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Waste generation and utilisation in micro-sized furniture-manufacturing enterprises in Turkey

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ABSTRACT

The number of small-scale businesses within most national economies is generally high, especially in developing countries. Often these businesses have a weak economic status and limited environmental awareness. The type and amount of waste produced, and the recycling methods adopted by these businesses during their operation can have negative effects on the environment. This study investigated the types of waste generated and the recycling methods adopted in micro-sized enterprises engaged in the manufacture of furniture. An assessment was also made of whether the characteristics of the enterprise had any effect on the waste recycling methods that were practised. A survey was conducted of 31 enterprises in the furniture industry in Gumushane province, Turkey, which is considered a developing economy. Surveys were undertaken via face-to-face interviews. It was found that medium-density fibreboard (MDF), and to a lesser extent, chipboard, were used in the manufacture of furniture, and two major types of waste in the form of fine dust and small fragments of board are generated during the cutting of these boards. Of the resulting composite board waste, 96.9% was used for heating homes and workplaces, where it was burnt under conditions of incomplete combustion. Enterprises were found to have adopted other methods to utilise their wastes in addition to using them as fuel. Such enterprises include those operating from a basement or first floor of a building in the cities, those continuing production throughout the year, those in need for capital and those enterprises not operating a dust-collection system.

1. Introduction

Waste wood can be a potentially valuable resource for the manufacture of various materials and products (Lykidis and Grigoriou, 2008). The type and volume of wastes generated during the manufacture of forest products have changed over time depending on various factors. One of these factors is the reduction in the amount of wood resources available. One example is the change in the past and present utilisation of bark, a by-product of the forest-products industry. The economic value of bark is much lower than that of wood, both quantitatively and qualitatively. Therefore, it has been considered a worthless by-product of the forest-products industry, and has mostly been given away or sold at a low price (Lu et al., 2006). Today, bark can be used as a medium-layer material in board production (Pedieu et al., 2008) and as a raw material in insulation board production (Kain et al., 2012). Ilomäki and Melanen (2001) reported that small and medium-sized enterprises (SMEs) in Finland, which is rich in forest resources, have shown less effort in reducing material losses compared to the country's metal industry.

One of the factors affecting the utilisation of industrial wood waste is the environmental pollution caused by fossil fuels and the regulations imposed to control such emissions (De Hoop et al., 1997). At a time when fossil fuels were much cheaper than wood, wood waste was destroyed by burning. The increase in fossil fuel prices and the environmental pollution caused by their use has resulted in the use of wood for generating energy (Hahn, 1982). The effects of legal regulations on wood waste management can be seen in the management of MDF waste. In Tennessee, where it is a legal requirement for MDF residues to be disposed of in a landfill, the number of landfill sites has diminished and burial costs have subsequently risen, resulting in efforts to demonstrate that these wastes can be utilised to improve soil (EPA, 2011). Lippke and Puettmann (2013) reported that in the forest-products industry, in which biomass is generated as a by-product, it was prohibited to burn wood wastes in boilers for heat production and it is only relatively recent that fossil-fuel boilers have been converted into renewable biomass-burning boilers.

Another change in the management of industrial wood wastes is the reduction in the amounts of waste generated. In commercial

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forestry applications, the amounts of waste generated in the process from cutting a tree to delivering it to the end consumer as a product has been reduced. Those parts of felled trees that are unsuitable for lumber and plywood production are used in paper production. Wastes generated during lumber and plywood production are used in the production of composite panels, whereas bark is used to generate energy by burning (Hahn, 1982). Blatner et al. (2012) reported that by-products generated as a result of lumber production in the western United States fell from 59% to 51% in the last 40 years, despite the decline in lumber volume.

Recycling of all industrial wood waste is theoretically possible, but in practise there are factors that limit recycling practises. These include waste collection and transportation, the scale of the business, the industrial sector in which the company operates, the amount and type of waste produced, environmental regulations and the level of development within a particular country.

The presented study aimed to identify the types and utilisation methods of solid waste generated by micro-enterprises operating in the furniture industry in the province of Gumushane, Turkey. This region is considered a developing economy by gross national income per capita (The World Bank, 2014). The presented study evaluates if certain properties of these businesses have any impact on solid waste utilisation. For these purposes, the research questions were defined as follows:

- What kind of solid wood wastes are generated in the micro-sized enterprises?
- How are these wood wastes utilised by these enterprises?
- How does location in the province, sites in city, and operating periods of the businesses affect the selection of waste utilisation methods?
- How do problems faced by businesses affect the utilisation of wood wastes?
- Are there any differences in the utilisation of wood wastes between businesses with and without dust collection systems?

1.1. The forest-products industry and its waste materials

The forest-products industry uses wood as a raw material. This industry includes lumber, furniture, paper and paper products, pulp, and other wood industries (Pentti et al., 2002). It is usually divided into two distinct industrial sectors. The first is the primary wood-products industry, which covers a wide range of operations from lumber production to the manufacture of finished products that are mostly or completely made of wood or composite wood materials (Burton et al., 2003). The second is the value-added or secondary forest-products industry, which manufactures products by processing raw materials or semi-processed materials, and generally includes the production of pallets, light furniture, cabinets, doors, and windows (Monroe et al., 1999).

A portion of the raw material becomes waste during the production process (Gombatz, 2007). These wastes vary due to the differences in raw materials that are involved in production, in the actual production processes, and in the different finished products in the primary and secondary wood-product industries. Wood waste refers to materials that are unsuitable for the production of wood products. They take different forms such as bark, small chips, sawdust, wood edges, and low-quality wood rejected by the manufacturing process (Burton et al., 2003). These wood wastes can be classified into three types: bark, coarse, and fine waste. Bark waste consists of the bark on the exterior part of the log. Coarse wastes include slabs, timber edges, and veneer cores that are suitable for chipping. Fine wastes include by-products that are not suitable for chipping, such as sawdust and veneer clippings (Murphy et al., 2007).

Wastes generated in primary and secondary wood-product factories are biomass resources (Skog and Rosen, 1997). The intended use of this biomass can be divided into energy and non-energy applications. The use of biomass for energy involves combustion to meet the energy needs of homes and industrial enterprises. Non-energy uses include the production of composite boards and wood pulp, land reclamation, animal bedding materials, landscaping, and agricultural mulch; the remainder is sent to landfills (MERAF, 2002; Murphy et al., 2007).

The large-scale use of sawdust and shavings is very problematic. The geographical location of the waste resources and the markets that could use them limit the development of a significant market for these wastes. Long transport distances are generally acceptable only for highly valuable products such as high-quality wood flour. Low-grade products can be used for agricultural applications. Timber shavings can be sold to markets close to where the waste is generated (Harkin, 1969). Other reasons for the limited use of wood waste are the lack of integration of the companies that generate the waste and those that ultimately use it (Nemerow, 2006) and the long delays during waste collection, which can degrade the quality of the waste (Nemli et al., 2007).

It is technologically possible for some factories to meet all of their energy needs by burning the wood waste that they generate; however, it may not be an economical investment (Carll et al., 1982). In some cases, it may not be possible to use waste as a fuel or in other beneficial ways. In such circumstances, the only benefit of wood waste disposal by incineration is to reduce the volume of the waste material (MERAF, 2002).

The type and quantity of emissions arising from burning wood wastes depend on two main factors: the type of biomass (chemical composition) and its physical properties, and the technology used to burn the biomass (Suzdalenkol et al., 2012). Although there are limited data regarding the exact emissions generated in the combustion process, biomass is also an important source of particulate emissions as well as combustion by-products. This is particularly true when they are not incinerated correctly or under conditions of incomplete combustion. The burning of wood wastes can cause serious particulate matter emissions. Pollutants other than particulate pollutants, particularly carbon monoxide, manganese, and organic compounds, can be released in large quantities under conditions of incomplete combustion (Burton et al., 2003). The main drawback of biomass burning is the large amount of emissions that result from improper combustion compared to fossil fuel combustion. This is especially true for the burning of biomass using devices such as woodstoves, ovens, and wood boilers (Van Loo and Koppejan, 2008). Therefore, to reduce emissions, wastes generated during the processing of engineering panels, such as MDF, should be burned only in industrial locations rather than in conventional home stoves, and at temperatures of about 1000 °C (URL 1, 2013).

1.2. The Turkish furniture industry and the quantity of wastes generated

SMEs have an important role in the global economy. Although their contribution varies from country to country, they globally constitute 70% of domestic gross national product (O'Laoire and Welford, 1996 cited in Ilomäki and Melanen (2001)). This type of enterprise (with less than 200 employees) comprises 99% of all businesses in the European Union and 85% of the gross national product. They pollute the environment during their activities but they are often not aware of their impact (Mitchell et al., 2011). Redmond et al. (2008) determined that 39% of small businesses (with 1–20 employees) believe they have no effect on the environment (Redmond et al., 2008). Only 24% of SMEs in the European Union are engaged in activities to mitigate their effects on the