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# Fresh ready-mixed concrete waste in construction projects: a planning approach

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**Abstract**

In the current study, how planning and truck-mixer based waste amounts per 1 $m^3$ fresh ready-mixed concrete (RMC) can be determined was presented. Toward this aim, the formation process of the fresh RMC waste in construction projects was first introduced in a detailed manner, together with an in-depth literature review in this specific domain of the construction engineering and management. Then, the measurement procedure of the waste amount or coefficient of the fresh RMC was revealed and discussed as a practical and creative planning knowledge. Hence, a useful and realistic waste management perspective about the cost and potential environmental savings of the RMC waste was drawn.

## 1. Introduction

Construction wastes not only affect the economy of a country, but also consume natural resources and pollute the environment for a very long term. According to Garvin [1], 40-50% of the energy produced in the world and 16% of available water resources are consumed to produce construction materials defined as waste. $CO_2$ that appears in the production process of such materials makes up 50% of the total $CO_2$ emission in construction. Given the transportation of these material wastes, this share of 50% likely reaches up to 75%. In this environmental pollution and resource consumption, it should be noted that the cement manufacture plays an important role. In addition,

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construction wastes occupy large areas by volume. They have a share of approximately 20-40% of the total area occupied by wastes in the US, Canada, Hong Kong, Australia, Japan, and European Union countries [2,3,4]. This share can likely increase further if wastes are measured in weight [5,6].

Today, the construction industry tries to deal with enormous amounts of wastes as they are very damaging to the environment. However, it is very hard to assert that the construction industry has generally constituted and improved its waste-based business culture so far. In order to reveal the current position of the construction industry as a whole in terms of types and amounts of construction wastes, it is inevitable that various types of estimates and plans on sub-sectors of the construction industry should be carried out.

In this context, how planning and truck-mixer based waste amounts per 1 $m^3$ fresh ready-mixed concrete (RMC) can be determined was presented in the current paper as a part of an on-going research project. This is because, in a reinforced-concrete building project, concrete can have a big share of about 10% of the total project budget [7]. Of course, these amounts can be single numbers or interval-based values. This decision can be based on a statistical analysis of the real world data. Thus, while preparing their proposals, construction contractors in general and quantity surveyors and cost managers in particular can better estimate the amount and cost of RMC by means of these numerical values, and can take some preventive measures to decrease these wastes. In other words, construction contractors will neither order excessive RMC nor bear the related additional cost. Project owners can make realistic estimates on the total project cost by employing these unit waste amounts in the calculation of the planned budget. With an accurate estimation of the amount of the RMC waste, RMC firms can save both RMC and its raw materials (i.e., aggregate, cement, and water) by related preventive and recycling efforts. In addition, by revealing the causes of the formation of the fresh RMC waste, responsibilities of construction contractors and RMC producers can be determined to prevent and minimize this kind of wastes. From another perspective, according to TRMCA [8], RMC of 102 million cubic meters was produced in Turkey in 2013. With this production amount, Turkey is in the first rank in Europe and in the third rank in the world after China and the US. Considering this huge consumption volume of RMC, it is evident that, both in Turkey and in other countries that consume high amounts of RMC, the determination of the accurate amount of the RMC waste has a vital aspect for customers, producers, and society in terms of the cost-effective business, sustainable natural resources, energy-saving processes, and the environmental pollution. Moreover, this amount can be used in the solution of conflicts between RMC producers and consumers about the amount of RMC delivered or about the loss of RMC.

## 2. Fresh RMC waste

In construction projects, amounts of materials used both in the cost estimating process by owners or their consultants and in the cost planning process by main contractors are determined through detailed quantity surveying studies on project drawings. However, given current on-site practices, it is nearly inevitable that there are almost always some natural differences between planned values calculated in quantity surveying studies and real material amounts used in construction job-sites because of some reasons such as poor workmanship and losses during the transportation and placing activities. In order to take into account these differences, planning engineers and technical personnel in construction projects assign some practical specific coefficients or percentages without making any measurement, but by being based totally on their own experience. It means that the nominal waste for each material is waste allowances typically used by construction companies in their quantity and cost estimates. Basically, they multiply these specific values by amounts of related materials and finally find out the last quantities that will be used in construction projects [9,10,11]. However, these last material quantities become different from those in practice owing to the fact that these coefficients cannot be successfully estimated and that some unexpected wastes are thus automatically created. In fact, this is because material wastes cannot be completely avoided and prevented due to different production methods and products in construction sites and unqualified quantity surveyors and estimators [12].

Especially in the last decade, many research studies have focused on the construction waste quantification issue. These specifically include waste generation activities both in the construction of new buildings and in civil and