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An Overview about the Current Situation on C&D Waste Management in Italy: Achievements and Challenges

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Abstract: The disposal volume of material for Construction and Demolition in Europe is increasing each year, that the European Union has decided to take control of the matter unifying practices and goals to achieve. This article analyses how waste management works in Italy adjusting its system to the European Union, regarding Construction and Demolition, taking into consideration the disposal of material coming from C&D (Construction and Demolition) production. In Italy, the disposition may differ according to the regions in which it is divided, and this must be taken into consideration when analysing information that reflects the different logistical aspect linked to the territory. It is also necessary to consider how the volume of waste can vary according to the size of the region considered and the type of industrial development to which it belongs. The analysis of the Italian situation shows their achievements regarding reaching a good level of recycling waste volume; indeed, their amount of C&D recycled waste after 2010 was always up to the 70% value established by the European Union, though barriers are still present in the field of waste management. Through data collecting, it has been seen the different volume that is generated in construction-related activities in the country, along with the recovered waste volume. Thus, the goal of this paper is to deepen the general knowledge on waste produced by Construction and Demolition in Italy and waste management practices adopted according to the European Union.

Keywords: C&D waste; construction; demolition; European Union; recycling

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1. Introduction

The European Union wish to achieve a "society founded on recycling, that search to avoid waste production but which, in any case, uses it as a resource" [1]. Considering only the waste derived from construction and demolition, this kind is produced worldly in large quantities [2]. The level of hazardousness is quite low, and it is easy to avoid the arranged disposition, recurring in disposable in non-authorised places [3]. In the Italian case, considering the year 2018, the last year for which the data are known, the quantity of special waste generated was around 143 million tonnes, of which 59 million tonnes were only the product of C&D activities [4]. This means that the level of C&D waste production reaches 40% of generated waste, in line with the European data, and represents a valuable source if managed properly [5]. The results about generation and recovered waste imply not only the whole country but the regions too. As shown in Figure 1, the country is divided into regions, but a broader distinction is made between three categories: north, centre and south.

The different parts in which the country is divided offers a large variety of information that shows how the economy and the industrial development is directly linked to the different data obtained [6]. It must be considered that the three zones have a slight division in which everyone has a kind of purpose within the development of the country; the north is the head of the industries and production, the centre is the administrative director with the capital and the south manage the agriculture production. The article aims to emphasise

which are the zones with a higher quantity of waste produced and recycled and the reasons behind these findings. This country presents a detailed and updated collecting data system regarding waste management at a national level, yet one of the main problems is that the data are not homogenised at a regional level [7]. The 20 different regions of the country collect the information using their internal regulations and scales, and when it is necessary to collect them for a larger study at a national extent, usually it is not possible or remains at a statistical level because of the type of data [8]. As a consequence of the strategies adopted by the European Union, the decision on the application of the rules on Green Public Procurement will require the inclusion of clear and verifiable environmental criteria for products and services in the public procurement process [9].

Figure 1. Regions of Italy and division between territories. Source: Own elaboration.

Italy was the first country, among the EU Member States, to impose the obligation to apply CAM (Minimum Environmental Criteria) for public contracting stations, relaunching the importance that green purchases play as a strategic tool [10]. The usage of these practices aspires to a unified collective data system with clearer information regarding national and regional results.

With the good results in C&D waste material recycled that reached more than 75% in 2017 (the last year for which the data has been reported), the implication on the country on reaching the European standard is in good routes, but still, political and social barriers such as illegal practices implemented in the past maintain a level of distrust in the usage of recycled waste [11].

Therefore, this paper aims to evaluate issues that affect indirectly and directly the waste process and the role of current regulations by the European Union. An extensive study is done in the case of Italy, where the different waste production is analysed along with recovery rates.

2. Materials and Methods

The data collected in this study represent the whole country, but particular attention is paid to the differences and results among the 20 regions that form it. All the information collected is quite statistical, coming from the analysis and the interpretation of the different

evidence collected. The scenarios presented reflect the diverse nature of the territory and how the implemented policies and internal organisation can affect waste production. A fundamental source for the collection of data is represented by the official governmental website of ISPRA (Istituto Superiore per la Protezione e Ricerca Ambientale); this institution is the one in charge of collecting all the data regarding all type of waste, including C&D [4]. Thanks to the information stored by ISPRA, the situation in the entire country can be easily analysed. The data is quite exhaustive on a national level, but on a regional one, some improvement could be made. The organisation for waste management in this country is quite divided in between regions with their administration and their way of collecting data. This aspect represents pros and cons; the system allowed a better administration designed for suiting each region to every different need but offer data difficult to compare because of the different parameters considered. The material analysed is the result of a compilation work carried out by ISPRA in which all the production data concerning waste and in our case C&D waste have been grouped. The data taken into consideration were chosen because of their relevance to the study carried out. Data concerning the whole nation and subsequently the different regions were considered. All the numbers analysed were then reported in graphs to represent the concepts more clearly. To have a clearer understanding of the actual situation regarding C&D waste management, other sources have been consulted as well. The European Union [11] offered a large scale of data and the European Commission showed all the parameters and requirements requested by a European country in their sites and reports [9,12,13]. Additional information has been checked on EUROSTAT [14] and from a report made by DELOITTE company with the collaboration of ISPRA [7].

3. Results

This section of the article exposes the data analysed regarding C&D waste in Italy. The data collected concerns waste generation ratio and recovered waste ratio in the whole country and the different regions. The volume of waste changes depending on the zone considered, directly linked to its economy and industrial development.

3.1. Evolution of C&D Waste in Italy

In the country the generated waste is classified as special and municipal waste; regarding C&D waste, it belongs to the special waste group. This category presents two main subgroups, hazardous and non-hazardous waste. The C&D group can be hazardous or not; usually, the high volume belongs to the non-hazardous category, and this means that the chances of being re-used are high. This can be seen in Figure 2 where it is evident that the amount of C&D waste is up to 40%, especially after 2003.

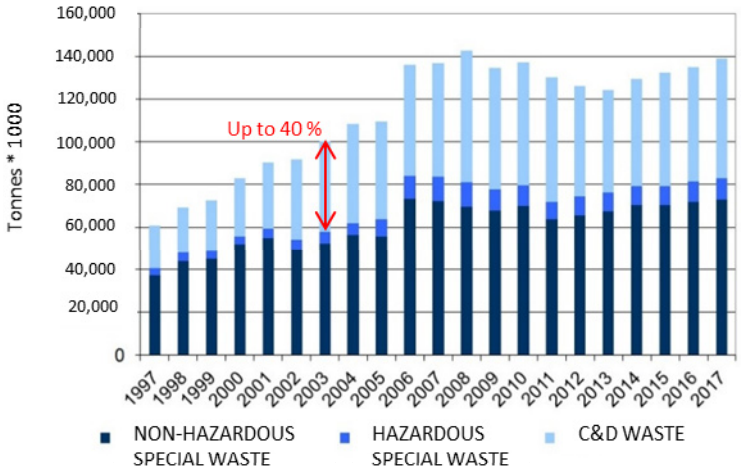

Figure 2. Special waste production in Italy. Source: Own elaboration from ISPRA data.

During the year 2017, the production of special waste reached almost 140 million tonnes and the volume of non-dangerous C&D waste was 56 million tonnes [4]. Analysing a larger period, it is much easier to comprehend the behaviour of waste production over time. Between the years 1997 and 2006, the production of special waste underwent a strong increase followed by a more contained growth trend. As shown in Figure 3, because of the economic crisis suffered by the country during the years 2008 and 2009, a reduction happened in special waste production of 5.7%. In 2010, thanks to better economic condition, the increase in production reached 1.8%, and then, following the decrease of construction activity, underwent a deflection again of 4.3%.

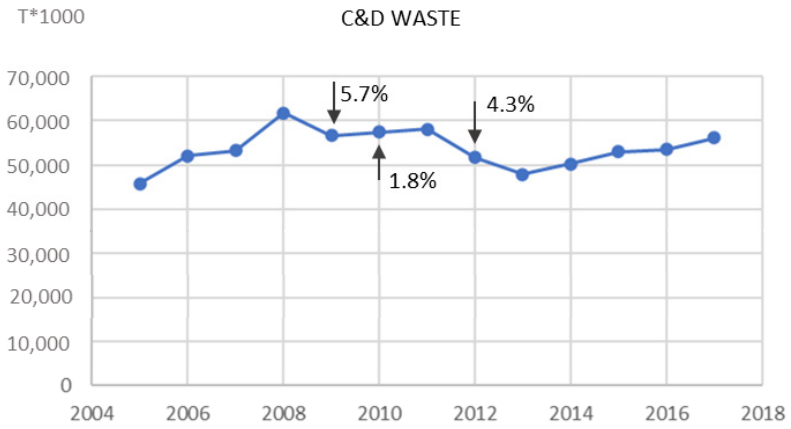

Figure 3. C&D waste production in Italy. Source: Own elaboration from ISPRA data.

This data confirms how the production of this kind of waste is directly linked with the economic situation experimented by the country: the more construction activity is done, the more waste is produced. Considering Figure 4, analysing the three main parts in which the country is usually divided, the waste production is concentrated in the most developed part of the country where the main industries are. The north of Italy presents a level of production of waste of almost 3000 kg per inhabitant, high compared to the 1500 kg per inhabitant produced by the south part. The average of waste production for the Italians is 2300 kg per inhabitant; the difference between the different parts of the country underlines once again an old inside problem in which the south part during the passage of the years remains underdeveloped from certain points of view, giving more space to the agricultural field. This aspect regarding the difference between the various parts of the country is the direct consequence of the policies implemented and of the territorial characteristics offered.

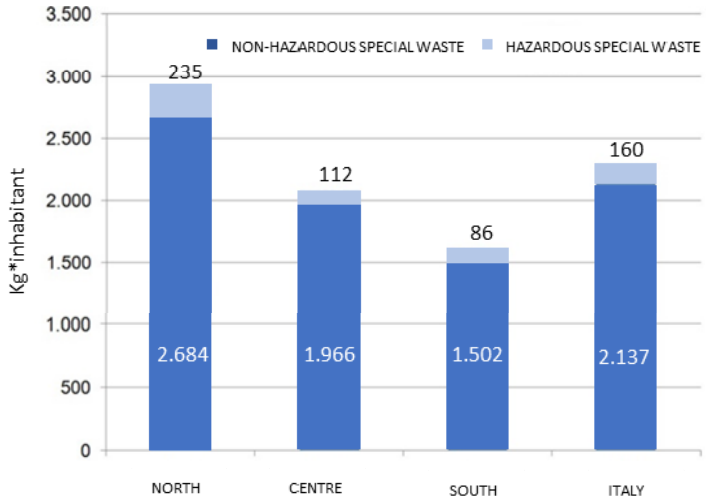

Figure 4. Special waste production in the main parts of Italy. Source: Own elaboration from ISPRA data.

Analysing the regions in-depth, the results obtained are different because their size and activity are various. Studying closely Figure 5a–c, the data has been divided into the three main categories in which the country is usually studied: north, south and centre. The data collected encompasses a span of five years in which an economic crisis occurred and somehow it affected the production of C&D waste.

Figure 5. (**a**) C&D waste production in the northern regions of the country. Source: Own elaboration from ISPRA data. (**b**) C&D waste production in the northern regions of the country. Source: Own elaboration from ISPRA data. (**c**) C&D waste production in the northern regions of the country. Source: Own elaboration from ISPRA data.

The one with the highest rate of production is Lombardia with more than 13 million tonnes of waste in 2018. This region is the biggest one in the country, with a fervent industrial activity, and this data is a clear reflection of its status. Even in 2014 the production of waste of this area of Italy presented a level of material production up to 11 million tonnes, the highest rate among all the regions that are part of the north area. Small regions such as Valle D'Aosta, with a difficult environmental landscape, where its strong points are not in its industrial production but in its nature and territory, are the ones with low waste production, reaching less than 0.18 million tonnes per year [4].

The situation in the centre is similar, with the bigger quantity of waste grouped in the larger regions such as Toscana with a value up to 3.6 million tonnes of waste in 2018, followed by Lazio with 3.5 million in 2018. In the centre, because the number of regions that comprise it is reduced, the results are more homogeneous with two regions with higher rates and the other two with reduced numbers, but in the range of more than 1 million such in March in 2018, as shown in Figure 5b.

As shown in Figure 5c, the South, similar to the North, comprises eight different regions that generally create distinct scenarios regarding data. The main waste production is generated by Puglia, reaching 3.7 million tonnes in 2018. This data is far from the 13 million generated by Lombardia in 2018 but is the most important data for the southern area. Predictably, the production of waste in this part of the country dominated by agriculture activity is low, with a difference of almost 10 million tonnes in waste amount. The lower data is collected in Molise, which produced only 0.26 million tonnes of C&D waste in 2018, taking into account that this is a small region with low industrial activity.

The production of waste leads to its disposal afterwards. The proper collection of the material allows to better management of it and following Article 181 of Legislative Decree 152/06, paragraph b, by 2020, at least 70% in terms of weight, reuse, recycling and other types of material recovery, including backfilling operations, should be reached. The behaviour of the country under these circumstances is quite good, considering that, after 2011, the quantity of waste prepared for re-use has overcome the set quantity, reaching 75% of generated waste [4]. As shown in Figure 6, the level required by the European Union of 70% was not achieved before 2010, reaching a rate of 68.5% of C&D waste material prepared to be recycled. This behaviour changed after 2011, when the set goal of 70% of waste was overcome by 4.1%, with an upward attitude that arrived at 76.2% in 2015, the best data obtained to date.

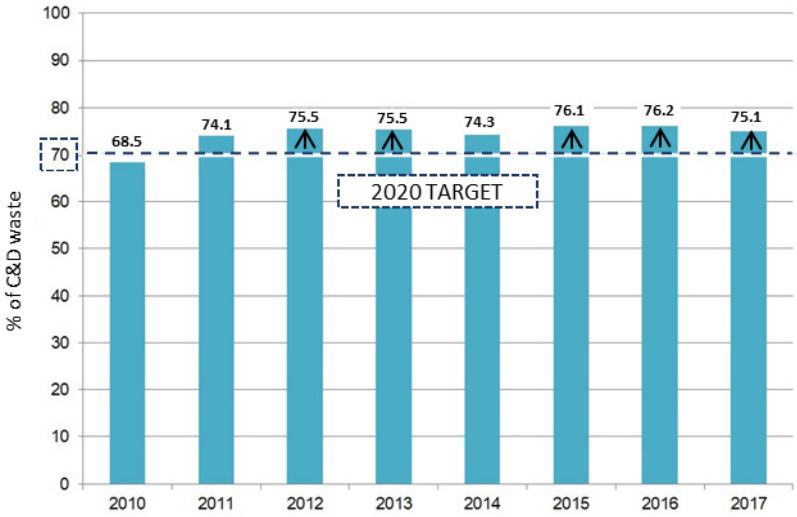

Figure 6. Preparation for reuse, recycling and other forms of material recovery, excluding backfilling. Source: Own elaboration with ISPRA data.

3.2. Challenges in Italy Regarding Sustainable Waste Management

The existing challenges within the sector undermine the possibility for this field to reach the status of an active component of the economy. As it can be observed in Table 1, the challenges can be summarised in nine points of relevance.

Table 1. Challenges in Italy regarding C&D management Source: Own elaboration.

Challenges
1-Distrust in the use of products derived from waste
2-Lack of reliable data on the production of inert waste
3-Lack of updated technical tools
4-Poor source separation waste and use of selective demolition practices
5-Lack of mining taxation
6-Lack of prohibition or obligation to contribute to landfilling of inert waste
7-Obligation to carry out analysis for waste sent for recovery/recycling
8-Criteria End of Waste
9-CE marking

The use of materials coming from C&D activities in Italy is quite reticent due to related illegal practices that happened in the past. The waste material is usually used in road works, where its characteristics are the same as the materials taken from a new source, but if not treated properly before its use, they can create serious problems for the construction company, of both legal and technical nature. It is fundamental to complete the recycling process properly to have a good quality material afterwards. Considering this aspect, the official data of waste production from C&D provided by ISPRA are only estimated and it is conceivable that illicit practices still exist today.

To bring out all the quantities of waste produced by the renovation and demolition of buildings, an intervention in the public administration would be useful. With the correct quantification of data, a proper value of re-used C&D waste can be analysed and estimated if the required percentage of 70% request from the European Union is reached. The main reasons for the reduced large-scale production of recycled aggregates and the spread of their use may include the absence or lack of specific tools, such as the special specifications, updated to the harmonised European sector standards. Therefore, the public works sector must ensure that the Special Tender Specifications are updated based on the most recent European technical legislation, which no longer distinguishes the aggregates based on their origin, but based on their characteristics.

Because of the traditional way of managing waste, Italy does not require a particular commitment in the selection activities at the source of the different types of waste, but thanks to the European Commission requirements, during C&D activities, the different types of waste should be identified through a preventive audit and after a waste management plan should be drawn up [11]. Another type of activity that encourages the use of recycled elements is the taxation of virgin materials; the increase in the cost of the latter could help its use only where higher performance aggregates are required, leaving other uses to recycled aggregates and reused land. The introduction of a ban on landfilling of inert waste could create a similar effect which would aid the consequent development of recycling activities.

The current regulatory framework, therefore, provides for the obligation to carry out analysis for waste sent for recovery/recycling and the exemption for waste sent for disposal, with obvious penalties for recovery/recycling, for waste produced by micro-restructuring of civilian homes. It is also necessary to consider that often the delivery to recovery plants takes place in small quantities, which should however be characterised by the waste producer. This cannot happen as the cost of the analysis would be much higher than that of the conferment of the refusal.

The concept of End of Waste to set technical and environmental criteria to establish when waste ceases to be such and becomes a non-product no longer subject to waste

legislation, could help the cause of waste management, but the criteria have not yet been defined at the European level and it is now clear the intention from part of the Commission to allow the various Member States to do so. The European standards relevant to recycled aggregates have been introducing the concept that products placed on the market must be evaluated for their performance characteristics and not on their nature. Only the CE marking of the aggregates can guarantee the end-user about the characteristics of the material purchased. In a correct market trend, it is up to the user to request minimum characteristics to the aggregates, and to the manufacturer to guarantee them. Therefore, the manufacturer is the one assuming the responsibility both for determining the properties of the materials and for establishing a control process in the factory. It is believed that if the designers and construction managers, in which one provides for the use of aggregates, requiring the accompanying of the material with the necessary documentation, most of the problems of the recycled aggregates market would be solved.

3.3. Management Perspective

An important opportunity for the development of the sector is the application of the rules on Green Public Procurement (GPP) in the various sectors of the use of recycled aggregates. With the publication of Law 221/2015, Italy was the first country, among the EU Member States, to impose the obligation to apply CAM (minimum environmental criteria) for public contracting stations, relaunching the importance that green purchases play as a strategic tool [10]. Included within the Law are a program agreement and incentives aimed at supporting the recycling sector. With the subsequent Code of Public Contracts (2016), the compulsory inclusion of CAMs in tenders was confirmed. They will be required for the assignment of design services and works for the new construction, renovation and maintenance of buildings and for the management of public administration construction sites which include, among the criteria to be applied for the evaluation of projects participating in public tenders, properties referring to concrete. Therefore, to date, all the regulatory tools necessary for the correct dissemination and application of GPP in the construction sector seem to have been developed. However, the use of recycled aggregates in the construction sector is not yet very developed as many recycled materials are used in infrastructural works. Therefore, given their importance, it is hoped that the Ministry of the Environment will resume and complete the CAM for the assignment of design and works services for the new construction, renovation, and maintenance of infrastructures, and that also the public administrations will apply the foreseen provisions imposing the use of recycled materials [12]. The current management of waste disposal is organised in phases that should allow the correct re-use of the material. In a demolition process, the waste should be separated between hazardous and non-hazardous, and differentiated to have the more pure source to be recycled, where all the material impossible to use again will be labelled as non-recoverable. When the waste is sent to a plant to be treated, the process provides an acceptance step, followed by pre-storage, separate waste storage phase and finally the treatment step [15].

4. Discussion

The differences between regions and industrial activities show how the discrepancy of C&D waste production can be significant within the country. To have a clearer perception of how data can change based on the economic status of a region, the territory and the size, some specific cases have been chosen collecting data during a five-year time frame. Confronting the most prolific region, Lombardia, with the less fruitful regions such as Molise and Valle D'Aosta, it can be seen that not all regions present the same behaviour regarding production over time. As shown in Figure 7, the production of Lombardia was linked with economic issues with a decreasing value until 2015 and increasing the quantity of waste with the improvement of the economy after the crisis, with the highest value of 13.2 million tonnes in 2018. The decrease and increase phenomena were not so extended, with only a difference of approximately 1 million tonnes. In the case of Valle D'Aosta,

the increase during years 2014 and 2015 presented a difference of 221,005 tonnes with a decrease after 2015 with a difference of the value of 399,764 tonnes. Clearly, the values seem small compared to the 1 million tonne difference found in Lombardia, but the low total rate of waste production as to be considered, because this region is small and so is the production. This result shows how for the small region of Valle D'Aosta the economy was affected in a different way having more repercussions, compared to Lombardia, where, thanks to its status as a bigger region, could survive better to the difference of the market.

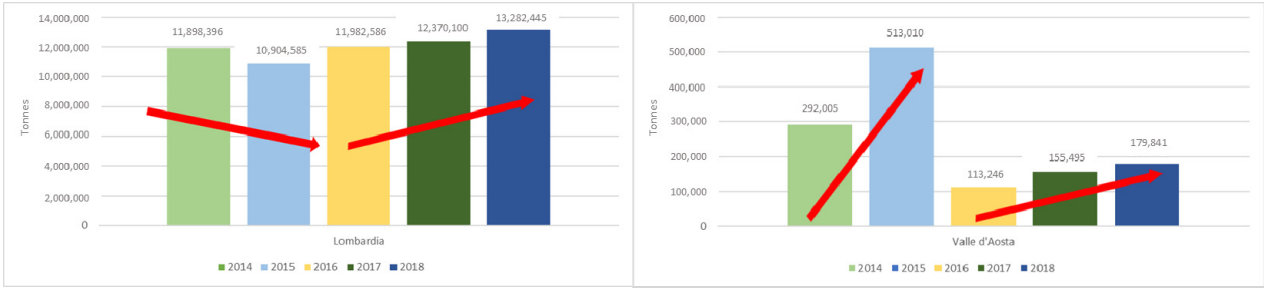

Figure 7. C&D waste production behaviour in the region of Lombardia and Valle D'Aosta. Source: Own elaboration with ISPRA data.

Considering the region Molise in the South compared to Lombardia, another behaviour is presented. This region, similar to Valle D'Aosta, is small and with a limited number of inhabitants and reduced industrial activities. As shown in Figure 8, the adaptation to the economic situation arrived at different timing. In Lombardia the decrease took place between 2014 and 2015, and after that there was only a recovery phenomenon. In Molise, there was a gradual increase in C&D waste production until 2016 with a small decrease of only 6550 tonnes in 2017, followed by another increase of 114,473 tonnes.

This behaviour presents a different approach to the economical market, showing that for this part of the country where the industries are not so prevalent, other factors take place in the quantity of waste produced, leading to a smoother transition between increase and decrease and with pick often unexpected [16].

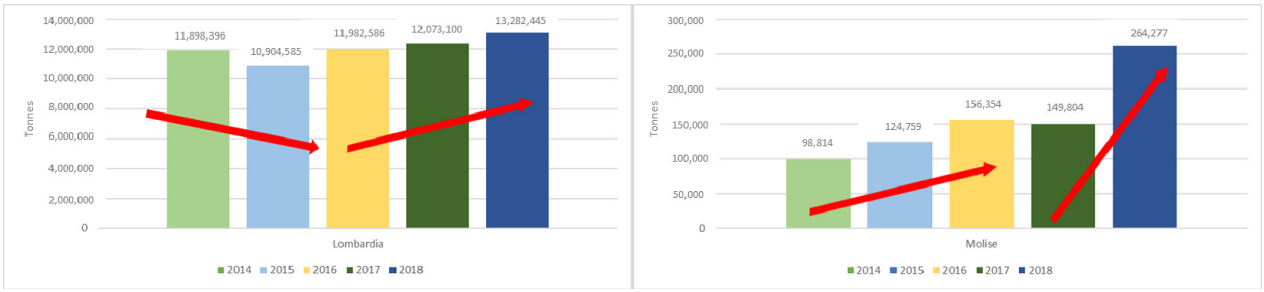

Figure 8. C&D waste production behaviour in the region of Lombardia and Molise. Source: Own elaboration with ISPRA data.

The recycling and waste management regarding C&D affects the residue waste from processing materials and components, casings or their packaging, demolition residues, excavations polluted by hazardous substances and water resulting from the processing [3].

Considering that 40% of the special waste production is C&D [4] and according to the European Union at least 70% of that should be recycled, as shown previously in Figure 6, the country somehow manages to reach that objective, achieving 75% of recycled material in 2017 [4]. The law establishes that the person who must deal with the disposal of construction waste is the waste producer, meaning, the company or the individual who carries out the work. For the correct management of the waste, a priority hierarchy was established, where the less sustainable options presented are the last shown in Figure 9.

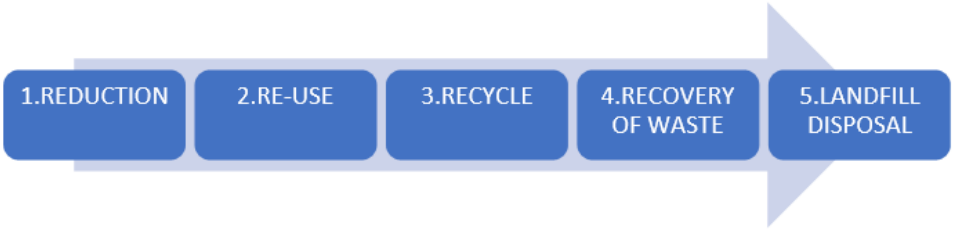

Figure 9. Options for waste management Source: Own elaboration.

Although construction sites, in addition to being places of "production" of waste, can also be considered as potential places for reuse of part of the waste materials, the fragmentation of the process and the lack of geographical and temporal coincidence between demolition activities and activities construction often makes it difficult, if not impossible, to reuse the waste produced on-site [8]. The treatment of special waste, in which C&D waste category is placed, provides for the recovery of material for 71.9% of them, corresponding to 84.1 million tons (by deducting temporary storage) while only 9.4% is disposed of in landfills (10.9 million tons); 66% of this type of waste is treated in the regions of Northern Italy [4].

The production of waste material coming from C&D presents different kinds of components. The capacity of recycling such waste depends on the source; it is not the same if the residue is concrete or wood. In Italy, in buildings that were built in the 1960s and after, the prevailing material found during renovation works is concrete [8]. Analysing the situation of the materials obtained after C&D works, the elements achieved are various: metallic, glass, plastic, wood, minerals. In Figure 10 we can deduce how the volume of waste arranged for recycling increased from 2010 up to 2017, but it must be added that during these years the production of waste decreased, reaching 57,421,000 tonnes in 2010 and 56,112,000 tonnes in 2017 [4]. This growth in data regarding reuse is possible thanks to the improvement of the recycling rate up 9.19%.

Figure 10. C&D waste material prepared to be recycled (tonnes). Source: Own elaboration from ISPRA data.

The results of materials prepared to be reused show that most of the waste are minerals with 86.4% followed by iron waste with 11.9% of the total. The treatment with the material recovery of waste from C&D mainly consists in the crushing of rubble and its use as a low-quality material for soil shaping, the covering of exhausted landfills and the construction of road and railway substrates [8,17].

Landfill Analysis in Italy

In many European countries, landfill corresponds to the last stage before the potential of C&D waste is lost. Regarding Italy, the disposal, which the legislation identifies as residual in the waste management hierarchy, consists in the final treatment and storage of waste and scraps that cannot be further exploited. Typically, the disposal can be identified

with the deposit in landfills, even if the legislation includes in this definition all the preliminary treatment processes that are carried out on the waste in order to minimise the final impacts. Waste is only allowed to landfill if it complies with the admissibility criteria of the corresponding landfill category as established by the decree D.Lgs 13 January 2003, n. 36. To ascertain the admissibility of waste in landfills, some sampling and analysis methods are used. Taking into account that landfills for hazardous waste have a higher level of environmental protection than those for non-hazardous waste, and that the latter has a higher level of environmental protection than those for inert waste, the delivery of waste that meets the criteria for admission to any category of landfill in landfills with a higher level of protection is allowed. According to the last data collected by Eurostat [14], the mineral waste from construction and demolition in the country in 2021 has reached a value of 2.2% over the total production. The quantity of C&D waste disposed in the landfill had a value of 37 million tonnes in 2014, which decreased to 18 million tonnes in 2018. Through this data it can be observed the tendency of the waste destined to landfill that is in continuous decrease.

5. Conclusions

This current paper addresses the actual state of the situation regarding C&D management in Italy, showing the good results in reaching the levels of waste recycling and re-use established by the European Union reaching a level of 75.1% of C&D waste material prepared for being recycled. Nevertheless, more changes and improvements must be taken care of regarding the diverse results in between regions. As shown in the comparison between Lombardia, Valle D'Aosta and Molise, the data are still too affected by the territory and development of each zone, the response to the economic situation has been driven by the industrial development of each region, being more affected if more developed. This aspect is impossible to remove but a more homogenous result could be reached if the regulations and rules are adapted in the same way everywhere. Another aspect to be addressed is the management of the waste that is not recycled. In 2012 even if 76% of the C&D waste was recycled, 24% went to landfill [7]. This data is still too high in value but is improving in recent years. The main material almost recycled in its whole is mineral waste, in which only 3% reaches landfill waste disposal; other materials still suffer the distrust from the user, poor source separation waste and lack of selective demolition practices [12]. Once even these aspects are addressed, this can continue the path to better management towards sustainability and good practices.

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