Diverting construction and demolition (C&D) waste from landfill is a challenge for Palestine today to reduce the amount of solid waste flowing into landfills or dumpsites [1].Based on the questionnaire and interview survey in West Bank, issues on C&D waste addressed are summarized as follows: i) Random dumping of C&D waste material, either disposed in valleys, lands, or on the roads sides; ii) Exploitation and utilization of C&D waste materials through applying the 3Rs strategy; iii) Conscious consuming and minimizing the depletion of natural resources, as well as promoting reusing and recycling practices; iv) Safe disposal of C&D waste material, as some of the materials and their components are harmful contributing to many problems on the scale of environment and public health; v) C&D including hazardous materials contra banding from the Israeli's side to the Palestinian areas.C. Guideline of C&D Waste Management The purposes of the Guideline for C&D Waste in Palestine are: (i) to define the way in which stakeholders (construction or demolition works clients, planners, designers, contractors, sub-contractors, and suppliers) can act cooperatively in order to reduce C&D waste generated; (ii) to promote the minimization of the waste generation; (iii) to provide stakeholders (designers, developers, practitioners and relevant authorities) with an agreed upon basis for determining the adequacy of C&D waste management plan (WMP); and (iv) to provide both general and specific guidance in relation to preparing the appropriate C&D WMP for a certain scale of projects which exceeds a specified threshold size.(2) Coordination and cooperation with MSW service providers However, coordination and cooperation is possible between MSW and C&D waste management in some cases: (i) Assigning the locations of designated dumpsites for the C&D waste; (ii) Reusing some materials in the C&D waste can be utilized for the daily or final cover of solid waste in the sanitary landfill; (iii) Manufacturing and marketing some types of recycled materials such as cardboard, glass and plastics which are contained in both MSW and C&D waste; and (iv) Responsible organization for collection, transportation and disposal of C&D waste will be JSC or Local Government Unit (LGU) which is the same as MSW management as defined by the draft bylaw.Expected functions and specifications of the sorting facilities attached with transfer stations are as follows: (i) The transfer station is a land or building(s) at which C&D waste materials are received, crushed, and sorted for subsequent transport to a C&D waste processing facility or to a C&D waste disposal site; (ii) The transfer station is equipped with the necessary heavy machines such as loaders and bulldozers for on-site conveying; (iii) Enough number of transfer stations should be established in each governorate, to avoid illegal dumping of C&D waste at the roadsides or at the privately-owned land; (iv) The site (land and/or building(s) and installations of the transfer station are owned or hired by the LGU and/or the JSC.The questionnaire was distributed to JSCs and Local Government Units (IGUs) of 12 governorates in West bank (Jenin, Tubas, Tulkarem, Qalquilya, Salfit, Nablus, Jericho, Ramallah-Albireh, NW+N Jerusalem, NE+SE Jerusarem, Bethlehem, and Hebron), the Palestinian Contractors Union (PCU), and the Ministry of Public Works.D. Proposed C&D Waste Management System (1) Relationship with the municipal waste stream Integration between municipal solid waste (MSW) management and C&D waste management is not possible because: (i) Collection, transportation, and disposal operations are completely different as solid waste in its nature and generation source; (ii) Collection containers and vehicles used in both MSW and C&D waste are different in material, design and job; (iii) Collecting of C&D waste by MSW containers is not acceptable

as the C&D waste may damage these containers; (iv) Transporting of C&D waste by MSW compacter vehicles must be forbidden as this may damage the compaction and hydraulic systems of the vehicle; and (v) The responsibility of collection and transportation of C&D waste belongs to whom generates the C&D waste, i.e., owner of the building or contractor, as defined by the draft bylaw.Processes related to transfer station are as follows: (i) The contractor collects C&D waste from the generation site, using containers usually rented or provided by the hauler; (ii) A hauler takes the C&D waste containers to a nearby transfer station via small vehicles; (iii) The amount of C&D waste in the vehicle is weighed at the entrance of the transfer station and certain rate of gate fees is to be paid for the transfer station; (iv) Recyclable materials are sorted and put in suitable containers or bins which are finally moved to the processing facilities inside the transfer station or hauled to processing facilities outside the transfer station.Some examples of how to obtain and approve a license is as follows: for owned or hired C&D dumpsite, the license is issued by the MoLG and approved by EQA; for a transfer station, it is issued by the MoLG and approved by EQA; for a truck used for C&D hauling from the generation site to transfer stations or to dumpsites, it is issued by the MoT and approved by the LGU; for a sorting and processing facilities inside the transfer station, the license is issued by the MoLG and approved by the MoNE; for a processing facility outside the transfer station, it is issued by the MoNE and the LGU in that area; and for operating a mobile stone crusher or other onsite treatment equipment, the license is issued by the LGU in that area and approved by EQA and the MoNE.The handling of C&D hazardous waste generated during construction and demolition processes is the responsibility of the contractor, who should do the following: (i) collecting the hazardous waste properly according to bylaw; (ii) placing it in special bins and cover these bins; (iii) storing the bins in an isolated area of the project site; and (iv) transporting the hazardous waste in a safe way to an designated landfill after getting the required permission from the landfill operators who will dispose of the hazardous waste properly without causing any problems to public health or any environmental negative impacts.The Palestinian Environment Law No. 7, 1999 has included "constructional waste" in its definition of Solid Waste under Article 1. Under Article 5, the law has stated that the Environment law shall protect the natural resources from constructional activities, among others. The Law has stated under Article 10 that "All agencies and individuals, in conducting any digging, construction; demolition, mining or transportation of debris and sands generated by such activities, shall commit themselves to take all necessary precautions for safe storage and transportation of such materials to prevent any environmental pollution".TABLE 2: Good practices of C&D waste management at LGU level Governorate LGU Good Practice Tulkarem Qafeen Reuse soils and rocks for reclamation of land in the city Hebron Alsheokh Crushing stone and reuse (300 ton/month) Hebron Bani Ne'em Crushing stone and reuse (150,000 ton/year) Jericho Jericho Reuse for landfill covering material Figure 3: C&D waste dumpsite near Silwad.A. II. Present Situation of C&D Waste in West Bank Reconnaissance Survey in and around Ramallah area In order to obtain general idea on C&D waste problem in West Bank, Palestine, a reconnaissance survey was held along motor roads around Ramallah–Al Bireh in 2015, where various real estate development projects including construction and demolition of buildings and infrastructure are currently implementing.Suggestions are as follows: (a) allocating enough number of dumpsites in each governorate, (b) enforcement of relevant laws and

regulations, (c) cooperation between contractors and the Palestinian Contractor Union, and (d) establishing a information system of expected generated C&D wastes in order to offer that waste for those who need such wastes.(4) Licensing Procedures to obtain the necessary licenses for C&D waste management from the concerned authorities is as follows: (i) License is issued by the relevant authority and according to its specific regulations; (ii) License for C&D waste handling is issued by the MoLG or the LGU in its service area; (iii) In some cases, issuing the license needs the approval of EQA or the MoNE or both.(i) New residential development of 10 houses or more; (ii) New developments including institutional, educational, health and other public facilities, with an aggregate floor area in excess of 1,250 m2; (iii) Demolition/renovation projects generating in excess of 100 m3 in volume of C&D waste; and (iv) Other C&D projects generating more than 500 m3 of waste. Moreover, JSCs and LGUs in West Bank are facing problems as follows: 1) Lack of quantitative and qualitative C&D Waste, Also the number and the site of the random dumpsite for this special waste; 2) Reluctancy from the Local Authorities side, and not prioritizing the C&D issue; 3) Lack of awareness about the harmful impacts on Public Health and Environment; 4) C&D Waste Material lack of similar experiences among other neighborhood countries.The National Strategy for Solid Waste Management (20102014) [7] stated the following: "Currently, there are no clear standards or regulations for handling special waste in the Palestinian Territory and, thus, most of it finds its final destination in solid waste landfills or on remote roadsides (as is the case for C&D waste). There are also no national policies identifying best handling alternatives such as recycling options for these wastes despite the fact that much of it is recyclable".Proposed system (Figure 6) is required to develop appropriate infrastructures for C&D waste management by government, private sector, or public–private partnership initiatives, where the infrastructure includes transfer stations with C&D waste sorting facilities, processing facilities for recyclable components of C&D waste, and C&D waste dumpsites.Hazardous wastes are frequently encountered in demolition projects and may include asbestos, lead paints, contaminated soil, adhesives, drywall, and additives for concrete and blocks.In this paper, construction and demolition (C&D) waste is defined as waste materials that are produced in the process of construction, renovation, or demolition of structures which include buildings of all types (both residential and nonresidential) as well as roads, bridges, and other infrastructures based on US–EPA [3].Using a galvanized sampling tank of capacity 0.5 m3, C&D waste was sorted for measuring composition: concrete, bricks, stones, metal, plastic, wood, gypsum, asphalt, tiles, paper & cardboard, and other materials.The governmental bodies expected to be responsible for the licensing and approval of different processes of C&D waste management could be: Ministry of Local Government (MoLG); Environment Quality Auhority (EQA); Ministry of National Economy (MoNE); Ministry of Public Health (MoPH); and Ministry of Public works and Housing (MoPWH).In the West Bank of Palestine, the area called Area C, more than 60% of Palestinian territory, is virtually occupied by Israel, while in Areas A and B which is under the control of the Palestinian Authority, construction of buildings and infrastructure is being actively promoted, and then, a large amount of C&D waste is generated.TABLE 1: Generation source of C&D waste reported by LGUs, West Bank Source of C&D waste according to LGUs report LGUs (%) Construction of houses for Palestinian people 61% Transportation of C&D waste from outside the service area 22% Demolition and

destruction of Palestinian houses 19% Demolition and destruction of Palestinian unlicensed houses by Israeli side 10% According to the result of questionnaire survey in 2016, 111 LGUs answered the generation sources of C&D waste, where four main sources were pointed (TABLE 1): construction of houses for Palestinian people (61% of LGUs), transportation of C&D waste from outside the service area (22% of LGUs), demolition and destruction of Palestinian houses (19% of LGUs), and demolition and destruction of Palestinian unlicensed houses by Israeli side (10% of LGUs).Through conducting questionnaire survey and workshops to highlight the issue of C&D Waste materials, the JSCs and relevant agencies started to think about the C&D waste materials as a serious concern and how to reuse and/or recycle them.The purpose of this draft bylaw is to regulate and minimize the amount of solid waste generated by new constructions or demolition of structures that are sent to dumpsites or landfills for disposal.E. Waste Management Plan The Waste Management Plan (WMP) of the C&D waste for each construction or demolition project is an important plan that helps builders and contractors to achieve contractual and environmental goals by minimizing C&D waste generated from their projects.Under these circumstances, the Ministry of Local Government (MoLG), which is the supervising agency for solid waste management in Palestine, aims to grasp the current state of C&D waste and formulate an appropriate waste management system including bylaw, guideline, and standards that meets the conditions of Palestine.Figure 2: Random dumping of C&D waste, West Bank (2015) The C&D waste at survey area includes materials such as soil and sand, brick and blocks, concrete and aggregate, wood, metal products, roofing materials, plastic materials and packaging of products.B. Questionnaire Survey for JSCs, LGUs, and relevant parties in West Bank In general, the responsibility for solid waste management lies with the Joint Service Councils (JSCs) for Solid Waste Management (or municipalities), so improper disposal of C&D waste is a problem that cannot be ignored by them.Ministry of Public Works and Housing reported generation rate of C&D waste as 0.25 kg/person/day.limited activities but these indicated needs of reuse and recycle of C&D waste at local levels.However, according to the interview with the Head of the Palestinian Contractor Union (719 member companies), they have some estimations from the views of generators) of C&D waste, as follows [5]: (i) It can be roughly estimated that during building; each 1 m2 of building surface requires approx.D. C&D Waste Characterization and Quantification Survey in West Bank The C&D waste characterization and quantification survey was held in 2017 by the Universal Group of Engineering and Consulting under the supervision and ownership of MoLG–JICA Project [2][5].This generation rate range is comparable with a previous study results by Al-Sari et al. (2012) [6] in Palestine, where the quantity of waste generated during the construction of buildings ranged between 17 and 81 kg/m2 of building floor.Thus, in a survey carried out by the MoLG on 142 LGUs in the West Bank, most of them were keen to enact strict legislations that could control the C&D management in Palestine.Summarizing the above results, it is estimated that about 200,000 tons of C&D waste are generated annually, although variations are expected depending on the trends of the building and roads construction businesses.It is the best way to segregate C&D wastes at the generation site, but if it is difficult to implement a source separation, non-segregated mixed C&D waste will be transported to sorting facilities attached with waste transfer stations.After C&D waste sorting and processing is completed, the recycled materials are taken to the

market and the unrecyclable part of the C&D waste is hauled, by large vehicles, to the C&D waste dumpsite outside the city.However, because the legal system for C&D waste management has not been developed in Palestine, most of the C&D waste generated so far has been randomly dumped in the land around the construction site and in the suburbs, which leads to deterioration of the land environment, disturbance of proper land use, increase of solid waste amount, and wasting of construction materials which can be recycled.Components of C&D waste typically include stone, concrete, asphalt, wood, metals, plastics, and gypsum wallboard.In Gaza Strip, recycling of C&D wastes is a common practice due to the siege imposed by the Israeli and Egyptian governments.C. Interview with Other Stakeholders on C&D Waste Quantities of C&D wastes have no accurate statistical estimation in any region in Palestine.The objectives of the survey are (i) to estimate the generated quantities of C&D waste in generation sites of the C&D waste in West Bank and (ii) to estimate types and composition of generated C&D waste, as well.Figure 4: Averaged composition of C&D waste generated in West Bankbased on the results of field measurement [5] The survey also estimated the annual generation rate of C&D waste in West Bank [5].B. Basic Concept The management of C&D waste should emphasize and consider the waste management sequence as follows: (1) the first priority should be given to waste prevention and minimization; (2) the second priority to reuse and recycling; and (3) the disposal of the waste should only be considered as the last option.If it is owned or hired by the private sector (e.g., contractors), it is the private sector's responsibility to appoint the personnel; (vii) There are governmental, private and public–private partnership options for investment in setting up these transfer station and facilities in each governorate.Some transfer stations have their own processing facilities within their vicinity and hence large trucks load the unrecyclable waste in the transfer station and take it to dumpsites.The C&D waste management plans may be ignored or at least postponed in some conditions where the local authority considers it unworkable to operate such a plan due to nuisance, space restrictions, noise, technical reasons, etc.ISBN: 978–1–63248–191–7 DOI: 10.15224/978–1–63248–191–7–17 According to the field observation, C&D waste are randomly disposed along the motor road Route 60 [4], in particular near Aljalazon (Fig.Some of C&D waste containing stone materials are packed by plastic bag, which is probably convenient for handling and transportation but inadequate for stabilization and landscape disturbance.In urban areas, construction industry generates a lot of C&D waste and disposed them without any guidance or control by public authority, which cause impacts on the environment and increasing public concern.(ii) Random dumping of C&D wastes could be attributed to the absence of public dumpsites and the high cost of transportation to remote dumpsites.Based on above–mentioned C&D waste generation rate and the data of annual building license, the C&D waste quantities generated from buildings are roughly estimated for the years 2011–2016 as shown in Fig.Proposed System for C&D Waste Management A. Legal Framework and Draft C&D Waste Management Bylaw Regarding the laws and legislations in the Palestinian system about C&D waste, there is a great lack for environmental legislations and regulating of C&D waste in the territory.Based on the Concept for C&D waste management, a Guideline of C&D waste management is prepared by the MoLG–JICA Project, which encourages creating integrated approach for C&D management over Palestine.It is essential that the conditions imposed by relevant authorities are fully complied by licensees and permit

holders.Implementation of regulations should be simple to make authorization applications for reuse and recycling of C&D waste, which is a more pleasant scheme for contractors.It could be also owned or hired by the private sector; (v) Operation and maintenance inside the transfer station is the responsibility of the owner/tenant; (vi) The personnel in charge of running the station are appointed by the LGU and/or the JSC.(5) Hazardous C&D Waste Hazardous wastes have their own special disposal procedures and regulations and should be carried out according to the Palestinian Environmental Law.Of the 4th International E-Conference on Advances in Engineering, Technology and Management - ICETM 2021 Copyright (C) Institute of Research Engineers and Doctors.Mostly it is composed of stone materials excavated from ground or concrete blocks generated by demolition of old building.Stone materials and rock debris is the largest component followed by concrete block and asphalt.Therefore, a questionnaire survey for JSCs officials in West Bank was conducted in 2015-16 to get an idea of the status of C&D waste in their jurisdiction.There are no legislation and guideline for dealing with C&D waste in most governorates, and they pointed the necessity of bylaw and guideline for C&D waste management.The majority of them had asked for rules/legislations/guidelines to control all processes of collection, hauling and disposing of all types of C&D waste.In many cases, municipalities direct contractors to deliver C&D waste to future roads or places that need to be leveled and sometimes the waste is sold as a cheap agricultural soil.Based on the direction of the National Strategy (2017-2022), a draft of bylaw of C&D Waste Management has been prepared by the MoLG-JICA Project, which was submitted to the Minister of Local Government, which will be enacted in near future.The guideline procedures for handling and managing of C&D waste are in accordance with the proposed draft bylaw.For example, it is imperative that all haulers engaged for the removal of C&D waste material from the site should possess the requisite authorizations.Land clearing debris, such as excavated rocks, stumps, and dirt, are also included in the C&D waste.Some of the C&D disposal site was also utilized for municipal solid waste dumping, which results mixture of C&D and municipal solid waste.The estimation was based on scientific methods which helped in estimating annual C&D waste generation rate.In general, metals showed low percentage, probably as a result of an increase in the amount of metals now collected selectively from dumpsites.According to the measurement results of C&D waste generated from a house construction site in Nablus city, the generation rate of C&D waste per unit floor space was estimated around 50 kg/m2.5, where the estimation was done by multiplying 85% of the annual licensed area (m2) by 50 kg/m2.It is compulsory that the WMP be prepared for projects in excess of certain thresholds.For Projects that are not reaching the threshold values, the C&D waste management should be carried out entirely by the owner of the project or the contractor without preparing a WMP.A study has been organized and implemented since 2015 with the support of Japan International Cooperation Agency (JICA) [2].The purpose of the study is setting effective safe practical solutions to minimize solid waste amount and avoiding illegal dumping of C&D waste in Palestine.In the interview survey, the Head of the PCU mentioned that no current regulation to control C&D waste in West Bank, Palestine.On the contrary, recycling of C&D waste in the West Bank is more selective and restricted to certain materials where the most attractive material is iron bars.Moreover; each 1 m2 of building surface requires 80-100 kg of iron bars with a waste percentage of 5%.The average percentage of each component of C&D

waste by weight are summarized in Fig.4.According to the data of road construction projects in West Bank in the period of 2015–2016, it was estimated that waste asphalt 1,035 ton/year and base course and soil 3,746 ton/year.Law No. 79/1966 has only one article No. 42 which considers that C&D waste affects negatively the scenery of the streets in the city.The, the National Strategy for Solid Waste management (2017–2022) [8] stated to formulate legislation and policies related to C&D management.(3) Sorting Facility and Transfer Station Sorting of C&D waste is very important for effective and efficient reuse and recycle.Some contractors might haul their own waste and recyclables to and from the transfer station to dumpsites.Some C&D projects may generate hazardous materials that require special handling.The necessity of preparing a WMP is judged according to the size of the project.Down-slopes along motor road are often random dump sites for C&D waste.Others are more or less small amount; mortar, bricks, iron & metals, plastic, wood, and glass.Thus, the minimization of C&D waste was a pressing issue.12 JSCs at governorate level answered to the questionnaires.PCU is ready to apply any new guidelines and bylaw on C&D waste management.0.8–1.0 m3 of concrete and the generated waste is estimated around 3%.The percentage of the C&D waste components and the total sample weight were calculated.Figure 5: Estimated annual C&D waste generation amount (ton/year) over West Bank [5] Another C&D waste generation source is road construction sites.The draft bylaw defined important words and terms, and responsible authorities.Operation and maintenance (O/M) inside the dumpsite are the responsibility of the owner/tenant.The consideration of such postponement can be exceptionally raised during the planning phase of the project.Four LGUs reported some C&D waste management practice as shown in Table 2.Therefore, almost all components of C&D waste are being recycled.However, there is a need for strict regulations to control C&D waste.A total of 14 samples (waste piles) from 5 locations were chosen to represent the C&D waste in the West Bank.Generalized diagram of proposed C&D waste management system.The following is the thresholds at which a WMP of the C&D waste should be prepared.In this case, the C&D waste management should be carried out totally by the owner of the project or the contractor without referring to the WMP.The site was controlled by a private company and closed in 2013.These were very Proc.All rights reserved.However no qualitative data is available at that time.III.1).Figure 6.