduct were announced to all interviewees in advance because of the complicated nature of the construction and demolition business in Vietnam: 1) results collected in the interview is to be used for research purposes in the SATREPS project only, and 2) the identity of interviewees are kept confidential and are only disclosed to SATREPS project members.

The set of interview questions in the Appendix aims to reveal several areas of information on CDW management, consisting of 1) current status of solid waste management in general, and CDW management in particular in the local region, including information of CDW landfills if available, 2) implementation status of CDW policies, 3) current supply of construction materials in the local region, 4) difficulties of the local authorities in CDW management, and in adopting recycled materials from CDW, and 5) attitude towards the reuse and recycling of CDW in the future. Official meetings were set up at the People's Committee of every target district with relevant person(s) in charge after the delivery of survey forms from SATREPS team. In addition, the following local units were identified in each district for the data collection: 1) Natural Resources and Environment Bureau, 2) Urban Management Bureau, 3) Project Management Unit, 4) Economic – Infrastructure Bureau, and 5) Urban Regulations Inspection Unit.

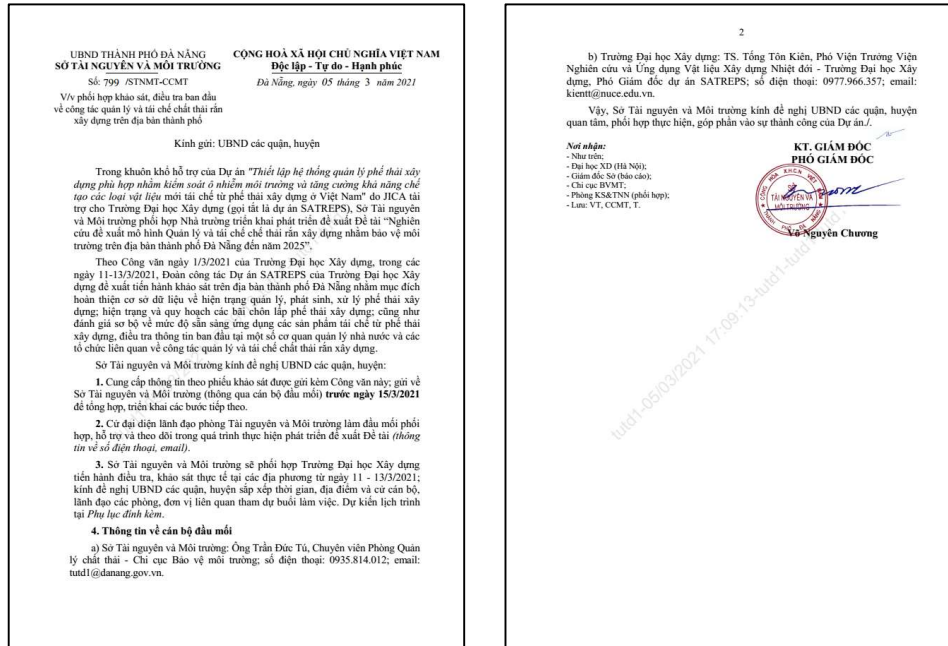


Figure 3: Announcement No. 799/2021/STNMT-CCMT of Da Nang DONRE



Figure 4: Face-to-face interviews with governmental agencies of (a) Hai Chau District and (b) Cam Le District

Table 2: List of agencies contacted in Da Nang

S/N	District	Name of Agency
1	Hai Chau	Natural Resources and Environment Bureau
2	Cam Le	People's Committee (mutual meeting with all bureaus and ward-level committees)
3	Thanh Khe	Urban Management Bureau
4	Son Tra	Natural Resources and Environment Bureau Urban Management Bureau
5	Ngu Hanh Son	Natural Resources and Environment Bureau Urban Management Bureau Urban Regulations Inspection Unit Project Management Unit
6	Lien Chieu	Urban Management Bureau
7	Hoa Vang	Natural Resources and Environment Bureau Economy-Infrastructure Bureau Project Management Unit Urban Regulations Inspection Unit

2.2. Estimation of CDW Generation

In order to investigate CDW generation from demolition activities, the SATRPES team was divided into sub-groups, as shown in Table 3, together with adopted methods (e.g., Wu et al., 2014). It is noted that the adopted methods 2 and 3 can be determined either by performing quantity surveys on as-built drawings and/or by requesting them from contractors. Considering the realistic scenario in Vietnam, the area-based calculation method (GRC group) was adopted (e.g., Ha Tan Nghiem et al., 2020). This method provides specific and precise amounts of CDW together with comprehensive per square-meter data.

Table 3: Groups and methods to quantify CDW from demolition sites

S/N	Group of method	Method	Description
1	Site Visit – SV	Direct measurement	Calculate CDW stockpile by geometry
		Indirect measurement	Record number of transport trucks
2	Generation Rate Calculation – GRC	Per-capita multiplier	Amount of CDW ÷ Population Unit: kg/capita/year
		Financial value extrapolation	Amount of CDW ÷ Building value (USD) Unit: kg/USD
		Area-based calculation	Amount of CDW ÷ Gross Floor Area (m ²) Unit: kg/m ²
3	Lifetime Analysis – LA	Building LA	Amount of CDW ÷ Building age (year) Unit: kg/year
		Material LA	Amount of CDW ÷ Material age (year) Unit: kg/year
4	Classification System Accumulation – CSA		Based on GRC, considering effects of the classification system
5	Variables Modelling – VM		Model the CDW generation process by a function of influencing factors

For estimating the CDW generation, the gross floor area (GFA) of each building is determined on as-built drawings, and verification with information of direct measurement on site as a first step (Fig. 5). The volume of concrete (V_C) is determined by calculating the total volume of slabs, beams, and columns (V_{RC}), then subtracting the volume of reinforcing steel (V_S), while that of brick (V_B) is determined by calculating the total volume of brick walls. By studying the quantity survey spreadsheet of a demolition contractor, two values, V_{RC} and V_B , can be easily obtained, together with an estimated mass of reinforcing steel m_S . Volumes V_S and V_C are then calculated as follows:

$$V_S = \frac{m_S}{\rho_S} \quad [m^3] \quad (1)$$

In formula (1) above, the density of steel was taken as $\rho_S = 7850 \text{ kg} / \text{m}^3$.

$$V_C = V_{RC} - V_S \quad [m^3] \quad (2)$$

Converting volumes V_C and V_B into a mass by multiplying them by the bulk densities of concrete without reinforcing steel $\rho_C = 2200\text{kg} / \text{m}^3$ and of clay brick $\rho_B = 1500\text{kg} / \text{m}^3$, we have:

$$m_C = V_C \times \rho_C \quad (3)$$

$$m_B = V_B \times \rho_B \quad (4)$$

In case the demolition debris is available, by recording the mass of steel collected for scrap selling, and the number of transport trucks from demolition site, two values m_S , and total $V_C + V_B$ can be easily obtained. The generation rate of CC–CB is then calculated by the following formula:

$$G_{CC-CB} = \frac{m_C + m_B}{GFA} \quad [\text{kg} / \text{m}^2] \quad (5)$$

Employing the value of estimated mass m_S of reinforcing steel, generation rate of steel can be determined as follows:

$$G_S = \frac{m_S}{GFA} \quad [\text{kg} / \text{m}^2] \quad (6)$$

The generation rate of main categories of CDW from a demolition site was calculated as:

$$G_{CDW}^{demolition} = G_{CC-CB} + G_S \quad [\text{kg} / \text{m}^2] \quad (7)$$

For new buildings, since complete sets of construction drawings can be more easily obtained, a detailed quantity survey can be carried out to determine the mass of concrete (without reinforcing steel) m_C , brick m_B , and reinforcing steel m_S . By measuring the GFA on floor plans, the expected CDW generated from these new buildings can be determined by the following formula:

$$G_{CDW}^{construction} = \frac{m_C + m_B + m_S}{GFA} \quad [\text{kg} / \text{m}^2] \quad (8)$$



Figure 5: Photos of on-site survey

2.3. Basic Information Survey of CDW Landfills

In order to collect basic information of CDW landfills, two methods of survey were employed: 1) Site visits to collect on-site information of landfills and 2) Interviews: Semi-structured interviews will be conducted with relevant people, including the site manager (if available), site workers, and people in surrounding area to collect data on operations and current status. Moreover, as the method of site visits, two steps were conducted to collect the information efficiently:

- Step 1: Preliminary survey (1–2 days)

A team of experts conducts a brief surveillance of survey areas. This step is crucial as it would identify specific locations of the main investigation. The list of known CDW landfills is obtained from the Da Nang EPA. For locations with operating companies, it is necessary to make an official contact and ask for permission to take photos. This step was conducted one month prior to the official visit.

- Step 2: Site visit (1 day for illegal dumping sites, other locations may depend on the appointment)

Visit all locations specified in the previous step and fill in the basic information form (e.g., Nguyen H.G. et al., 2021). During both steps 1 and 2, the method of interview was employed with local people and with people working on site. Unlike a structured interview which has a rigorous set of questions that does not allow researchers to divert, a semi-structured interview is open with flexible questions. This style of interview enables researchers to avoid suspicion because topics related to waste (in general) and to CDW (in particular) are rather sensitive. Besides, representatives of Da Nang DONRE accompanied the SATREPS team for all site visits to assist and authorize the survey works

3. Results from Data Collection and Interviews to Government Agencies in Da Nang

3.1. Solid Waste Management Master Plan of Da Nang City

According to solid Waste management master plan of Da Nang City (Decision No. 9019/2016//QD-UBND), a new treatment complex with an area of 100 ha will be placed in Hoa Nhon, Hoa Vang district for the period 2021 - 2030. Technology applied in the treatment complex includes a sanitary landfill of 4 million tons, a sanitary landfill with landfill gas recovery of more than 1 million tons of degradable waste, an incinerator with a capacity of 230 thousand tons per year, a safety landfill for about 220 thousand tons of hazardous waste and a composting plant with 600 thousand tons per year capacity.

According to Decision 1577/2019/QD-UBND, waste will be classified into four groups: recyclable, bulky, hazardous, and others. Waste separation at source have been conducted in some districts and will be entirely implemented before 2025. From 2021 - 2025, the collection infrastructure system will be improved, and four transfer stations in Hai Chau, Son Tra, Ngu Hanh Son, Cam Le will be constructed with a capacity of 200 – 500 tons per day. The amount of construction and demolition waste generation in 2030 is approximately 2700 tons per day, and the amount will be landfill is estimated at about 543 tons per day. Therefore, in 2020 – 2030, Da Nang City plans a total area of 19.2 ha for CDW landfilling, including six operating open dumped landfills and nine planning ones. Legislation for CDW collection, recycling and treatment will be developed to improve the current situation of CDW management in the city.

3.2. Current Status of Solid Waste Management

Statistics of current solid waste generation and its projection from interviews are displayed in Fig. 6. Being a central urban district, Hai Chau District has the highest generation of solid waste, while Hoa Vang – being a rural one – has the lowest generation. Through interviews, it was revealed that most districts are experiencing a reduction in the rate of urbanization and development due to the effects of the COVID-19 pandemic in the year 2020. However, it is obvious that this effect is temporary, and all districts agreed on the overall trend of a steep rise in

the projection of the future amount of solid waste in the next decade. Data in 2020 is also the most complete as the average daily generation of solid waste (MSW) of every district is provided by the Da Nang EPA. Contacted Districts did not have any information on the ratio of CDW to municipal solid waste. A general estimation of 6–7% was given by the authorities of Thanh Khe District.

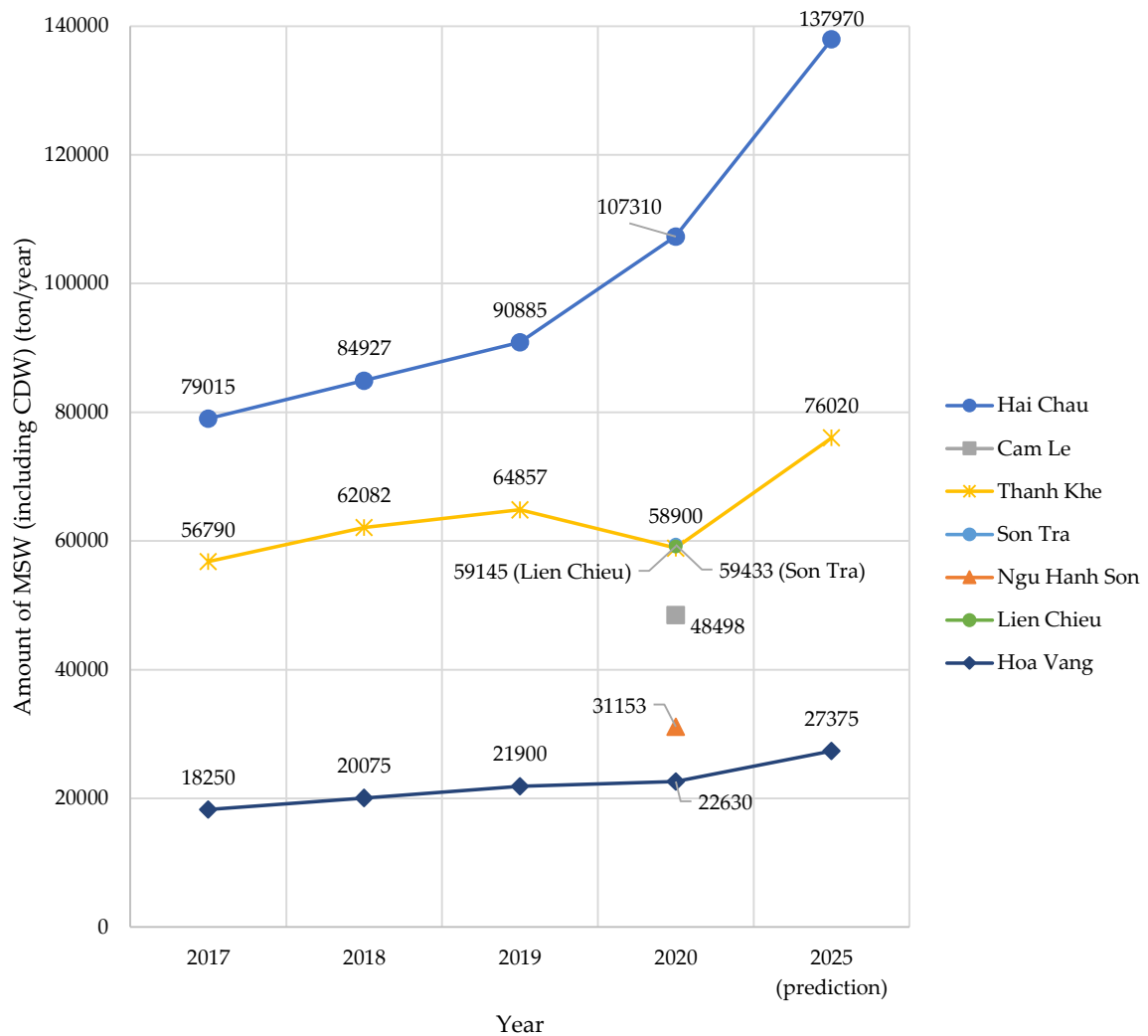


Figure 6: Generated solid waste from some districts of Da Nang City in recent years (Source: Data from interviews to district agencies)

3.3. Implementation of CDW Policies and Regulations

Figure 7 displays the results of self-assessment of 14 interviewees of their awareness and execution of Circular No. 08/2017/TT-BXD on Regulation on Construction Solid Waste Management. Only 1/14 interviewees assessed himself as having high level of compliance to the Circular, making up 7% of the total pool of responses. As answers are ranked on four levels, it is possible to adopt fuzzy logic theory to convert linguistic variables to numerical values for data analysis (Zimmermann, 2001). Taking the average of all numerical values yields the final number of 0.57. Referring to the scale of conversion shown in Fig. 8, the overall level of compliance/implementation of Circular No. 08 in Da Nang can be considered as Medium-Low.

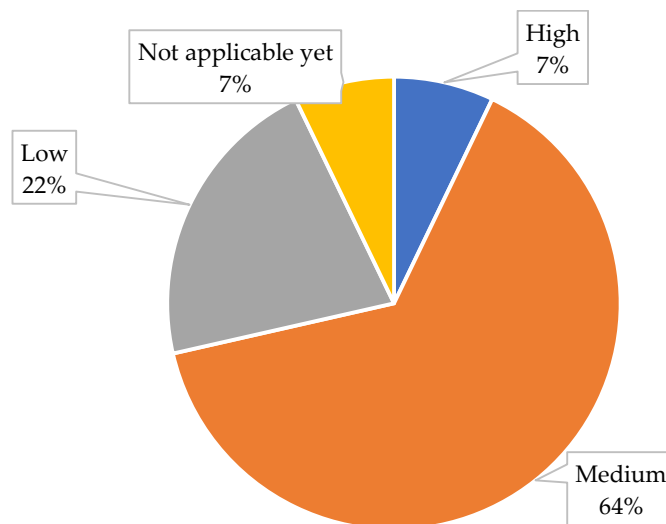


Figure 7: Level of compliance/implementation of Circular No. 08/2017/TT-BXD

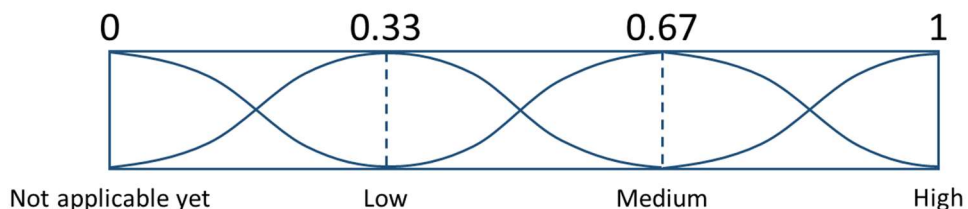


Figure 8: Linguistic variables of level of compliance/implementation of Circular No. 08/2017/TT-BXD

3.4. Treatment and Recycling of CDW

The interview form gave all interviewees 5 choices of treatment and recycling methods (if available) for CDW. Several methods can be selected simultaneously. Answers to this question are displayed in Fig. 9. It is obvious that the most popular way of treating CDW in Da Nang is currently “Reuse for leveling” with 13/14 interviewees (93%) confirming the adoption of this method in their local regions. It is also obvious that the recycling of CDW is an unknown concept to people in Da Nang, as none of the interviewees selected this option (0%). Several other remarks are as follows:

- As of current status, Da Nang only has one planned landfill that is in operation at Khanh Son, Lien Chieu District. The location and photo of this site are presented in Fig. 10. It is further clarified by Da Nang Environmental Protection Agency that Khanh Son Landfill is operated by Da Nang Urban Environment Company (URENCO), and its main function is to treat MSW by backfilling. CDW is actually not managed by URENCO (in other words, it is not their responsibility to accept CDW), and the presence of CDW in small amounts in Khanh Son Landfill is due to illegal dumping.
- Illegal dumping is reported by 6/14 correspondents (making up a rate of 43%). These correspondents are from four districts, namely: Hai Chau, Son Tra, Ngu Hanh Son, and Hoa Vang. It is remarked by interviewees that “illegal dumping sites are scattered, the amount per site is also not large – usually several piles of CDW”.
- It is reported by officers of Hoa Vang District (the area of which makes up 2/3 of the whole Da Nang City) that CDW generated in the district is very limited because there is no major construction/demolition work. All CDW generated is employed for backfilling.

Among 14 collected interview forms, it is also noted that none of the authorities was able to provide information about contractors taking on demolition works or transporting CDW. The reason is that contractors register their business license with the Department of Planning and Investment, during which process they declare their fields of operation. After that, they can start operating according to their registered information. Local authorities and even other departments (such as DOC, DONRE, and so on) do not manage such information. They will only investigate whether a certain contractor is violating its declared fields of operation when there are incidents. This situation is the same in all surveyed cities and provinces, and it shows a limit in the current

management system that must be rectified if proper treatment of CDW is to be achieved. Local authorities and relevant departments in the field of construction – environmental management must possess information on demolition contractors, who are among the direct stakeholders in handling CDW.

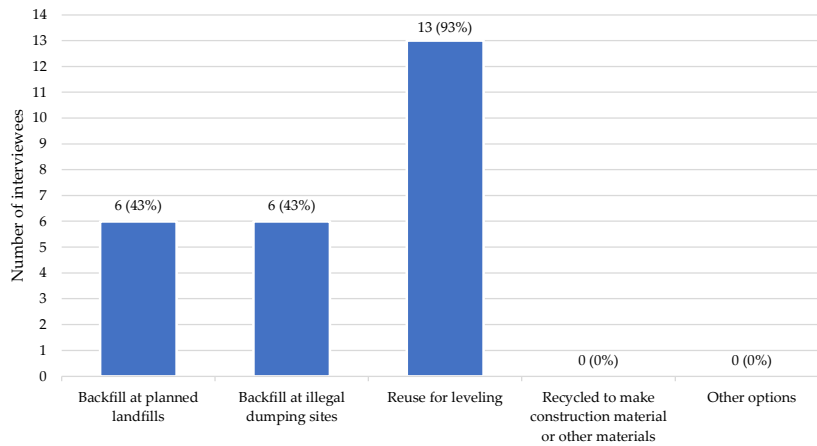


Figure 9: Methods of treatment and recycling of CDW



Figure 10: (a) Location of Khanh Son Landfill ($16^{\circ} 2' 32.2404''$ N, $108^{\circ} 8' 31.4952''$ E) (map data © 2021 Google) and (b) Photo of Khanh Son Landfill

3.5. Capability of Supplying Basic Construction Materials in the Local Region

The interviewed authorities do not have any statistics of the demand for basic construction materials in their respective regions. This response is predictable because the statistics of production and consumption of construction materials are not commonly gathered by local authorities. Information obtained in this question is from the personal experience of a number of interviewees (either they personally knew some material manufacturers or they had just built their houses recently). A number of notable points are summarized as follows:

- Cement in Da Nang can be supplied locally by Hoa Khuong Cement Factory (Hoa Vang District), but the majority of the market is supplied by manufacturers in Quang Binh Province (Song Gianh Factory), Hue City (Dong Lam Factory), Quang Nam Province (Thanh Long Factory, Xuan Thanh Factory), or as far away as Thanh Hoa Province (Long Son Factory). Relative locations of these factories are presented in Fig. 11. The average price is comparable to those of the two other large cities in the North (Hanoi) and in the South (Ho Chi Minh City), which is from 1,460,000 VND/ton to 1,600,000 VND/ton (packaged type).
- Sand is supplied from the nearby Quang Nam Province with the unit price of 400,000 VND/m³, which is rather high. The reason for this high price is unclear because Quang Nam Province is just next to Da Nang, the transportation fee must be reasonable. Another source of sand supply is from a Taiwanese factory which filters and washes sand from the ocean. The unit price from this source is even higher: up to 1,000,000 VND/m³. Compared to the unit price of sand in Hanoi and in Ho Chi Minh City (200,000-300,000 VND/m³), the price of this resource in Da Nang is unreasonably high. Note that in the Construction Materials Price Norm (Danang DOC, 2021) issued by Da Nang DOC, the unit price of sand is only 220,000 VND/m³, which is more reasonable. The reported numbers were obtained from the personal experience of interviewees.
- Gravel is self-sufficient in Da Nang because the city itself possesses a vast source of limestone in the mountain range. Gravel produced from Da Nang is also exported to other provinces. Depending on the type of gravel, the unit price can be from 140,000 VND/m³ up to 285,000 VND/m³.
- Brick is also sufficiently self-supplied in Da Nang, the average price of clay brick is 1,400 VND/unit, and that of unfired brick is 1,600 VND/unit.

- There is a good distribution of ready-mix concrete plants throughout the city. The Construction Materials Price Norm issued by Da Nang DOC (2021) listed 8 such plants and reported an average price of 1,050,000 VND/m³ for M300 concrete.

From the information obtained, it can clearly be seen that all construction works in Da Nang are currently employing natural materials; artificial/recycled materials are new concepts. This situation is virtually true in Vietnam in general. It can also be predicted that in the near future Da Nang would have no urgent need of artificial gravel, but the unreasonably high price of natural sand is something that can be exploited.

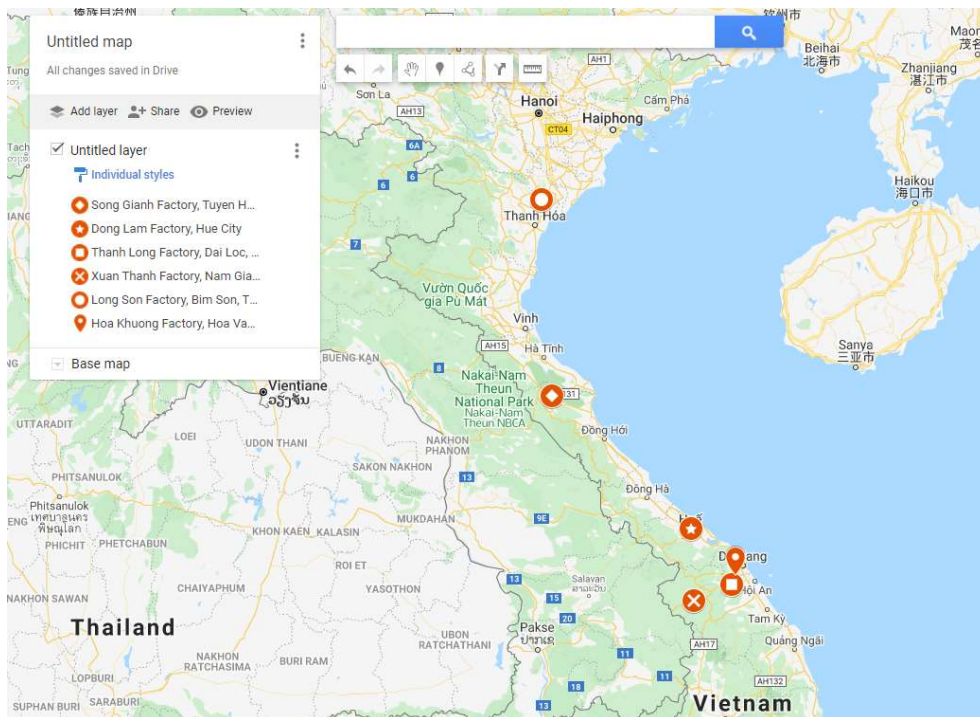


Figure 11: Cement suppliers in Da Nang (modified after map data © 2021 Google)

3.6. Orientations for Promoting Recycling Activities of CDW

A set of four options were suggested to interviewees regarding possible actions to promote recycling activities of CDW, the details are as follows:

- OPT1: Nothing
- OPT2: Supporting policies, call for investment, loan, prioritized land rental

- OPT3: Propaganda to raise the awareness of people and businesses about sorting, collecting, and recycling CDW
- OPT4: Promotion, price subsidy, product sales, tax incentives.

The result is shown in Fig. 12. It is clearly seen that many interviewees admitted ignorance about recycling CDW. The Natural Resources and Environment Bureau (NREB) of Ngu Hanh Son District declared that such policies would only be appropriate in about 5–10 years. The only rural district (Hoa Vang) has the same reason for selecting “Nothing” as their options: current CDW is fully reused for leveling, hence there is no need for CDW recycling in the seeable future.

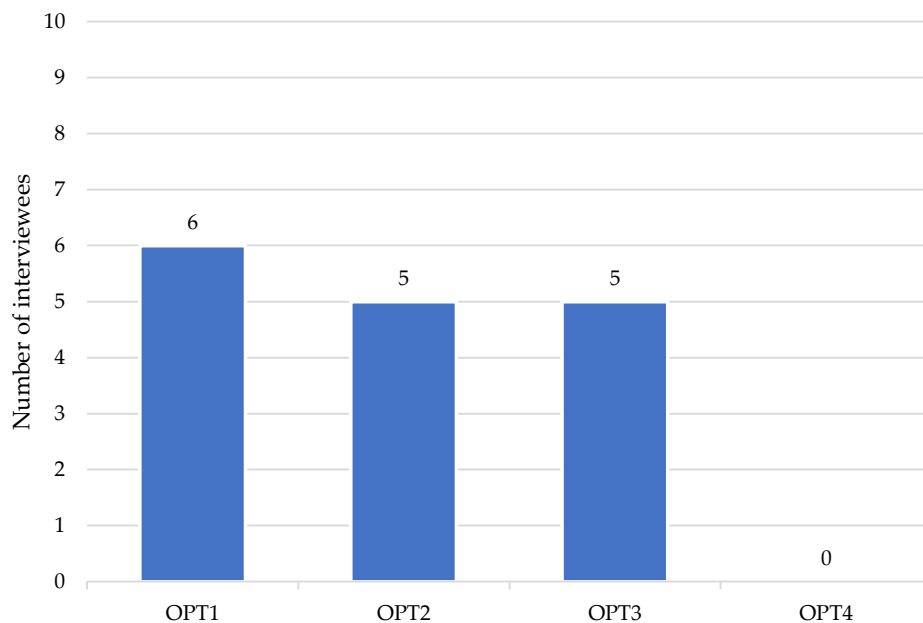


Figure 12: Selection of current policies to promote recycling activities of CDW

3.7. Obstacles When Adopting Recycled Materials from CDW

All interviewees are provided with a list of five possible obstacles, both subjective and objective, that they would potentially face when adopting recycled materials from CDW. Each obstacle was assessed on five levels of difficulty, from very low to very high. These linguistic variables were then processed by fuzzy logic with a scale as displayed in Fig. 13. The obstacles ranked from 1 (highest numerical value; the hardest obstacle to overcome) to 5 (lowest numerical value; the easiest obstacle to overcome) are shown in Table 4. In case there is more than one obstacle with the same score, they will share a common rank number in the table.

From the answers of 14 interviewees, the top two hardest obstacles are:

- No production line of recycled materials from CDW; and
- Lack of standards, regulations... on recycled materials.

It is clearly seen that these two obstacles are objective, meaning that they are related to policy makers (for encouraging and facilitating the production of recycled materials), and researchers (for establishing standards and regulations, thus allowing recycled materials to be employed in construction projects). Concerns about recycled materials themselves (their quality and price) only come in third and fourth place, which is quite a positive response since there is no discrimination towards recycled materials.

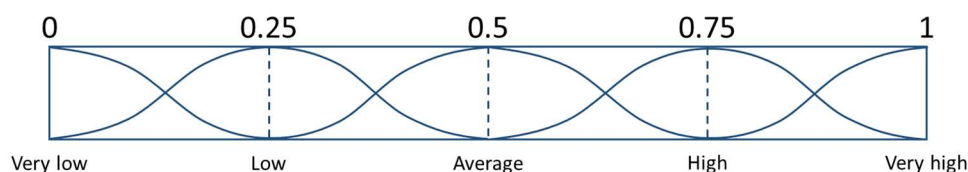


Figure 13: Linguistic variables of level of difficulty of obstacles when employing recycled materials from CDW

Table 4: Ranking of obstacles when employing recycled materials from CDW

S/N	Obstacle	Opinion of Authorities in Da Nang	
		Numerical value	Ranking
1	Higher price than natural materials	0.63	4
2	Concerns about quality of recycled materials	0.70	3
3	No production line of recycled materials from CDW	0.79	1
4	Low awareness of owners and contractors	0.52	5
5	Lack of standards, regulations... on recycled materials	0.75	2

3.8. Level of Readiness to Apply Recycled Products from CDW in the Local Region

One of the most important factors to consider about recycled products is whether people are ready to adopt them. The interviewees were asked to assess whether the stakeholders in Da Nang (owners, contractors, material suppliers, etc.) are ready for the introduction of recycled

products from CDW. The answers were ranked in four levels: High – Average – Low – Not yet Applicable, and statistics of responses are summarized in Fig. 14. The majority of interviewees selected the most neutral answer (Average – 9/14, which is 64.29%). According to this result, the level of readiness is average – which means Da Nang stakeholders would be indifferent towards this new type of construction materials.

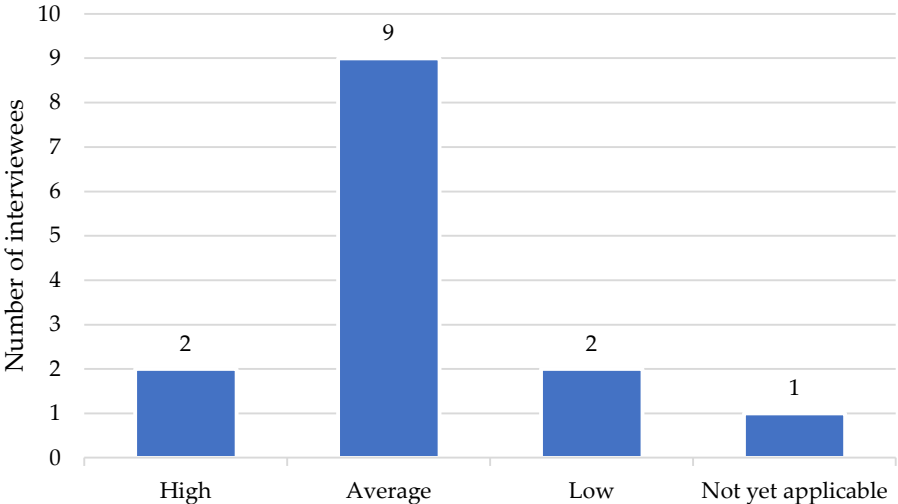


Figure 14: Level of readiness to apply recycled products from CDW in Da Nang

3.9. Summary of Difficulties in CDW Management

The list of difficulties in CDW management is summarized from 14 interview forms, and is sorted from highest to lowest level of consensus as follows:

- There is no professional company in charge of gathering CDW, as well as no proper planning for CDW landfills (12/14, or 86%);
- Rapid rate of urbanization, together with the fact that construction and demolition projects are scattered, making it hard to gather CDW (6/14, or 43%);
- Low awareness of stakeholders in the importance of treating and recycling CDW (3/14, or 21%);
- Lack of official guidance in transporting and treating of CDW, and the official quotation of these activities (2/14, or 14%).

4. CDW Generation in Da Nang

4.1. Summary of New Construction Permissions

Upon contact, the statistics of new construction permissions in the entirety of Da Nang City in the three most recent years (2018-2019-2020) are provided by Danang DOC and district agencies via the questionnaire survey. Table 5 presents the raw data of the supplied statistics. Among the seven surveyed districts, Cam Le District, Thanh Khe District, and Lien Chieu District could provide only approximate values of each year or an approximate average value of three years. The data, however, is still sufficient for analysis.

Table 5: Summary of new construction permissions in Da Nang in three recent years (Source: Collected data from Da Nang DOC and district agencies)

S/N	District	Year		
		2018	2019	2020
1	Hai Chau	91	116	105
2	Cam Le	4300	4600	2950
3	Thanh Khe	2000	2000	2000
4	Son Tra	1884	2049	1300
5	Ngu Hanh Son	2915	3007	1788
6	Lien Chieu	2500	2500	3000
7	Hoa Vang	963	954	692
Total		14653	15226	11835

4.2. Projection of CDW Generation from Statistics of New Construction Permission

Figure 15 summarizes the rising trend of total number of construction permissions issued in the latest three years 2018, 2019, and 2020. There is an average of $N = 13,905$ new buildings being permitted per year. Calculated average GFA of new buildings from the construction permission data in Son Tra District and Ngu Hanh Son District is also shown in the figure. The new buildings are on a 2- to 5-storey scale and are built of reinforced concrete. The average GFA values vary from 324 to 498 m², with the average value of $GFA_{ave} = 396$ m².

Based on collected data from previous studies in the Northern provinces (detailed methodology is presented in Section 3.2 of this report), the average generation rate of CDW is estimated as (Hoang N.T. et. al., 2020):

$$G_{CDW} = 0,61 \quad [\text{ton/m}^2]$$

Note that this generation rate was determined by small demolition sites with GFA of 1000 to 8000 m² in Hanoi. The scale of these buildings is rather similar to those in the detailed reports of Son Tra District and Ngu Hanh Son District.

In conclusion, the potential CDW generated from new buildings in Da Nang annually is estimated as:

$$G_{CDW}^{new} = N \times GFA_{ave} \times m_{CDW} = 13905 \times 395.5 \times 0.61 = 3,354,651 \quad [\text{tons}]$$

This number means that with the current rate of construction (approximately 13,905 new buildings of average GFA 396 m² per year), when all of these buildings are demolished in the future (20–30 years from now), they will generate nearly 3.4 million tons of CDW in the environment. That is a huge amount, and it must also be noted that this rate of construction is predicted to increase even further as Da Nang is a vibrant, developing city. When dividing this amount of CDW by about 10 years, the amount of CDW generated by Da Nang city will be about 919 tons/day. This value is only about 1/3 times that of Hanoi and Ho Chi Minh City (about 3000 tons/day), but nearly twice as large as the amount generated by Hai Phong city (about 519 tons/day) (Tuan Nguyen et al., 2018).

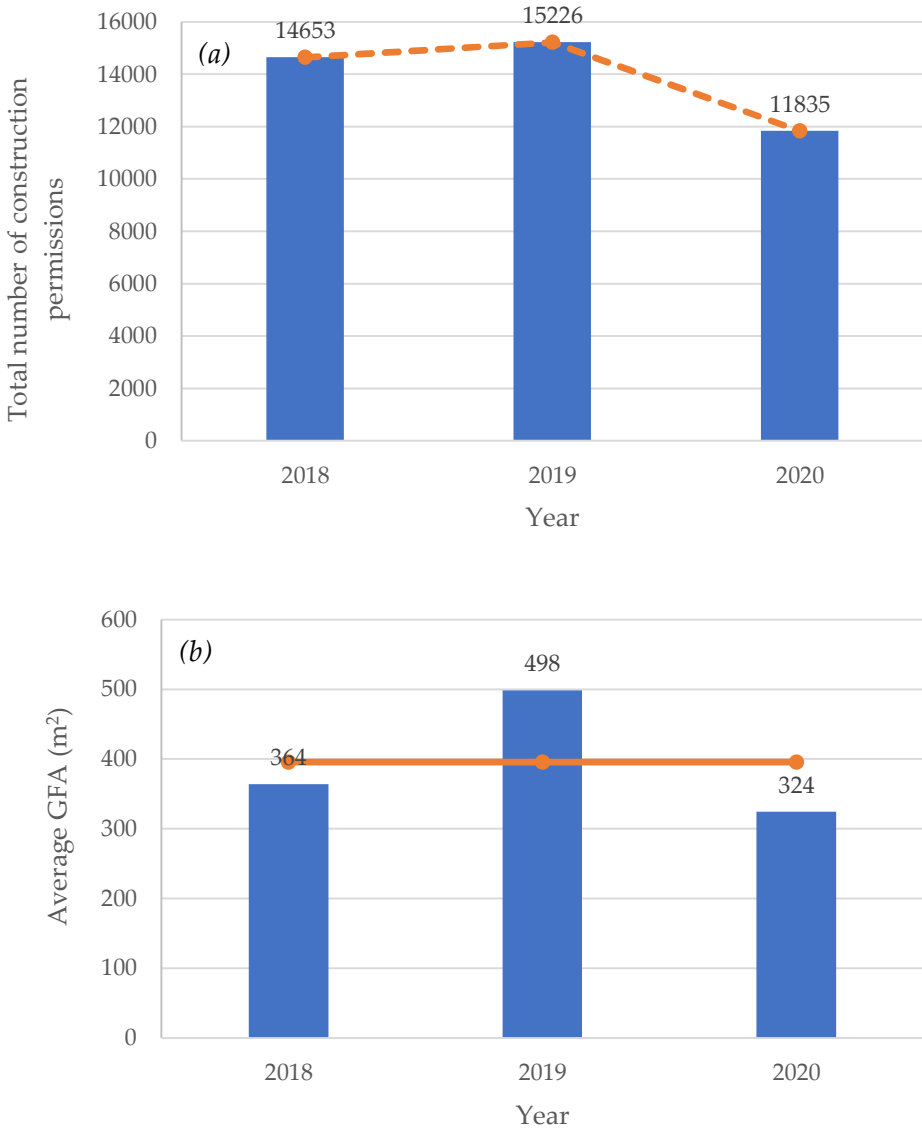


Figure 15: (a) New building construction permission in Da Nang City and (b) Average GFA of two districts in Da Nang for the latest three years

5. CDW Landfills in Da Nang

5.1. Planned CDW landfills

Upon initial contact, Da Nang DONRE and DOC provided a number of official documents and reports on planned and existing locations of CDW landfills in the city. According to the report of the solid waste treatment planning of Da Nang city to 2030, vision to 2050 (Da Nang CPI, 2016). In line with the city's economic development and rapid urbanization, and to facilitate the collection, transportation and dissemination of information on CDW supply and demand, CDW dumps are planned according to the districts are shown in Table 6 and the preliminary CDW collection and dumping sites are shown in Fig. 16.

According to Decision No. 9019/2016/QĐ-UBND on 28 December 2016 of Da Nang People's Committee, locations of CDW landfills are quite well-planned; they are evenly spaced throughout the city, with smaller gathering points at the city center and larger points to the outskirts. Unfortunately, since 2016, none of these planned CDW landfills has gone into official operation except for one at Hoa Minh CDW Landfill at Lien Chieu District. Another location among the list of 14 is reported to have the presence of CDW at Thuan Phuoc Bridge area, but currently all CDW dumped here is illegally. These two locations would be investigated in the main survey, but all other locations were replaced following the actual situation of the city. This fact confirms the necessity of preliminary survey.

Table 6: List of planned CDW landfills in Da Nang according to Decision No. 9019/2016/QĐ-UBND (Source: Da Nang CPI, 2016)

S/N	Location	Expected Scale (ha)			Note
		2020	2030	2050	
Total area		9.1	19.2	39.9	
I	City Center Area				
1	CDW Landfill at the North of Thuan Phuoc Bridge	0.05	1.0	2.0	Location according to General Plan (existing project by DOC)
2	CDW Landfill at Cam Le District – Le Dai Hanh Road	0.05	0.05	0.05	Location according to General Plan (existing project by DOC)
3	Hoa Cuong CDW Landfill, Hai Chau District	0.1	1	1.5	Location according to General Plan (existing project by DOC)
4	Hoa Minh CDW Landfill, Lien Chieu District	0.1	0.1	0.1	Location according to General Plan (existing project by DOC)
II	Suburban Districts				
1	CDW Landfill on Pham Van Xao Road, Son Tra District	0.15	0.15	0.15	Location according to General Plan (existing project by DOC)
2	CDW Landfill at Son Tra District (2)	1	2	3.5	Proposed
3	CDW Landfill at Lien Chieu District, North of Hoa Khanh Industrial Zone	1	2	4	Proposed
4	CDW Landfill at Ngu Hanh Son District (1)	1.5	3	3.5	Proposed
5	CDW Landfill at Ngu Hanh Son District (2)	1.5	3	3.5	Proposed
III	Hoa Vang District				
1	Hoa Nhon CDW Landfill	2.3	3	5	Location according to General Plan (existing project by DOC)
2	Hoa Nhon CDW Landfill	0.58	1	1	Location according to General Plan (existing project by DOC)
3	Hoa Phong CDW Landfill	0.15	1	1	Location according to General Plan (existing project by DOC)
4	Hoa Khuong CDW Landfill	2	4	5	Proposed
5	Hoa Son CDW Landfill	2	4	5	Proposed

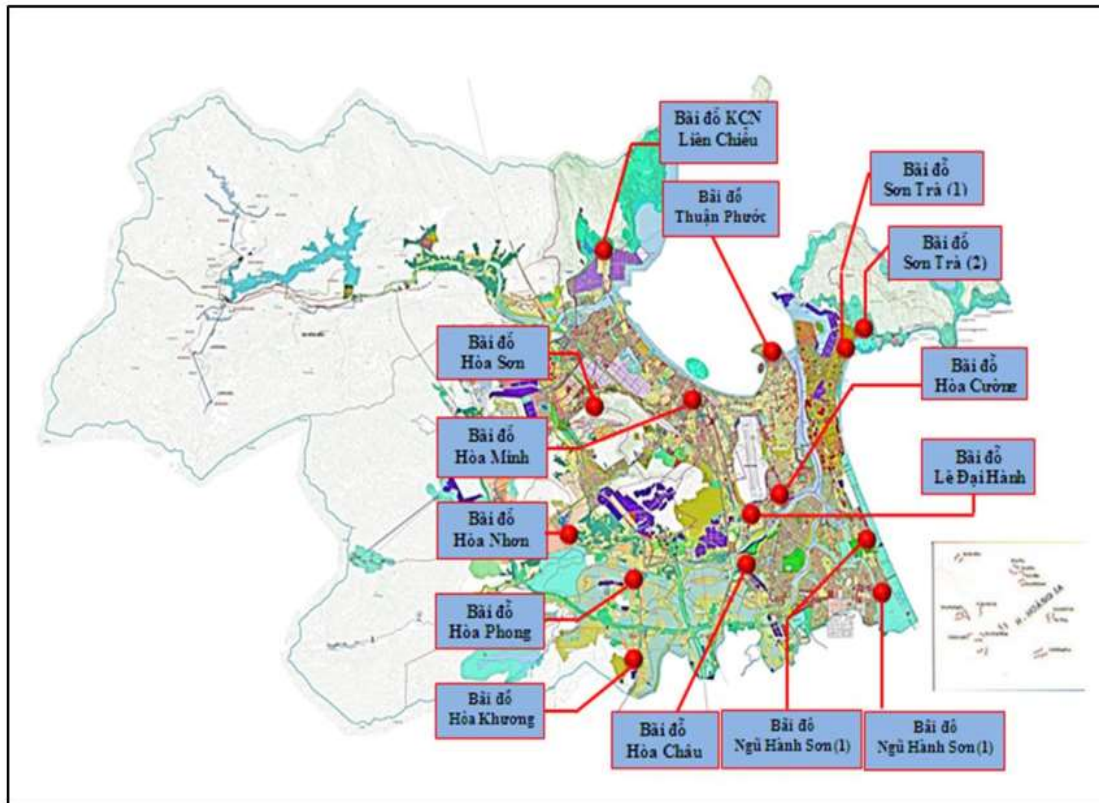


Figure 16: Map of planned CDW landfills in Da Nang according to Decision No. 9019/2016/QĐ-UBND (Source: Da Nang CPI, 2016)

5.2. Basic Information Survey of CDW Landfills in Da Nang

With the official aid from Da Nang EPA, sites with the presence of dumped CDW (both official and illegal) were investigated. A map of surveyed locations is shown in Fig. 17, which also includes the investigation route. Numbers are assigned as follows:

1. Illegal CDW dumping site at Hoa Thuan Dong Ward, Hai Chau District;
2. Illegal CDW dumping site under Thuan Phuoc Bridge, Hai Chau District;
3. CDW landfill at Son Tra District, operated by Phung Huy company;
4. Hoa Minh CDW landfill at Lien Chieu District;
5. Illegal CDW dumping site along To Hieu Road, Lien Chieu District;
6. Illegal CDW dumping site along Nguyen Sinh Sac Road, Lien Chieu District.

Detailed earth views and photos of current status of six investigated locations are displayed in Figs. 17 to 24, and survey sheets are presented in Tables 7 to 12.

According to the report of Da Nang Environmental Protection Agency in February 2021 (Danang EPA, 2021) and throughout the city there are a number of other illegal CDW dumping sites which possess the same characteristics as the four surveyed locations above (being vacant land under bridges or in urban development areas). The list of locations according to this report is as follows:

- Lien Chieu District: Thanh Vinh Road, Hoa Khanh Bac Ward (approximate area of 2,000 m²).
- Thanh Khe District: Mainly concentrated along Nguyen Tat Thanh Road (summarized in Table 13).
- Cam Le District: Along Tran Nam Trung Road, no specific locations (already cleaned up before Tet of the Year of the Ox 2021).
- Hai Chau District: Under Tuyen Son Bridge (between Asia Park and the back of Lotte Mart).
- Hoa Vang District: Hoa Chau residential area (Pham Hung Road); a surveillance camera was installed, illegal dumping cases were fined, so the status of illegal dumping has been improved.



Figure 17: Investigation route of CDW landfills in Da Nang (map Source: Da Nang City Portal, 2021)



Figure 18: (a) Aerial view of illegal CDW landfill at Hoa Thuan Dong Ward, Hai Chau District (map data © 2021 Google) and (b) Photo of Site

Table 7: Basic information of illegal CDW dumping site at Hoa Thuan Dong Ward, Hai Chau District

Item no.	Content	Illegal CDW dumping site at Hoa Thuan Dong Ward, Hai Chau District
1	GPS location	16° 3' 7.1856" N; 108° 13' 22.872" E
2	Estimated area (m ²)	43,350 m ²
3	Landowner	Unknown
4	Operation company/institute	Unknown
5	Number of workers	0
6	Intake per day/week/month	Unknown
7	Operation years	1-2
8	Estimated life years	Not long (1-2 years at most)
9	Photo	(See Fig. 18)
10	Groundwater level	Unknown
11	Acceptable waste	MSW, CDW
12	Previous land use	Urban land for development
13	Height of dumped waste	0
14	Surrounding environment	Buildings
15	Accessibility	Good (in the city center)
16	Workability	Poor (low amount of CDW in general)
17	Weather	Wet season: May - October, heavy rain Dry season: November - April, light rain
18	Remarks	The site looks like a planned urban development project with established infrastructure (roads, water and electrical lines). It is currently being exploited to illegally dump CDW due to the lack of guards and fences. This situation will not likely last for so much longer because the area is in a favorable location and construction works should take place soon.



Figure 19: (a) Earth view of illegal CDW landfill under Thuan Phuoc Bridge, Hai Chau District (map data © 2021 Google) and (b) Photo of site

Table 8: Basic information on illegal CDW landfill under Thuan Phuoc Bridge, Hai Chau District

Item no.	Content	Illegal CDW dumping site under Thuan Phuoc Bridge, Hai Chau District
1	GPS location	16° 5' 36.7224" N; 108° 13' 2.082" E
2	Estimated area (m ²)	100-200 m ²
3	Landowner	Public land
4	Operation company/institute	None
5	Number of workers	0
6	Intake per day/week/month	Unknown
7	Operation years	3-4 (cleaned up from time to time by URENCO)
8	Estimated life years	Unknown
9	Photo	(See Fig. 19)
10	Groundwater level	Unknown
11	Acceptable waste	MSW, CDW
12	Previous land use	Reclaimed land from the ocean when building Thuan Phuoc Bridge
13	Height of dumped waste	0.5-1 m
14	Surrounding environment	Buildings, Han River
15	Accessibility	Good (in the city center)
16	Workability	Average
17	Weather	Wet season: May - October, heavy rain Dry season: November - April, light rain
18	Remarks	Being under a large bridge and having a not-so-large area, the site is typical for an illegal dumping location. Individual dump piles can be clearly observed, which are most likely discharged by small trucks (10-ton or 15-ton types).

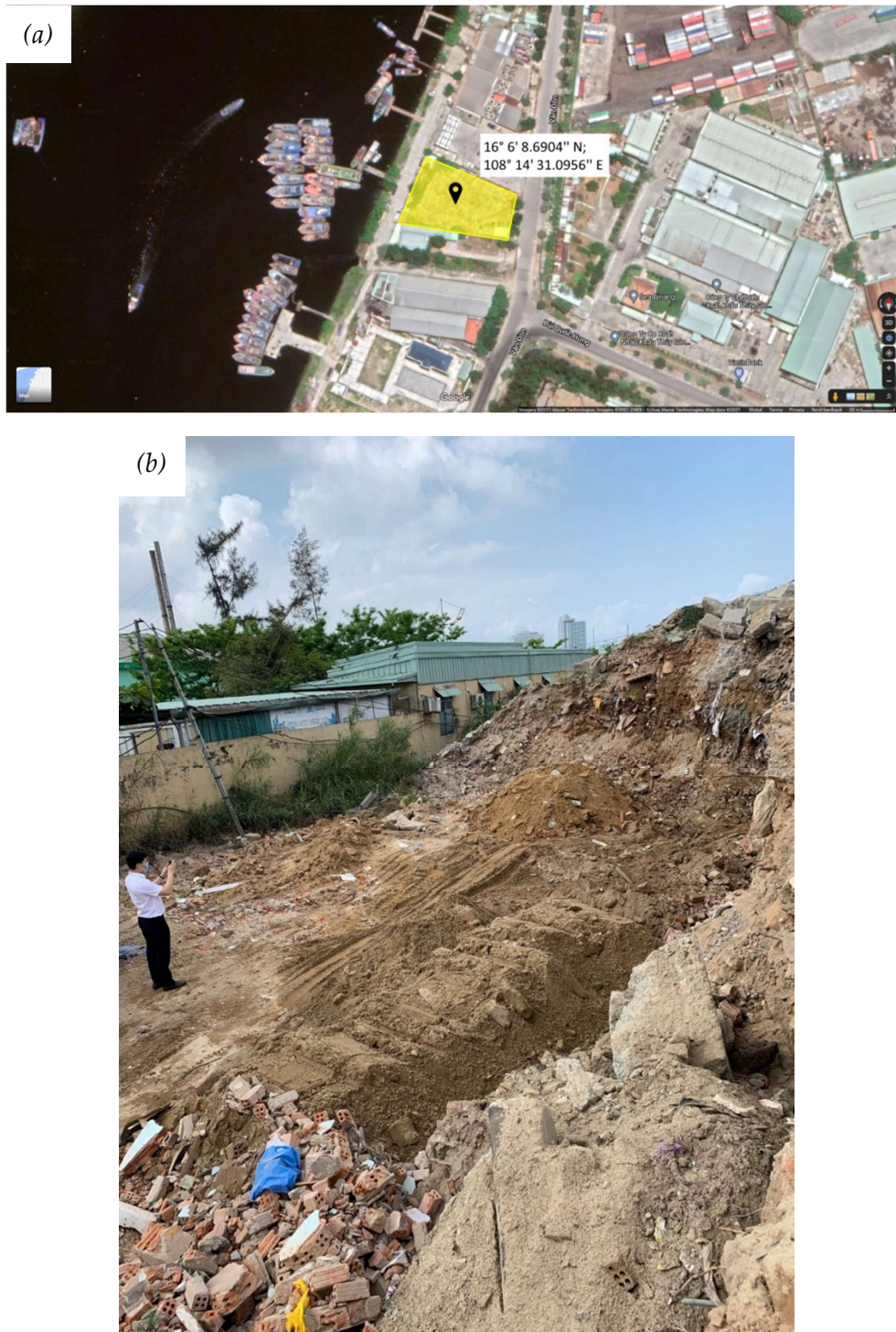


Figure 20: (a) Earth view of CDW landfill at Son Tra District, operated by Phung Huy company (map data © 2021 Google) and (b) Photo of site

Table 9: Basic information of CDW landfill at Son Tra District, operated by Phung Huy company

Item no.	Content	CDW landfill at Son Tra District, operated by Phung Huy company
1	GPS location	16° 6' 8.6904" N; 108° 14' 31.0956" E
2	Estimated area (m ²)	2,510 m ²
3	Landowner	Public land
4	Operation company/institute	Phung Huy One-Member Commerce and Service Company Limited
5	Number of workers	2-3
6	Intake per day/week/month	<10 trucks per day (15-ton type)
7	Operation years	4
8	Estimated life years	5-10
9	Photo	(See Fig. 20)
10	Groundwater level	Unknown
11	Acceptable waste	CDW
12	Previous land use	Vacant land
13	Height of dumped waste	3-5 m
14	Surrounding environment	Factories, Han River
15	Accessibility	Good (15-minute drive from city center)
16	Workability	Excellent (high amount of CDW, excavator available)
17	Weather	Wet season: May - October, heavy rain Dry season: November - April, light rain
18	Remarks	<ul style="list-style-type: none"> • Da Nang People's Committee approved this site as a temporary gathering point of CDW in Decision No. 4586/QD-UNND on 11 July 2016. Then, the People's Committee of Son Tra District selected Phung Huy company as the operator of this site. • Each truck is charged 20,000-30,000 VND (depending on type) when disposing CDW on the site. • CDW can be sold to construction sites for backfilling at the rate of 50,000 VND/m³, including fees for backhoe and transportation truck. • Otherwise, when the site is almost full, some can be transported to Khanh Son landfill.

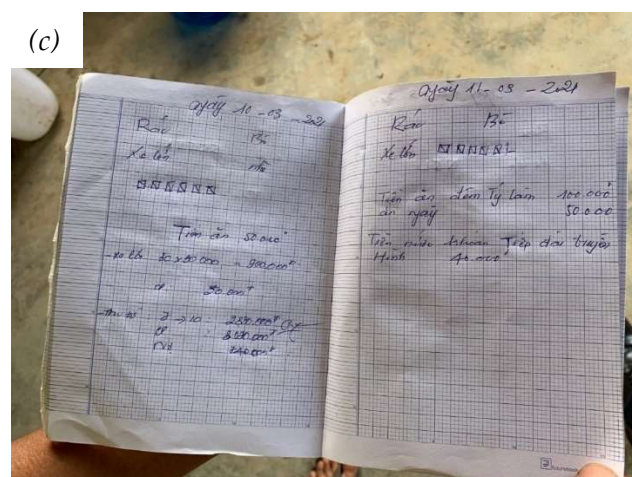


Figure 21: (a) Earth view of Hoa Minh CDW landfill along Hoang Thi Loan Road, Lien Chieu (map data © 2021 Google), (b) Photo of site, and (c) District daily log of CDW dump trucks

Table 10: Basic information of Hoa Minh CDW landfill at Lien Chieu District

Item no.	Content	Hoa Minh CDW landfill at Lien Chieu District
1	GPS location	16° 4' 21.6696" N; 108° 9' 39.0924" E
2	Estimated area (m ²)	6,130 m ² (actual area for CDW dumping around 2,000 m ²)
3	Landowner	Public land
4	Operation company/institute	Tam Phuc Kien One-Member Company Limited
5	Number of workers	5-6
6	Intake per day/week/month	20-30 trucks per day (15-ton type)
7	Operation years	3-4
8	Estimated life years	5-10
9	Photo	(See Fig. 21)
10	Groundwater level	Unknown
11	Acceptable waste	CDW
12	Previous land use	Vacant land
13	Height of dumped waste	3-4 m
14	Surrounding environment	Vacant land, urban area
15	Accessibility	Good (15-minute drive from city center)
16	Workability	Excellent (high amount of CDW, excavator available)
17	Weather	Wet season: May - October, heavy rain Dry season: November - April, light rain
18	Remarks	<ul style="list-style-type: none"> • Da Nang People's Committee approved this site to be an official CDW landfill in Decision No. 9019/QD-UNND on 28 December 2016. Currently, Tam Phuc Kien company is the operator of this site. • Each truck is charged 30,000 VND (15-ton type) when disposing CDW into the site. • CDW can be sold to construction sites for backfilling at the rate of 50,000 VND/m³, including fee for backhoe and transportation truck. • The guard makes a log of daily operation as shown in Fig. 21.



Figure 22: (a) Earth view of illegal CDW dumping site along To Hieu Road, Lien Chieu District (map data © 2021 Google) and (b) Photo of site

Table 11: Basic information on illegal CDW dumping site along To Hieu Road, Lien Chieu District

Item no.	Content	Illegal CDW dumping site along To Hieu Road, Lien Chieu District
1	GPS location	16° 4' 19.4376" N; 108° 9' 57.294" E
2	Estimated area (m²)	640 m ²
3	Landowner	Unknown
4	Operation company/institute	Unknown
5	Number of workers	0
6	Intake per day/week/month	Unknown
7	Operation years	Unknown
8	Estimated life years	Unknown
9	Photo	(See Fig. 22)
10	Groundwater level	Unknown
11	Acceptable waste	MSW, CDW
12	Previous land use	Urban land
13	Height of dumped waste	< 0.5 m
14	Surrounding environment	Urban area
15	Accessibility	Good (15-minute drive from the city center)
16	Workability	Poor (low amount of CDW)
17	Weather	Wet season: May - October, heavy rain Dry season: November - April, light rain
18	Remarks	The site looks like a temporary vacant lot in an urban area. Surrounding houses are already built, while the owner of this piece of land has not built.

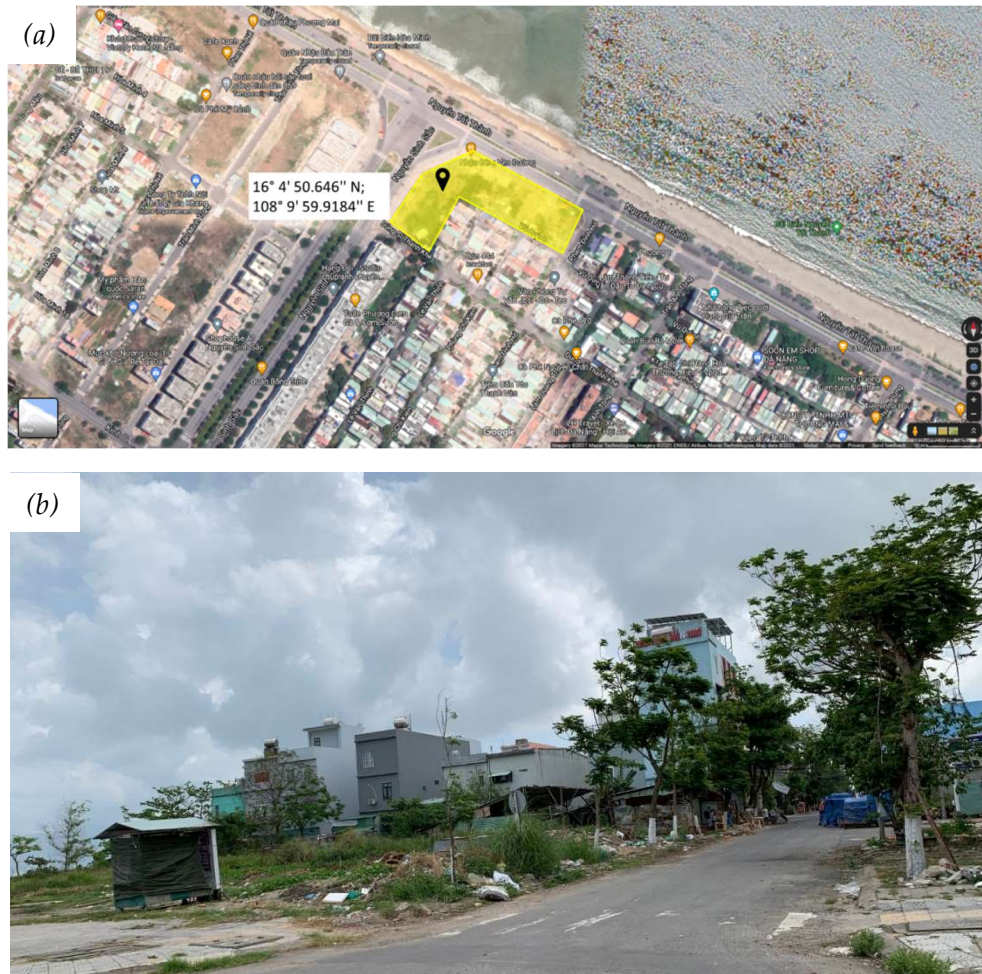


Figure 23: (a) Earth view of illegal CDW dumping site along Nguyen Sinh Sac Road, Lien Chieu District (map data © 2021 Google) and (b) Photo of site

Table 2: Basic information of illegal CDW dumping site along Nguyen Sinh Sac Road, Lien Chieu District

Item no.	Content	Illegal CDW dumping site along To Hieu Road, Lien Chieu District
1	GPS location	16° 4' 50.646" N; 108° 9' 59.9184" E
2	Estimated area (m ²)	9,260 m ²
3	Landowner	Unknown
4	Operation company/institute	Unknown
5	Number of workers	0
6	Intake per day/week/month	Unknown
7	Operation years	Unknown
8	Estimated life years	Unknown
9	Photo	(See Fig. 23)
10	Groundwater level	Unknown
11	Acceptable waste	MSW, CDW
12	Previous land use	Urban land
13	Height of dumped waste	< 0.5 m
14	Surrounding environment	Urban area
15	Accessibility	Good (15-minute drive from the city center)
16	Workability	Poor (small amount of CDW)
17	Weather	Wet season: May - October, heavy rain Dry season: November - April, light rain
18	Remarks	The site looks like a temporary vacant lot in an urban area. Surrounding houses are already built, while the owner of this piece of land has not built.

Table 13: Location of illegal CDW dumping at Thanh Khe District

S/N	Location	Approx. length (m)
I	VACANT LAND LOT	
THANH KHE TAY WARD		
1	Vacant land lot beside house No. 1877 (next to Hung Gia Tran restaurant)	10.2
2	Vacant land lot beside house No. 1755	10.2
3	Vacant land lot beside house No. 1747	15
4	Vacant land lot beside house No. 1685	5
5	Vacant land lot beside house No. 1647	5
6	Vacant land lot beside house No. 1643	5
7	Vacant land lot beside house No. 1591	15
8	Vacant land lot beside house No. 1463	10.2
THANH KHE DONG WARD		
1	Vacant land lot beside house No. 1435 (Be Xiu restaurant)	12.5
2	Vacant land lot beside house No. 1427	20
3	Vacant land lot beside house No. 1407	10.2
4	Vacant land lot beside house No. 1331	5
5	Vacant land lot beside house No. 1319	10.2
6	Vacant land lot beside house No. 1243	20
7	Vacant land lot beside house No. 1227	5
XUAN HA WARD		
1	Vacant land lot beside house No. 1177	12.5
2	Vacant land lot beside house No. 1131	5
3	Vacant land lot beside house No. 1027	10.2
4	Vacant land lot beside house No. 957 (next to SkyNew restaurant)	30
5	Vacant land lot beside house No. 825	20
6	Vacant land lot beside house No. 717	10.2
II	CDW GATHERING, TRANSIT POINTS	
1	Opposite Cay Dua restaurant (parking lot)	–

6. Concluding Remarks

This study focuses on collecting information, data of new buildings in Da Nang to serve the management of solid waste in general and forecast the amount of construction and demolition waste in the near future. The study also initially investigated the current status of the management of CDW in Da Nang to reveal attitudes of governmental agencies and enterprises towards CDW recycling and management, and towards recycled products. Basic information on current CDW landfills in Da Nang is also presented in this study based on site visits arranged to gather actual data. Based on the obtained results, some conclusions and lessons learned are as follows:

1. The management of construction and demolition waste at Da Nang is currently not receiving attention, there is no specialized management agency, and the statistics of the amount of waste generation is insufficient.
2. The propaganda and compliance with policies on CDW management are not paid attention and at a low level, the processing and recycling of construction materials are mainly reused for site leveling; illegal dumping is quite common due to the lack of centralized waste disposal sites.
3. The management and recycling of CDW in localities still face many difficulties such as: there is no professional enterprise involved in gathering CDW, as well as no proper planning for CDW landfill; low awareness of stakeholders in the importance of treating and recycling CDW; rapid rate of urbanization; lack of official guidance in transporting and treating CDW, and the official supervision to these activities.
4. There has been a thorough plan to establish CDW landfills all over the city since 2016; however, this plan has not yet been executed effectively. Among the 14 planned locations, only one has seen operation. Illegal dumping is still the main method for disposal of CDW in Da Nang – which negatively affects the scenery of the city for tourism.

Finally, general recommendations from this survey to strengthen and disseminate CDW management policies to people and relevant agencies and to develop building promotion policies for treatment and recycling CDW in the locality are:

1. In this study, the initial survey of CDW management status in Da Nang was studied. This means that the real situations regarding disposals and recycling were not studied well. It

is worthwhile to continue study focusing on the CDW composition and CDW flow at the demolition sites.

2. More investigation is needed on the status of illegal dumping of CDW since Da Nang is a tourism city and aims towards a clean environment.

APPENDIX: INTERVIEW FORM FOR AUTHORITIES

PEOPLE'S COMMITTEE OF
..... DISTRICT

THE SOCIALIST REPUBLIC OF VIETNAM
Independence - Freedom - Happiness

PART 1: QUESTIONNAIRE FOR AUTHORITIES ON MANAGEMENT AND RECYCLE OF CONSTRUCTION AND DEMOLITION WASTE

Purpose of the survey:

To collect information in the management and recycle of construction and demolition waste (CDW) in Vietnam for the SATREPS project "Establishment of Environmentally Sound Management of Construction and Demolition Waste and Its Wise Utilization for Environmental Pollution Control and New Recycled Construction Materials in Vietnam" by Hanoi University of Civil Engineering in collaboration with Saitama University, Japan. From this basis, a business model is proposed to promote the recycling of CDW in Vietnam.

A. General information

1. Agency name:

2. Address:

3. Phone number: Email:

4. Respondent name:

Position:

Phone number: Email:

B. Content of survey

1. Current situation of generated solid waste in the local region:

Year	Total Amount of Municipal Solid Waste (ton/year)	Ratio of CDW over Municipal Solid Waste (%)	Collected Ratio (%)	Recycled Ratio (%)
2017				
2018				
2019				
2020				
2025 (expected)				

2. Could you assess the level of compliance/implementation of Circular No. 08/2017/TT-BXD in local CDW management?

- High
 Medium
 Low
 Not applicable yet

3. Could you tell us the treatment and recycling methods of CDW being applied in the local area? (can choose multiple options)

- Backfill at planned landfills
 Backfill at illegal dumping sites
 Reuse for leveling
 Recycled as construction material or other materials
 Other options (Please specify):.....

4. Could you give information of CDW landfills in the local area?

S/N	Name/Address	Area (ha)	Start of Service (year)	End of Service (year)	Note
1					
2					
3					
4					
5					

5. If there is CDW landfill in the region, do you manage the types of CDW being dumped at that site?

- Yes
 No
 There is no CDW landfill

If YES, please fill in the table below.

S/N	Name of Landfill	Content (%)					
		Concrete	Brick/Rock	Mortar	Steel	Glass	Other

1							
2							
3							
4							
5							

6. Could you give information on local companies/contractors that demolish, collect, and/or transport CDW? Total number of companies/contractors:

S/N	Name of Company/Contractor	Scope of Work	Contact
1			
2			
3			
4			
5			

7. Information on capability of supplying basic construction materials in the local region.

S/N	Material	Supply Capability					Note (natural/ artificial)
		2018	2019	2020	2025	2030	
1	Cement, ton						
2	Sand, m ³						
3	Gravel/ Pebble, m ³						
4	Ready-mix concrete, m ³						
5	Asphalt concrete, ton						
6	Backfilling sand (road base, sub- base), m ³						
7	Brick, unit						

8. Could you specify the orientations for promoting recycling activity of CDW, and supporting policies and/or investment for recycling enterprises in the local area?

- Nothing
- Supporting policies, call for investment, loan, prioritized land rental.
- Propaganda to raise the awareness of people and businesses about sorting, collecting, and recycling CDW
- Promotion, price subsidy, product sales, tax incentives.
- Others:.....

9. Could you tell us about the difficulties and obstacles in the management and recycling of CDW in your local area?

.....

.....

.....

10. Rate the obstacles when employing recycled materials from CDW.

Level of difficulty Obstacle	Very low	Low	Average	High	Very high
Higher price than natural materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Concerns about quality of recycled materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No production line of recycled materials from CDW	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Low awareness of owners and contractors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lack of standards, regulations, etc. of recycled materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11. Assessment on level of readiness to apply recycled products from CDW in the local region.

High Average Low Not yet applicable

12. Please give information on old and licensed construction within the local area according to the attached form.

.....

.....

.....

Part 2. INFORMATION ON CONSTRUCTION AND DEMOLITION ACTIVITIES IN THE LOCAL AREA

1. INFORMATION OF NEW CONSTRUCTION PERMITS

Detailed information of newly licensed constructions in recent years

S/N	Category of Permit	2017	2018	2019	2020
1.	Total number of new construction permits				
1.1.	Permits for public construction works				
1.2.	Permits for urban housing				
1.3.	Permits for rural housing				
1.4.	Permits for temporary works				
2.	Total number of construction works exempted from permission				

Detailed information of newly licensed constructions in recent years (from 2017 to 2020)

S/N	Project Name/Address	Year of License	Investor	Scale/ Number of Floors	Gross Floor Area (m ²)
1					
2					
3					
4					
5					
...					

2. INFORMATION ON OLD BUILDINGS PLANNED TO BE DEMOLISHED OR RENOVATED

Detailed information of demolished or renovated buildings during the period of 2016-2020

S/N	Name/Address	Inauguration year (approximate)	Scale/ Number of Floors	Gross Floor Area (m ²)
1				
2				
3				
4				
5				
...				

Detailed information on buildings planned to be demolished or renovated during the period of 2021–2025

S/N	Name/Address	Inauguration year (approximate)	Scale/ Number of Floors	Gross Floor Area (m ²)
1				
2				
3				
4				
5				
...				

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