Analysis of the construction site waste management plans in Bulgaria, adopted in the period 2015-2017

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Abstract: At the end of 2017, a new "Ordinance on construction and demolition waste management and use of recycled building materials" was adopted in Bulgaria without assessing the application of the existing one. Then and until now, there is no reliable public data available on construction and demolition waste, based on which to make a statistical assessment and make management decisions. To clarify the manner of preparation and implementation of construction site waste management plans, a study of existing accepted projects was conducted. They were evaluated based on their content, chosen measures, and recognition of the application of priority order (hierarchy) in the management of the generated construction and demolition waste. Based on the analysis, it is argued that to make the Ordinance on construction and demolition waste management more effective, it should be accompanied by increasing the reliability and quality of waste data, implementing specific management decisions based on knowledge of material flows, development of a market for reused construction products and specialization of the designers of these plans.

1. Introduction

Legislation on waste management in Bulgaria was introduced in 2012, transposing the Directive 2008/98/EC [1] on waste (Waste Framework Directive, thereafter the FWD) into national law. A special "Ordinance on construction and demolition waste management and use of recycled building materials" was introduced in the same year [2]. In 2016, the Council of Ministers, without examining the impact of the existing Ordinance, proposed a draft for the adoption of a new Ordinance on construction and demolition waste management (thereafter the CDWM), which was issued at the end of 2017, and has been used without being updated for almost 3 years [3, 4]. According to the report of the petitioner (Minister of Environment and Water), the current regulation does not transpose European legislation [3], but the review of the document shows that the major principles of the FWD are included, such as an obligation to handle waste in a way that does not hurt the environment or human health and an encouragement to apply the waste hierarchy.

The Ordinance of CDWM stipulates that the main driver for achieving the national target for 70 wt% recovery of materials by 2020 of this waste streams is the development of construction site waste
management plans (thereafter the SWMPs). These plans must be designed for all new projects for construction, reconstruction, overhaul, and deconstruction of construction works, which have a relatively large total built-up area (for example for reconstruction and overhaul over 500 m² in [2] and over 700 m² in [4]) or are relatively long linear objects. The SWMPs shall ensure that enough resources and time are allocated to ensure [2]:

- targets for material recovery, including preparation for re-use, use of recycled construction materials and/or recovery of construction waste in backfills;
- measures for the selective demolition, where applicable;
- measures for separate collection, utilization and disposal of construction and demolition waste (thereafter the CDW);
- measures for prevention and minimization of the generated CDW on the construction or demolition site;
- instructions for keeping hazardous waste records;
- measures for the application of priority order (hierarchy) in the management of the generated CDW.

The only measurable targets are for material recovery of non-hazardous CDW, which apply to the year of opening the construction site, gradually increasing during the period 2014-2020. For example, for tiles and ceramics (code 17 01 03) this target increases from 30 wt% (2014) to 70 wt% (for 2020). The SWMP includes forecasts for the amounts of some dense CDW, which must be larger than the targets. An additional target is the use of recycled construction materials or treated CDW for recovery in backfills in amounts, depending on the type of construction and the scope of the permit for construction. According to the Waste Management Act [5], the contracting authority is responsible for the creation and implementation of SWMP and the specialists who prepare this plan are designers with full or limited design qualification. For this reason, following the introduction of the Ordinance of CDWM, several courses have been held for designers on how to design a SWMP and the Ministry of Environment and Water issued several national guidelines for the implementation of the Ordinance of CDWM. In 2010, the National Statistical Institute announced that they would start collecting data on CDW, and in 2017 the Bulgarian Universities included in their programs or curricula a discipline "Construction and Demolition Waste Management".

These activities only partially cover the activities set for implementation in the strategic waste management plans [6, 7]. At the moment there is no information available on the implementation of the main indicators set for achieving the targets, which can be established and proven by the lack of vision and strategies after 2020, lack of detailed and summarized statistics on CDW, lack of monitoring mechanisms and reports to national authorities, lack of data on the implementation of the SWMP, etc. Upon request for access to such information, the responsible institutions are denied. The data on CDW that Bulgaria submits to Eurostat is not reliable, as the misunderstanding of CDWM policies is influenced by national economic, social and technological factors [8, 9]. Research and popular publications in the field of CDWM are isolated [10, 11, 12].

On the one hand, Bulgaria, as part of the European Union, must be involved in solving some tasks related to CDWM, which is seen as a cornerstone of the circular economy [13, 14, 15]. On the other hand, the presented situation shows a great degree of uncertainty about the application of CDWM in Bulgaria. The present study attempts to understand the management problems in the field of CDW. For this purpose, information from publicly available real projects in the field of CDWM is examined. Based on the requirements, these SWMPs are analysed in terms of managerial approaches such as:

- determination of the resources, time and time plan for the activities;
- effective coordination, planning and organisation of the activities;
- adequate management and coordination structure on the construction/demolition site;
- proper procedures for monitoring and communication on the construction/demolition site;
- provided appropriate training necessary for all operators.
2. Materials and method

2.1. Data collection
The data for analysis were taken from sites up to date as of 30.06.2020, the information from which can be verified. Due to the extremely small number of SWMP available after 2018, it was agreed to consider plans adopted in the period 2015-2017, preceding the acceptance of the current CDWM Ordinance. To analyse comparable data, the choice of SWMPs was limited to:

- investment projects financed with public funds;
- plans, drawn up by designers with full design qualification;
- plans that include both parts: construction and demolition;

These data were confirmed by reviewing the name and content of the investment project, the manner of its approval, including download from the public procurement site (table 1). The design qualification was proved by reviewing the register of designers with full design qualification [16]. To understand the profile of the designer, information was taken about their speciality, which is derived from the section to which belong.

2.2. Data preparation
The data from the projects were processed by reviewing the projects themselves, from which several indicators were derived that can be quantified. When construction or deconstruction activities were mentioned in more than one page, they are marked as "partially described" (table 2). When there was a detailed description of the individual activities and processes, they were marked as "available", although most of the projects copy "technological part", which is a mandatory part of the content of investment projects [17]. The investigated plans have a part of the removal of construction products, none of them was audited before the demolition activities, which is a mandatory norm in most EU countries [18].

Although a reference to the Ordinance of CDWM is obligatory when SWMPs are designed, during the review of the projects it was noticed that a significant part of the explanatory note was a text that has been copied from the Ordinance. "Available" indicates cases when the copied texts are over one page. Another indicator that can be easily determined in the SWMPs is whether measures for separate collection of construction or demolition waste are considered (table 2). Here the assessment is "available", "unavailable" and "partial described", as the latter means that the designer has given only recommendations, without considering the way of organizing the activities and the processes of their implementation.

The main requirement for the approval of a SWMP by the mayor of the municipality or an official authorized by him is to set forecasts of mass percentages for material recovery of CDW higher than those established in the Ordinance of CDWM. The decision for approval can be taken, but whether real actions are set for its implementation can be understood from the way of calculating the amounts of CDW. The assessment is considered to be "available", "unavailable" and "unclear described", the latter means that the designer has accepted an amount of waste with unclear justification (table 2). The assessment "unclear" includes the case when the designer has accepted the amount of waste as a percentage of the mass of all construction products used in construction work (often this is 1 wt% for concrete and steel and 3 wt% for other construction products).

An additional indicator for assessing the accuracy of the prepared and adopted SWMP is the monitoring of the method of calculating the amount of CDW. It is generally accepted in construction that the used solid materials are determined in volume, while the Ordinance of CDW requires the amount of generated waste to be forecasted in mass with an accuracy of 50 kg. In case of the wrong conversion, it may happen to claim the creation of amount of CDW that exceeds the capacity of the contractor or leading to a violation of the principle of reducing the amount of waste. As the CDWM Ordinance does not specify a reference document for the densities of materials and waste generated by them, it was decided to find whether a specific document for this transformation is indicated and in which the individual types of waste are converted from volume to mass. The accepted assessment is "available", "unavailable" and "unclear described" (table 2).
Table 1. Summary for the studied 20 site waste management plans (SWMPs) (type of projects: B – building, C – low-rise construction, P – plumbing) (underlined letters must be entered in Cyrillic).

| №  | Project/Link                                                                 | Type | Speciality | Year | Pages |
|----|-----------------------------------------------------------------------------|------|------------|------|-------|
| 1  | Extension and expansion of an existing kindergarten in Regulated Land VI - municipality, quarter 36, village of Orizare, Municipality of Nessebar. www.cdg-radost.na4alobg.com/puso.pdf | B    | StrEng     | 2015 | 12    |
| 2  | Reduction of greenhouse gas emissions through implementation of energy efficiency measures in the administrative building of Ardino municipality. www.ardino.bg/docs/profil_na_kupuvaca_docs/Cast PUSO.pdf | B    | StrEng     | 2015 | 15    |
| 3  | Multi-family residential building in Sofia, zh.k. "Nadezhda", bl.403, ent. A, B and C, with Reg. №432-31PM-117-211 of the Agreement for financial assistance and implementation of energy efficiency renovation under project BG161PO001-1.2.01-001. www.zop1.bg/download/1001969 | B    | StrEng     | 2015 | 18    |
| 4  | Energy efficiency measures and accompanying activities of the building of "Otez Paisii" Secondary School, "Nikola Velehev" Secondary School and their dining rooms, Samokov. so-slatina.org/wp-content/uploads/2018/04/puso-Hubavka5.pdf | B    | WatEng, MinEng | 2015 | 23    |
| 5  | Internal renovation and improvement of the energy efficiency of the building of the exemplary community centre "Prosveta - 1908" Zlatograd – Second stage. www.prosveta.info/documents/Chitalishte_etap2_p3_Chast_PYSO.pdf | B    | Arch       | 2016 | 26    |
| 6  | Repair and restoration of an administrative building of the Black Sea Region Basin Directorate with identifier 10135.1506.802.1 according to the cadastral map of the city of Varna. www.bsbd.org/UserFiles/File/AOP/00889-2016-0001/11 Upr na stroit otpadatsj.pdf | B    | TechnEng   | 2016 | 26    |
| 7  | Thermal insulation and accompanying measures of the building of the IOMT-BAS in connection with the project "Investment Program for Climate" of the National Trust EcoFund. www.iomt.bas.bg/zop/project_2016/inv_project/Chast-PUSO.pdf | B    | WatEng, MinEng | 2016 | 18    |
| 8  | Replacement and reconstruction of boiler and heating installation of Belogradchik Municipality. belogradchik.bg/wp-content/uploads/2016/08/Chast-PUSO.pdf | B    | HVAC       | 2016 | 12    |
| 9  | Overhaul of hospital rooms and offices at the First Clinic of Nervous Diseases, located on the 14th floor in a high body of MHAT "St. Marina" EAD – Varna. www.svetamarinva.com/uploaded/system_documents/3577/PUSO - 14 etaj.pdf | B    | StrEng     | 2016 | 15    |
| 10 | Repair of detention facilities 01 RU SOFIA - SDVR, located in Sofia, 8 Shipchenski Prohod Str. www.mvr.bg/docs/librariesprovider8/dokumenti-ot-profil-na-kupuvacha/i_raionno_puso.pdf | B    | StrEng     | 2016 | 21    |
|   | Description                                                                                                                                                                                                 | Author(s) | Year | Page |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|------|
| 11 | Renovation of the assembly hall and lobby to the assembly hall of 49 Benito Juarez Primary School for the implementation of order №05-02-160 of the Sofia Directorate for Fire Safety and Protection of the Population. https://www.49ousofia.com/sites/default/files/profilk/PUSO.pdf | Arch      | 2017 | 8    |
| 12 | Construction, reconstruction and rehabilitation of pedestrian alleys and sidewalks, Bankya – Second stage. https://www.bankya.bg/downloads/A4_5.pdf                                                                 | StrEng    | 2015 | 8    |
| 13 | Reconstruction and improvement of the adjacent yard to the kindergarten "Priateli", located in Regulated Land - I, for nurseries, district 62 according to the zoning plan of the town of Kuklen, Kuklen Municipality. http://buyers-profile.kuklen.org/uploads/files/20180516dpkq596321/29232018161605_Plan za upravlenie na stroitelni otpadatsi.pdf | StrEng    | 2016 | 17   |
| 14 | Road PDV-2055 / Road 11-64 railway station Kaloyanovo - Razhevo Konare - Glavatar from km 0+000 to km 4+981. new.kaloianovo.org/attachments/article/63/IYCO.pdf                                                                 | StrEng    | 2016 | 15   |
| 15 | Reconstruction and rehabilitation of the street network in the town of Madan, Madan municipality - 3966.90 m. www.madan.bg/assets/migrate_files/-REKONSTRUKTSIYa-NA-VODOPROVODNA-KANALIZATSIONNA-M/1obzapiska_puso_mada.pdf | WatEng    | 2016 | 11   |
| 16 | Improvement of the central square in the General Nikolaev neighbourhood, Rakovski, municipality of Rakovski. rakovski.bg/profile/uploads/07.pdf                                                                 | WatEng, SurvEng | 2017 | 14   |
| 17 | Reconstruction, repair and furnishing of a kindergarten, Ugarchin. https://e-obp.eu/bp/Document/988eae65-8aa3-4121-b44f-2b35e9335c3b (Pregled) PUSO.pdf                                                                 | StrEng    | 2016 | 8    |
| 18 | Reconstruction and completion of the water supply network of the village of Gospodinovo, Byala municipality. https://e-obp.eu/bp/Document/6c7f7802-5c1c-4b0d-a09c-281db7fde354-Proekt s. Gospodinovo - chast 2.zip | StrEng    | 2016 | 14   |
| 19 | Reconstruction of an open drainage canal and the adjacent sidewalks on „28-ma” Street in the village of Dalgo Pole, Kaloyanovo Municipality. new.kaloianovo.org/attachments/article/55/Plan za upravlenie na stroitelnite otpadatsi.pdf | Road Eng  | 2017 | 16   |
| 20 | Reconstruction and replacement of part of the internal water supply network in the village of Opan, Opan municipality - Second stage. www.opan.bg/uploads/procurements/investisitionen-proekt-chast-upravlenie-na-stroitelnite-otpadatsi.pdf | WatEng    | 2017 | 29   |

Remark (abbreviations for designer’s speciality): Arch – architect, StrEng – structural engineer, SurvEng – Engineer of Geodesy and Applied Geodesy; WatEng – engineer of hydrotechnics and hydro constructions, MinEng – engineer of mining, geology and ecology, HVACEng – engineer of heating, ventilating and air conditioning, TechnEng – Engineer of Construction technology, RoadEng – Engineer of transport construction and facilities
Table 2. Evaluating the manner of development of site waste management plans (SWMPs)  
(● – available; ○ – unavailable; ◐ – partial described; ◇ – unclear described)

| Project № | Description of construction activities | Copying large texts of the ordinance | Measures for separate waste collection | Calculation of amounts of demolition waste | Calculation of amounts of construction waste | Reference to volume to mass calculations | Satisfaction of the requirements of the ordinance |
|-----------|----------------------------------------|-------------------------------------|---------------------------------------|-------------------------------------------|-------------------------------------------|--------------------------------------------|-------------------------------------------------|
| 1         | ●                                      | ○                                   | ◇                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 2         | ●                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 3         | ●                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 4         | ●                                      | ●                                   | ○                                    | ◇                                         | ○                                         | ○                                          | ●                                               |
| 5         | ●                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 6         | ●                                      | ○                                   | ◇                                    | ○                                         | ●                                         | ○                                          | ●                                               |
| 7         | ●                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 8         | ●                                      | ●                                   | ◇                                    | ◇                                         | ○                                         | ○                                          | ●                                               |
| 9         | ○                                      | ●                                   | ○                                    | ◇                                         | ○                                         | ○                                          | ●                                               |
| 10        | ○                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 11        | ○                                      | ○                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 12        | ○                                      | ○                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 13        | ◇                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 14        | ●                                      | ◇                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 15        | ●                                      | ●                                   | ◇                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 16        | ○                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 17        | ○                                      | ○                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 18        | ●                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 19        | ●                                      | ●                                   | ◇                                    | ○                                         | ○                                         | ○                                          | ●                                               |
| 20        | ●                                      | ●                                   | ○                                    | ○                                         | ○                                         | ○                                          | ●                                               |

One of the main principles for understanding and implementing pan-European waste management policies is adherence to the policies adopted by the five-level hierarchy. This hierarchy is enshrined both in the Law on waste management [5] and in the Ordinance of CDWM [2, 4]. Initially, it is assessed whether activities followed the waste hierarchy are planned during the development of the project. Then it is considered whether the project indicates or applies specific activities to prevent or reduce the hazard and amount of construction waste, preparation for re-use, material recovery, incl. transfer for recycling, as well as the use of construction waste for backfills and the use of recycled materials from CDW. The evaluation is "available", "unavailable" and "unclear described", the latter referring to the cases where the project does not contain information on implementation (table 3).

3. Data analysis and discussion

The examined SWMPs contain an average of 16 pages and there is no significant difference from the type of project. Most often, the plans are designed by a structural engineer, which is explained by the fact that these specialists represent the largest section of Chamber of Engineers in the Investment Design (CEID), which maintain and update registers of the engineering designers. Architects relatively rarely design SWMPs, which is due to the specifics of training of architects in Bulgaria (it is art-oriented, not technological) and the fact that specialized courses for the training for the Ordinance of CDWM were conducted with the initiative of CEID and not of Chamber of Architects in Bulgaria (the professional organisation of architects, landscape architects and urban planners), who maintains the register of practising architects.
Table 3. Evaluating the application of hierarchy principle in the site waste management plans (SWMPs)
(● – available; ○ – unavailable; ◇ – unclear described)

| Project No. | planning activities followed the waste hierarchy | prevention or reduction of waste generation | preparation for reuse activities | recycling activities, incl. back-filling operations | use of recycled materials from CDW |
|-------------|-------------------------------------------------|-------------------------------------------|---------------------------------|---------------------------------------------------|----------------------------------|
|             | indication applied activities                    | indication applied activities              | indication applied activities    | indication applied activities                      | indication applied activities    |
| 1           | ○                                                | ○                                         | ○                               | ○                                                 | ●                                |
| 2           | ○                                                | ●                                         | ○                               | ○                                                 | ●                                |
| 3           | ○                                                | ○                                         | ○                               | ○                                                 | ●                                |
| 4           | ○                                                | ○                                         | ○                               | ○                                                 | ●                                |
| 5           | ○                                                | ●                                         | ○                               | ○                                                 | ●                                |
| 6           | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 7           | ○                                                | ●                                         | ○                               | ●                                                 | ○                                |
| 8           | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 9           | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 10          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 11          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 12          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 13          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 14          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 15          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 16          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 17          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 18          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 19          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |
| 20          | ○                                                | ○                                         | ●                               | ○                                                 | ○                                |

Almost all projects copy content from the "technological part" part of investment projects. This regularity is because the SWMP, which together with the safety and health plan at the construction site, is designed based on the remaining parts of the investment project (architectural, structural, installations, etc.) and not simultaneously with them. Large parts of the texts and tabular material of the Ordinance of CDWM are also included in the projects.

In this way, the designer informs the contractor of construction/demolition about the commitments for the implementation of the Ordinance of CDWM, which leads to an increase in the number of pages of the SWMP. The presence of common texts in the examined SWMP, often irrelevant to the project activities, shows that the designers learn from each other by accepting the approved projects SWMP on the Internet as examples of good practices in the field of construction and demolition waste management.

In SWMP, the measures for separate collection of CDW streams are either not described or are described unclearly. The main reason for this situation is that in the Ordinance of CDWM does not require planning based on material flows [19]. Despite the information provided by the European Commission and good examples from leading European countries, this approach is not recognized by the designers of the SWMPs. Only three of the analysed SWMPs (No 6, 7 and 18 in table 1) indicate
that there is hazardous waste, but the designers do not indicate the quantities or prescribe specific activities with them. Calculations of the amount of construction and demolition waste are not made for the majority of the projects. There is no reference to the method of converting the amount of waste from volume to mass. On the one hand, this incorrectness can be considered as a gap in the requirements of the Ordinance of CDWM, but on the other hand, designers have the opportunity to use other regulations and standards in their calculations.

One of the main principles adopted in the legislation and policies for waste prevention and management is the implementation of a priority order of activities to achieve the most environmentally friendly results. This policy must be set by the Ordinance of CDWM and taken into account through the approved SWMPs. The Ordinance of CDWM specifies a text for compliance with the hierarchy, but half of the analysed projects are not based on its application. The other half of the SWMPs plan activities follow the waste hierarchy, but this planning is unjustified and unclear. The projects mention the prevention or reduction of waste generation, preparation for reuse, recycling activities and use of recycled materials from CDW, but this is not explained with specific activities that allow calculations of quantities of waste or materials. The hierarchical approach in CDWM is most recognizable in plumbing replacement projects, but they do not prescribe specific activities. The unclear indications of the activities in the hierarchy are mainly for activities on construction and demolition of buildings.

These circumstances do not lead to difficulties in conformity assessment the quantitative requirements of the Ordinance of CDWM. This means a formalism in the planning of CDWM, which in turn does not allow the accumulation of experience and expertise.

4. Conclusions

Based on the analysis of the content of construction site waste management plans in Bulgaria, adopted in the period 2015-2017, it can be argued that to make the "Ordinance on construction and demolition waste management and use of recycled building materials" more effective, it must be accompanied by increasing the reliability and quality of data for construction and demolition wastes. The requirement of the European Directive to achieve 70 wt% materials recovery by 2020 of this waste streams formalizes the design and to avoid this construction site waste management plans must describe specific management decisions for implementation based on knowledge of material flows, application of different management approaches to construction waste and demolition waste and development of the market for reused construction products. It is mandatory to apply good management practices, such as auditing before demolition activities. To meet the described requirements requires specialization of professionals in this field of the construction industry.

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