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CIRCULAR ECONOMY AND UPCYCLING OF WASTE AND PRE-CONSUMER SCRAPS IN CONSTRUCTION SECTOR. THE ROLE OF INFORMATION TO FACILITATE THE EXCHANGE OF RESOURCES THROUGH A VIRTUAL MARKETPLACE

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Abstract

The activities connected with the construction sector are responsible for several environmental impacts, both in the construction sector, and in the many manufacturing sectors involved in the supply chain of materials and products (mining sector, manufacturing sector, waste treatment etc.). The building products have a marked cross-sectorial connotation, according to the ANCE 2016 report, 31 economic sectors out of 36 are suppliers in the construction sector. One of the possibilities to reduce the environmental impacts of this sector is the limitation of the impacts of extraction, supply and production of materials, enhancing the possibility of using secondary raw materials from various sectors. From a circular economy perspective, the possibility of exchanging recyclable waste materials is crucial. In this regard, the paper presented, deals with the theme of strategies for the activation of waste inter-sectorial recycling scenarios. The hypothesis is the creation of a virtual marketplace, structured in an organized network, where the different users (producers or potential users of scraps/waste, industrial process planners, territorial administrators, etc.), can identify and locate scraps/waste usable for recycling. The use of the marketplace requires the profiling of companies that can offer resources and/or search for them, using specific search keys. The research can be conducted identifying: the secondary raw material obtainable (through the CER code and/or Omniclass 41), the origin or destination supply chains (through the NACE, UNI8290 and Omniclass 21 coding) and the georeferencing (through GIS). The work presented is the result of a post-doctoral research project funded by the Fondazione Fratelli Confalonieri of Milan, which had as its central theme, the systems for the exchange of recyclable waste and scraps.

Keywords: waste, recycle, circular economy, environment

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1. Introduction

The global environmental problems that humanity has to face today are largely due to the excessive exploitation of natural resources. This approach represents a serious problem for the planet, which face the exponential growth of its population (with a consequent request for a greater quantity of resources) and does not assist to a radical transformation of the actual trend on the resource management (in order to achieve a better control, a reduction, etc.). The Global Footprint Network annually estimates the date on which the Earth Overshoot Day occurs (the day in which humanity depletes the resources that the planet produces in a year), and we can observe that in the most industrialized countries, this day arrives always in advance on the calendar. In 2018, Earth Overshoot Day for the planet occurred on August 1, earlier than the last year. This is caused by the most widespread model of economic development at a global level (linear model with high production of waste), which does not provide for a strict control of the use of resources, and does not consider the need to transform all productions into sustainable production systems for the environment and the planet. Despite numerous initiatives aimed to change the production trends, Europe is still closely linked to the old production systems. The European Environment Agency (EEA, 2018) reported that Europe currently consumes almost twice the resources it can produce. This modus operandi is no longer sustainable and increasingly requires radical and widespread initiatives, aiming to a radical change in production systems and consumption models.

Among the main pressures inflicted on the environment by humanity, there are, with no doubt, waste. Waste are a manifold problem: their disposal is expensive both economically than environmentally, they can create problems to human health, they are not a valued resource etc. All the aspects listed are able to influence the quality of human life, turning waste into a serious problem, which can be perceived both at the local level and at the global level. Waste is also a problem for many companies, because they affect production both in economic terms (disposal costs) than in environmental terms (environmental impact of production). Turning waste into a resource, is therefore an important change, in order to make the industrial production more sustainable (Blengini et al., 2017; EC Communications, 2011a, 2011b, 2014a, 2014b, 2015). According to studies conducted in Europe, we can affirm that the construction sector, together with the use phase of the buildings (EC Communications, 2014b), are able to use about half of the materials extracted and to produce about a third of all waste. This sector generates environmental pressures at each stage of its life cycle, but it is possible to highlight the greater consumption of resources both in the production phase of construction products and in the phase of disposal. In the construction phase, the problem is connected to the use of resources (in many cases virgin materials) and to the production of waste (both during production than during assembly of material or component). In the phase of decommissioning, the main problem is the tendency to not recover waste from C&D, and to not separate them in an appropriate way to recycle etc.

The main theme is the average lifetime of materials or components, which is never long enough to compensate the impacts produced. This causes a great loss to the economy, because typically they are either disposed in landfills (finally ending the useful life cycle of the material) or are recycled according to the principles of downcycling (recycle that distorts the material as such, transforming it into something less noble and of a lower quality). Being able to make resource consumption more efficient is therefore one of the few viable strategies (EEA, 2017, UNEP, 2017) to improve the environmental situation. This represents a real change for the lifestyle of people and in production for the companies, and these changes must be encouraged and promoted in all possible ways. The information sharing is at the center of this research contribution (outcome of a post-doctoral research project funded by the Fratelli Confalonieri Foundation of Milan), which started with the aim of making productions processes more sustainable, through the contribution of sharing information and the creation of intelligent networks able to trade in resources.

The study is focused on the construction sector, because it is extremely representative of the waste management problem: too many sectors, large quantities of materials and countless companies involved (ANCE, 2016; Migliore et al., 2018). Moreover, the economic importance of construction sector should not be neglected, because it generates almost 10% of the GDP of the European economy and represents about 20 million jobs (EC Communication, 2012). Therefore, starting from the assumption that waste represents a resource and not a problem, the intention of the work is to make possible the tracing of waste and their cataloging and sorting through a virtual marketplace, in which different actors/users can interact tracing resources or tracking down possible partners to which allocate their waste.

2. Reduction and reuse of resources in the construction sector

The construction sector is currently object of numerous initiatives aimed at improving the management of virgin natural resources and the reuse/recycling of scraps/waste. Both in European than in Italian contexts, various initiatives have been launched to improve the current situation. The political interest on this issue is very high and many tools have been made available to support initiatives aimed at improving production systems by controlling and reducing the use of resources. In the European context, the 2014 COM 445 (EC Communication, 2014b) highlighted the actions that can be activated to make the construction sector more sustainable and the results which can be obtained. Among the possible actions listed (EC Communication, 2014b) emerge: the promotion of a design that can calibrate the use of resources with respect to the needs and functionality of the building and promotes the selective demolition scenarios; the planning of building site activities in order to improve a better energy-efficient use of resources and products; the promotion and the production of more resource-efficient construction products (use of recycled materials, reuse of existing materials, use of waste as fuel etc.); the spread of resource-efficient buildings and renovations, where construction waste is reduced and materials and products are recycled/reused in order to dispose a smaller quantity of waste in landfills. Obviously, some key aspects are fundamental for the success of long-term initiatives, such as the existence of an efficient recycling system at local, regional or national level which represents an attractive and cost-effective alternative to the landfill. It should be noted that the interest in recycling is often determined by specific factors: the transport distance to the recycling sites (positive balance between induced impacts and avoided impacts, economic compensation between disposal costs and transport costs to recovery sites, etc.), and the possibility of being able to guarantee a level of purity and standardization of the recovered materials that should be reused. The standardization factor will become one of the key aspects in the marketplace, because if the characteristics of scraps/waste material, (intended to direct or indirect recovery) are not clarified, it will be difficult to find potential users. The COM 455 also speaks about the importance of the dissemination of standardized and comparable information, a fundamental tool to allow anyone to make choices that are not only ethical but also, and expecially, professional and technical. Indeed, speaking about the great quantity of tools and supports for environmental improvement, means to acknowledge that often there is no linearity between information, especially between global scale and national scale.

Another aspect that emerges, related to products or building environmental certifications, is that they are predominantly voluntary, and the percentage of certified buildings is currently very low, about 1% (EC Communication, 2014a, Ecorys, 2014). This aspect, if supported at national and EU level, could encourage greater interest from companies to do better under the environmental point of view and to highlight the certification as a factor of competitiveness. Having available helpful and usable information, could in fact facilitate decision-making processes and launch industrial ecology scenarios at different scales.

3. The virtual marketplace for the exchange of resources

The purpose of this work is to demonstrate the importance of the role of information in promoting the recovery and recycling of resources, focusing on the construction sector. The actions carried out to structure the marketplace were: analysis of good practices (replicable and perfectible in other production contexts), taxonomy of waste (identification of fundamental characteristics that can allow the traceability of waste for a possible cross-sectorial transfer), contextualization on the territory of resources (geo-localization), creation of synergies in the marketplace.

3.1. Analysis of best practices in the European contest

A cognitive action carried out with the aim of identifying some possible best practices, already experimented and therefore replicable, was the one related to the study of research projects concerning the valorisation of waste in the European context. Nowadays, the experiences of recovery and enhancement are many, and they are rapidly spreading. However, research and documenting these experiences in an appropriate way is not easy; if the initiatives are conducted privately by the companies the modus operandi is never disclosed (for obvious reasons of industrial policies), but when these eco-innovation processes take place through public funding, we can rely on a lot of information.

For this reason, the study focused on research projects funded within the European Union on issues that concern the protection of the environment and more specifically the valorization, recycling or reuse of waste. These projects respond to the main macro themes (EC Communication, 2011a, 2011b, 2014a, 2014b, 2015) promoted by the EU on environmental issues, and the most analyzed were: Life projects (EEC, 1973), Cip projects (EU, 2006) and Horizon 2020 projects (EU, 2013), which represent the most successful initiatives found on the national and international scene. The study conducted on projects belonging to these investment programs, is divided into two phases. The first phase was aimed at identifying relevant projects in the construction sector that operate on the theme of recovery and valorisation of scrap/waste. The survey was conducted using the IT support provided by the European Union.

Concerning to recycling, the elimination of waste and its reduction, emerges that there is a marked interest in recycling, but the elimination and reduction of waste are actions that are difficult to implement on their own. However, in many cases it has emerged that some initiatives are addressed to combine both reduction, elimination and recycling.

It is clear that, in order to activate circular economy scenarios, it is not possible to limit the study to a single perspective. If the scope of the initiative is wider, more results will be achieved (it is necessary to overcome the "company boundary" and think about systemic solutions that can involve different subjects, even belonging to different sectors of goods). The second phase of the study was aimed to summarize the results of the analysis carried out on the projects (Fig. 1), and to categorize them according to different research keys (NACE code, CER code, Omniclass 21) that will be useful to filter and identify that projects which meet the needs of the users of the marketplace.

The categorization system used (Migliore et al., 2014, 2015, 2016) starts from the examination of the projects, identifies the type of innovation implemented (new production process, innovative production process, new product with recycled content, innovative product with recycled content, service) and categorizes the type of impact expected from the project (recycle, reduction or zero waste). Then, it tabs the projects using different types of codes that will allow the tracing (CER code for the type of waste, NACE code for the type of the product sector involved in entry and exit, Omniclass code to identify the type of product for the building involved etc.).

3.2. Proposal of a waste taxonomy

A very important action carried out with the aim of making fluid the exchange of resources, is tracing the waste with a unique code that makes its identification simple and immediate. The knowledge of scrap/waste is essential to be able the transfer and/or the reuse it in other production contexts.

Fig. 1. System of analysis and categorization of research projects identified as best practices

One of the problems that currently restricts the use of waste is a lack of knowledge of how and what is produced in terms of scrap/waste. Many waste materials are potentially reusable, but without a system that can trace and identify their position, quantity and quality it is difficult to implement any type of recovery. A valid strategy to facilitate the reuse and enhancement of pre-consumer material waste, could be the implementation of an easier access to information from potential stakeholders (end users). The activation of industrial synergies based on recycling, depends on the possibility of tracing waste that can be valorized.

The characteristics that distinguish them are not always compatible with the possible reuse or re-insertion in the supply chain of origin or in other supply chains. To do this, it is essential to share valid information about the characteristics of potentially

exploitable waste. The information has to be well organized and related to the various assessment purposes, that may be necessary to implement continuous recycling plans. It should be emphasized that waste is often not considered in its potential as a second raw material, due to insufficient information associated with it (spatial location, quantity, morphology, technical characteristics, availability over time etc.). Currently, the waste is identified with the CER code (EC Communication, 2014c), a unified system at European level that allows to recognize the waste compared to the sector and the production process that generates them, as well as for their hazardous or non-hazardous.

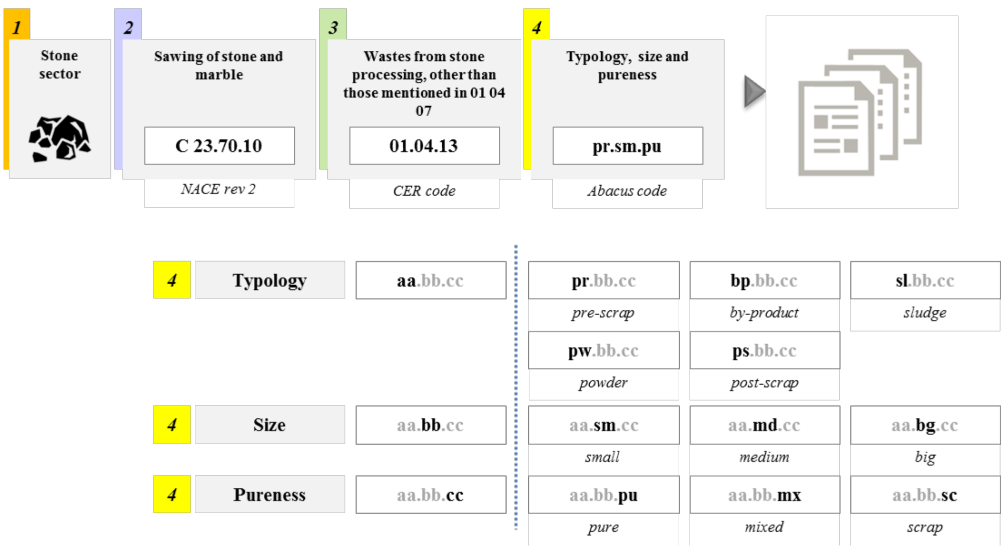

Fig. 2. System for the construction of the waste identification code

However, in some cases this code is rather generic (usefulness for a simple disposal), and useless for the purpose of a possible recovery/enhancement. The CER code is not created for this purpose and it fails to transmit information relating to the quality and characteristics of the waste. However, it represents a good starting point for being able to construct a speaking code that identifies a refuse in a univocal way by associating it with a series of useful information for the purpose described.

The proposal presented in this research project aims to associate different information through the combined use of the NACE code (Eurostat, 2007), the CER code (EC Communication, 2014c) and the Abaco code (Fig. 2). The proposed code is divided into 4 parts: the first part groups all the processes that compose it under the main production chain (it cannot be codified and can only be referred to as a trace for specific research on the supply chain); the second part of the code derives from the NACE database (Eurostat, 2007) and identifies the processes that mainly make up the supply chain; the third part identifies the scrap/waste according to the CER code (EC Communication, 2014c); the fourth and last part identifies the waste according to the "Abacus code". The Abaco code object of the research consists of three fields separated by points that identify three main peculiarities of the waste useful for the identification for recovery purposes.

Figure 2 shows the trace followed to build the Abacus code which is considered valid for recycling: the type (pre-scrap, byproduct, sludge, powder, post-scrap), the size (small, medium, big) and the purity of the waste (pure, mixed, scrap). Obviously will be also necessary to draw up a technical sheet that will contain specifications of mechanical, physical and chemical nature.

3.3. Contextualization on the territory of the materials

The last action carried out, to build the necessary information for the recovery and exploitation of waste, concerns the knowledge of quantity and location. This operation can be done through the use of GIS (Geographic Information System) applications. The information implemented with this logic can also contribute to evaluating other details, such as transport network, hydrography, population characteristics, economic activities, jurisdiction and other characteristics of the social and natural environment. In this study, these variables were not considered, but it is clear that they can be implemented and become useful data to provide other studies and other views of the territory.

With reference to the project conducted, the goal is to be able to place on the territory the quantities of by-products, waste and exploitable waste and to develop monitoring and analysis of possible scenarios. For example, through the Geoportal of the Lombardy Region, using the GIS set up for the land register, it can be shown how an instrument already in use at the regional level can also become useful for recycling and for the circular economy.

Figure 3 shows an extract of the elaborations that can be done through the Lombardy Region Geoportal and shows that this tool already provides an "identity card" of the quarries, information that can be implemented and made even more useful under other aspects. For example, by entering the quantities of materials extracted and the quantities of scrap/waste not recovered, it will be possible to provide useful data to the planners in order to activate management plans optimized from the environmental point of view. Similarly, the industries present on the territory could be mapped and with the same logic of the quarries, a series of information on the production of waste could be referred to them. All this information is part of the network of facilities made available in the marketplace to track industrial ecology scenarios.

3.4. Structure of the marketplace

The marketplace proposed by this research is configured as a space in which heterogeneous users with different objectives can relate in order to identify possible forms of collaboration. The common aim is to extend the useful life of resources, through exchanges of waste materials, which can turn into resources for other productions. The marketplace is therefore configured as a real network of companies and actors with decision-making power on the production chains. The expectations arising from the use of the marketplace are to encourage the exchange of scrap/waste through their technical profiling. This operation becomes possible according to the connections established between the needs of the different "users" (Fig. 3). The first users are the scrap/waste producers who want to offer it, the second users are the «users» looking for the secondary raw material, the other hypothetical «users» are professionals looking for materials with recycled content or «stakeholders» who intend to start up innovative recovery processes within their production chains.

The different users, profiling themselves, will have to define their scope of operation (NACE sector). This initial information will allow us to identify companies that belong to the same sector and which, having common interests, can establish profitable industrial connections for environmental improvement. Beyond this primary information, users will provide specifications to implement four macro-areas, sufficient to be able to track down resources (primary, secondary) and output products from production processes. The macroareas identified are raw materials (which are used to produce the main product of the supply chain), products, by-products (if any) and waste. Each user can fill out this information according to what he is offering and what he is looking for.

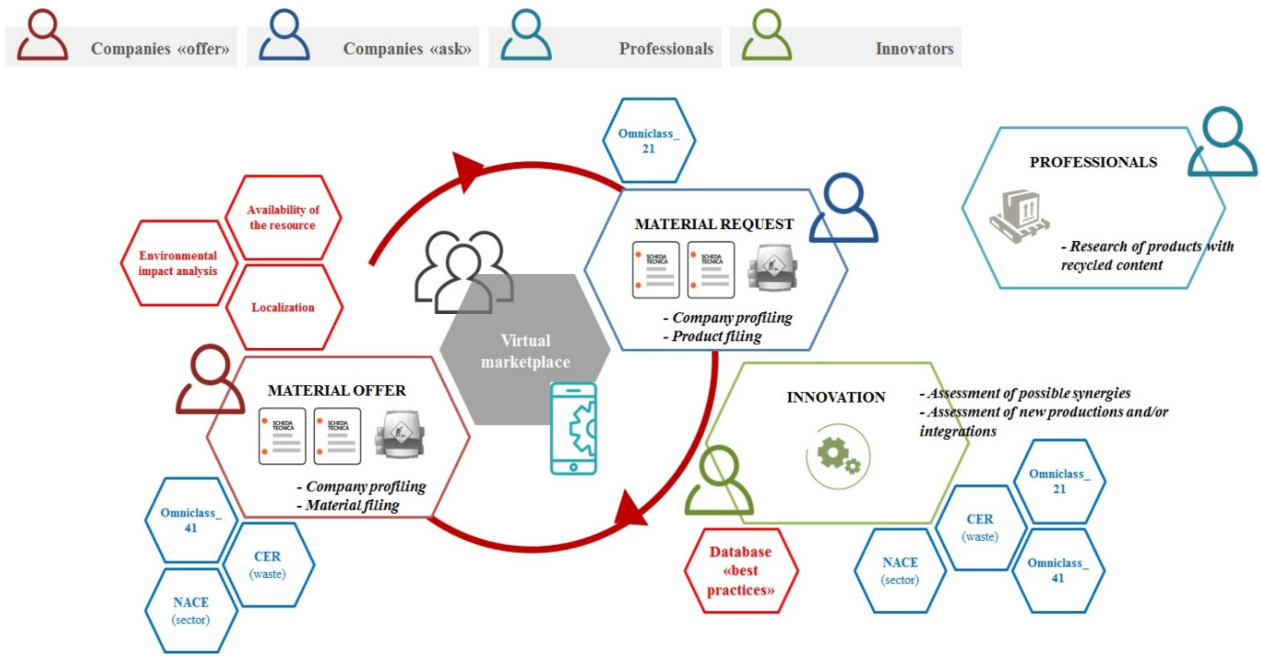

Fig. 3. Structure of marketplace

A greater quantity of information increases the chances of establishing connections, which corresponds to the principles of circular economy.

4. Conclusions

The research work presented focuses on the importance of the close relationship between the parties and the importance of unique and well-understood information. The reuse and exploitation of waste represents a difficult problem to manage due to stringent regulations on the sector. However if from industrial processes we learn to produce only products and by-products (previously called waste), there would be no waste production or at least this would be reduced. This operation becomes simpler and more immediate with the use of a virtual marketplace, because different users are related to different purposes, and the material that otherwise would be destined to landfill is made available.

Following the logic adopted, waste is no longer such, but becomes by-products, with standardized and well-declared characteristics. This simplification is the real strength if we want to promote the valorization and recovery of materials. It has to be noted that currently many resources are wasted (through landfill disposal) because we do not have full knowledge of what is available, and we do not know the hypothetical users of the resource.

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