Influencing Factors for the Use of By-Products in the Construction Industry

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ABSTRACT: In several European countries, the construction industry has to face an existing or future lack of natural resources. Although research on the use of by-products in the construction industry is abundant, countries in Europe do not reach the same rate of construction waste re-integration into construction works. In order to identify some influencing factors for the use of by-products in the construction industry, this paper studies the case of The Netherlands and France at a national and company level. It follows a methodology of participatory observation that enables the observer to obtain a good understanding of the local context and company-specific information. The paper aims at setting the basis to build an explanatory framework for the use of by-products in the construction industry according to several parameters derived from the participatory observation: socio-economics factors, national and international policies and companies’ strengths and weaknesses. When created and further elaborated, this framework could be generalized and serve for decision-making and policy building to increase the use of by-products in the construction industry.

1 INTRODUCTION

According to the World Business Council on Sustainable Development (2008), between 21 and 31 billion tons of concrete were consumed in 2006. Concrete is the second most consumed product on earth after water, which makes the construction sector one of the most important industries in the world. The European Federation for Precast Concrete (BIBM) defines concrete as “a mixture of sand, gravel and/or other aggregates bound together by a water-based binder, cement”. It can be used for various applications: construction of houses, production beams (structural applications) and tiles, or solidification and stabilization of roads (non-structural applications). For structural applications, primary raw materials (rocks, gravels, sand directly extracted from quarries) are mainly used. For non-structural applications, aggregates can be of a lower quality and by-products can be used instead of primary resources. In a context of increasing regulations on the extraction of primary aggregates, the identification and development of by-products and substitutes is of high importance. Sources for by-products and substitutes are manifold: secondary raw materials (e.g. bottom ash aggregates), other types of rocks (e.g. massive rocks), new types of aggregates (e.g. marine aggregates) and above all, recycled aggregates from ready-mix concrete leftovers and from deconstruction wastes. Countries have different approaches with regards to the use of by-products in concrete. This paper aims at identifying some of the driving factors for the use of by-products in the construction industry with a focus on recycled aggregates from ready-mix concrete leftovers and from deconstruction wastes in The Netherlands and in France.

2 METHODOLOGY

To identify some of the driving factors for the use of by-products in the construction industry, a casestudy approach is applied. Scientific methods count a variety of case-study approaches (Bryman & Bell 2011). Here, the positivistic approach has been chosen (Eisenhardt 1989) as it consists in extracting variables from local contexts in order to generate generalizable propositions and build theory (Bryman & Bell 2011). As two contrasting cases are considered, this research
can be furthermore defined as a comparative design case study (Bryman & Bell 2011), which allows understanding better certain phenomena by considering the same issue in at least two different sociocultural settings. This paper also includes longitudinal elements such as interviews conducted during a period of “participating observation” (Journé 2008) and according to Mucchielli principles (Mucchielli 1993). In this kind of participation, the researcher takes part to the activity of the people observed and obtains close information by adopting the organization’s codes, which facilitates the access to internal data and their interpretation. The choice of the cases is related to internships that I completed at INASHCO B.V. in The Netherlands and at Lafarge Aggregates in France for a period of respectively 10 months between 2009 and 2010 and one year between 2010 and 2011. INASHCO B.V. was created in 2008. It is a company based in Rotterdam that aims primarily at recovering small non-ferrous fractions from Municipal Solid Waste Incineration (MSWI) with a specific technology called the ADR. This technology enables the treatment and recovery of bottom ashes from MSWI that can be reused in the production of concrete as secondary raw materials. The performance of the ADR is also adapted to the recovery of aggregates from deconstruction wastes. Lafarge is a French company that started with the extraction of lime in 1833 as a family-owned business. To-day, Lafarge Aggregates is a subdivision of the Lafarge Group that has three other segments: Cement, Concrete and Gypsum. It is one of the worldwide leaders in construction materials with a turnover of about €16 million in 2012. In the case of Lafarge, the participating observation took place within a “research-action” (Liu 1983), where a change was introduced in the organization and the effects were observed. This change was the creation of the Recycling and Upgrading Direction at Lafarge Aggregate in October 2010. The analysis is the result of country and company data according to socio-economic factors, national and international policies and company strengths and weaknesses.

3 CASE-STUDY RESULTS

3.1 Socio-economics

The Netherlands and France are both industrialized countries but they differ in their population density and the availability of natural aggregates. According to the World Bank, population density in France was of 118.82 people per square meters in 2010 against 492.60 in The Netherlands. This affects the construction market as the rise in population and the changing lifestyles caused an increase in aggregate demand (UNICEM 2011). In France, the population rose from 54 million inhabitants in 1982 to 65 million in 2008. This caused an increase in aggregate demand to build accommodations from 347 million tones in 1982 to 432 in 2008. Nevertheless, accommodations are still insufficient, especially in Paris (40,000 accommodations against 80,000 needed), due to the increase of single-parent families (Fritz 2011). In The Netherlands, the demand for aggregates is also stimulated by stricter construction norms (CUR116) that impose the regular deconstruction and reconstruction of buildings. In 2011, France counted 1388 aggregate producers predicted to produce 379 million tones of aggregates whereas The Netherlands counted 135 pro-durers for 73 million tones (UEPG 2013). The recycling rate of these aggregates in France represents 5% of the total amount of available aggregates against 25% in The Netherlands. Due to its access to other kinds of aggregates like marine aggregates, France still has some years ahead before it needs to improve and increase the recycling rate of aggregates. Market maturity also has an important role to play. In France, the final users assimilate re-cycled aggregates to low quality products and the public administration does not support the use of recycled aggregates enough. In addition, the public lacks of awareness. For in-stance, the Lafarge group often has an image limited to the cement production, an activity responsible for large amounts of CO2 emissions. Out of 20 persons asked in 2011, no one knew that concrete could be recycled as a source for secondary aggregates (Fritz 2011). In The Netherlands on the contrary, the reuse of by-products is well perceived as it is a necessity.

3.2 National and international policies

At a European level, the 2008/98/CE Directive on waste set the objective to recycle 70% of deconstruction wastes by 2020. Hence, national and international policies have to consider incentives such as landfill taxes or subsidies (Duran & al. 2006). Taxes in the European Union may
vary from a few euros up to €200/tone (Fischer & al. 2012). The Netherlands is among the first EU countries that adopted landfills taxes in 1995 with €84.78/tone. Consequently, the amount of recycled waste rose by around 30% in the period 1995-2003 (Barellings & al. 2005). In addition, Dutch companies participate actively to the elaboration of norms and regulations for the reuse of recycled aggregates. Customers, suppliers and R&D institutes work together to document new materials that could be used in the technical guideline CUR 116 - concrete with aggregates as coarse aggregates (INASHCO 2014). This is how the Dutch Government endorsed the use of upgraded bottom ash from MSWI as aggregate for concrete. This technical guideline allows 50% of bottom ash aggregates in concrete without reinforcement and 20% in concrete with reinforcement. In France, such participatory system also exists and is centralized by the CERIB, the national testing center for the concrete industry. But the integration of new specifications such as in the “fascicule 65 français donnant les exigences au béton dans les bâtiments publiques” (French document n°65 giving the requirements of concrete in housing applications) is slower. Although companies are willing to use by-products and are convinced of their compatibility with concrete applications, the lack of supportive norms prevents them from using and promoting recycled aggregates. The landfill tax for construction wastes in France came into force in 1999 with the “Taxe Générale sur les Activités Polluantes” (TGAP) that follows the polluter pays principle (Fischer & al. 2012). The TGAP was about €30/tonne in 2012 (Fischer & al. 2012). Although this amount is still reasonable compared to the cost of recycling or recovering construction aggregates, it tends to rise (€40/tone in 2015) which is supposed to reduce the amount of construction wastes going to landfills (Fischer & al. 2012).

3.3 Company strengths and weaknesses

My experiences at INASHCO and Lafarge Aggregates made me understand through a participating observation how the use of by-products in the construction industry strongly depends on companies’ strengths and weaknesses. The top management support is the first step. At INASHCO, this is anchored in the company’s mission that is to “maximize economic value and environmental benefits by optimizing recycling effectiveness and marketing of the recycled products”. At Lafarge, the creation of the Recycling and Upgrading Direction in November 2010 and the launching of a recycled aggregate brand, “Aggneo”, also supports this commitment. A parallel step is the analysis of the economic feasibility of the business, which is closely linked to the location of the recycling plants compared to the sources of recycled aggregates. In the Netherlands, large quantities of recycled aggregates are treated on large waste collection platforms. This is possible as distances between deconstruction sites and recycling platforms are usually short, which makes the transportation costs rather low and allow hence economies of scale. In France, distances between de-construction and recycling sites are usually longer. This makes the collection of high deconstruction wastes quantities difficult, although concrete represents more than 80% of deconstruction wastes (Fritz 2011). Contrary to the lime or the cement market, for which the sale price allows transportation up to 200km, the aggregate market is very local and does not go beyond 25km on average (Fritz 2011). Another important driving factor is the selection and quality of by-products, which is closely related to available technologies. In The Netherlands, the technologies are very effective to recycle and upgrade construction wastes. For instance, INASHCO’s ADR enables recovering the metals in bottom ash from MSWI up to the very fine fractions below 1mm. This results in a bottom ash aggregate that can be used for concrete tiles, blocks and bricks according to the EN 12620 and the CUR 116 norms. The ADR can also be used to recycle deconstruction wastes and hence eliminate impurities such as small plastic particles. In France, the recycling issue is starting at the waste collection. Deconstruction wastes are not homogenous and their quality differs from site to site. In addition, there is no real traceability in place to control the amount of wastes available and determine the economic feasibility of treating them due to competition between construction waste users and producers (road constructors, deconstruction companies, ready-mix concrete producers, pre-cast products manufacturers). Also, the contracts signed for construction works generally lack of requirements for waste treatment (Fritz 2011). Last but not least, the employee involvement is an important strength as employees represent the company and build on the company’s image and reliability, from the secretary to the sales representative. At INASHCO, the importance of recycling aggregates is at the heart of the company’s strategy. At Lafarge, in 2010-2011, the top-down approach resulted in different awareness levels.
with regards to this new activity.

4 DISCUSSION AND CONCLUSION

In France, contrary to the Netherlands, recycled aggregates are mainly used for road applications or for filling up quarries. Despite the existence of the EN-206 20 allowing the use of recycled aggregates in concrete, there are no uniform practices as the quantity, the quality and the transportability of these by-products strongly vary depending on the local European or national context but also within one region or even within one company. As mentioned by Tam (2009), the construction industry should develop homogenous policies in concrete recycling, governments should provide more financial support and the standards should clearly specify for which applications recycled aggregate could be used. But this paper shows that driving factors are also situated at a market and company level and they furthermore differ depending on the country. The change in the aggregate sector follows above all the forecasted economic gains and the regulatory context. Mentalities are in some countries like in France an important barrier for the use of by-product in the construction industry due to a lack of awareness or acceptability. The re-use of by-products is lacking behind due to a lack of involvement of prescribers like municipalities. The results of this study should be completed by further investigation and literature review to build a comprehensive framework and allow its use for country comparisons and for policy-makers to analyse the driving factors for the use of recycled aggregates in their country.

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