CONTROLLING WASTE ON BUILDING SITES BY DEVELOPING A WASTE DISPOSAL PLAN

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ABSTRACT

Almost four million tonnes of construction waste are produced annually in the Netherlands. This amount must be reduced, which is why it is no longer allowed to dump construction waste. Instead, it must be separated into recyclable fractions. The remainder may then be incinerated, preferably in a way that generates energy.
The government is trying to enforce this aspect of sustainable building by prohibiting dumping of construction waste and charging high rates for waste incineration.
For the building contractor who does not separate construction waste, this means losing a great deal of money. It is therefore in the building contractor's interest to separate waste flows in such a manner as to minimise costs.
This is not as easy as it may seem, however. Careful thought is to be given first to identifying the best way to separate the waste, remove it from the building site and store it. Once a decision has been made, it is then laid down in a waste disposal plan.

This paper discusses a method that the process designer can use to develop a waste disposal plan in conjunction with other implementation plans. This method is comprised of a set of instructions for the process designer and the foreman.
It contains a literature study regarding construction waste flows and analyses of waste disposal at three building sites from source to disposal. The instructions for the process designer consist of a step-by-step plan, which utilises his knowledge, as well as experience from previous waste disposal plans. The instructions can also be converted into a computer program. The instructions for the foreman are such that the transfer of information describing implementation is done using pictograms.

Construction site waste flows are managed through the development of a waste disposal plan and a set of instructions for the process designer. In addition, insight is gained into the amount of construction waste produced and its composition. At the same time, application of the waste disposal plan will lead to a cleaner construction site, which may reduce the risk of accidents.

KEYWORDS:

Construction waste; sustainable building; cost control

INTRODUCTION

This paper describes the results of a graduate research project into the manageability of building site waste flows [Benschop, 2000]. To this end, observations of waste flows on a number of building sites were conducted. Based on this study, a waste disposal plan was designed to control waste flows. Furthermore, a set of instructions is described for process designers to facilitate the development of a waste disposal plan.

PROBLEM FORMULATION

In the Netherlands, the quantity of construction waste produced each year totals just under four million tonnes, giving rise to environmental problems. The government attempts to reduce the amount of construction waste produced to limit the scale of environmental impact. Dumping waste is forbidden and increasing waste processing rates leads to higher costs for building contractors.
Consequently, it is important for construction companies to deal with construction waste as economically as possible, also for financial reasons. That is why it makes sense to think carefully about how to deal with building site waste during the planning stages. The objective of this research project was therefore 'Controlling waste on building sites by developing a waste disposal plan.'

CONSTRUCTION WASTE FLOWS ON BUILDING SITES

Three building sites were observed regarding the nature and amount of waste produced during the construction of a building, as well as how it was produced. Also investigated was how the disposal of building site waste was addressed and what minimum requirements the disposal process should meet.
The composition of construction waste is quite diverse. Building sites contain a wide range of waste materials, which generally come from one of ten different sources.

1. packaging materials, including transport materials
2. tooling of materials
3. processing of materials
4. waste or dissipation of materials
5. equipment and tools employed
6. materials left over
7. transport of materials
8. damage, breakage, deterioration during storage
9. production errors
10. removal of building site obstacles that hamper construction

Most of the waste materials originally found their way to the building site in the form of packaging. Construction waste appears to arise primarily in tooling and processing areas, as well as storage facilities. On the building sites investigated, the main building contractor produced about as much waste as the sub-contractors.
It was revealed during the investigation that there is no data available regarding the amount of construction waste produced and its composition. The division of the total amount of construction waste produced over the project was not constant.
The construction waste flow on and from the building site is not well-organised. Separation and removal of waste is sometimes outlined by the process designer, but not always implemented as described. The transport of construction waste on building sites is not organised.
The composition of construction waste flows is determined by the level of waste separation and the sub-contractors' obligations with respect to construction waste. Waste separation that exceeds the statutory regulations is not always considered. The amounts to be transported are comparatively small, while the distance the waste has to travel is large.
The government can exercise influence on three levels as far as the handling of construction waste by construction companies is concerned. Minimal waste separation into hazardous and non-recyclable waste is required on a national level. In addition, municipalities and provinces can impose supplementary requirements.

COSTS OF CONSTRUCTION WASTE

Apart from the environmental impact, construction waste entails costs that are the building contractor's responsibility. Material and labour costs are added to those for waste removal from the building site and the processing of construction waste. Total costs can be calculated using the formula:

Total costs of construction waste =
Material costs + Labour costs + Disposal costs + Processing costs

The materials removed from building sites as construction waste were at one time purchased as a new product. The costs of packaging materials, however, are also incorporated into the price of the product. Costs have been incurred for the purchase of all materials that leave the building site as construction waste. The construction firm ERA Bouw conducted an investigation into the extent of these costs and it appears that for every NLG 1 spent on waste disposal and processing, NLG 5 to 10 was spent on purchasing the new products [Source: Stichting Bouwresearch].
Once materials have outlived their usefulness on the building site, a great deal of work must be done before they are placed in the right container. The waste must be collected, separated and transported. Had this material been incorporated into the building and not become construction waste, this effort would not have been necessary.
With a sufficient supply of the various waste flows and sufficient space on the building site, separating construction waste on the building site requires scarcely more labour time than the disposal of unsorted waste. The construction supervisor, however, will need to put more effort into instructing and supervising employees. For the collection of rubble, the Stichting Bouwresearch construction research foundation estimates a target of 0.5 man hours per cubic metre. These values are rough estimates and heavily dependent on building site conditions, such as walking distances, number of storeys and suchlike.

GUIDING PRINCIPLES FOR THE DESIGN OF A WASTE DISPOSAL PLAN

Prior to designing the waste disposal plan, a number of requirements and guiding principles should be established.
One of the requirements is that the plan should reflect how the building site is used. This involves a well-organised structure and limited scope. Information must be quickly accessible regarding how to deal with construction waste at a particular moment and at a specific location. The waste disposal plan must also be made available to sub-contractors. The plan must also supplement the draft Construction Plan developed by the Eindhoven University of Technology [Leijten].
The following considerations constituted the foundation of the design:

- Decisions are made on the basis of costs. A building contractor, however, will only accept a waste disposal plan if it results in lower costs, and not based on environmental impact or safety.
- Initially, a design structure is selected that works well on paper and will be computerised later.
- The construction waste flows are organised starting at the source.
- The waste disposal plan must be feasible for new residential and non-residential construction.
- The design time required by the process designer to generate a waste disposal plan must be limited.
- The main building contractor is responsible for the disposal of construction waste.
- Construction time is divided into periods, which are described as stretches of time characterised by a relatively constant construction waste flow as regards composition and relatively constant building site conditions.

- The construction waste flow is described for a field, which can be defined as part of a building or building site, for which the construction waste flow is organised independently.
- The determination of the amount and composition of construction waste does not take place by making an estimate of waste per construction element, but is rather based on building properties. For this, reference frames should be developed on the basis of experience.

WASTE DISPOSAL PLAN

A design structure has been developed to allow the process designer to make structured decisions regarding the transport of construction waste on the building site, final on-site storage, transport from the building site, and the processing of construction waste. These decisions are made with a view to the costs.
The decisions are made based on a six-step process.

1. Gauging the number of periods.
2. Dividing the building into fields.
3. Estimating the amount of construction waste.
4. Determining the waste categories present.
5. Selecting a collection system.
6. Developing a waste disposal plan.

In the first step, the construction time is divided into a number of periods. In relation to these periods, it is assumed that the amount of construction waste and its composition remain constant, and that the building site conditions do not vary either. The second step leads to the division of the building and building site into fields. Fields are sections of the building whose construction waste flow is organised independently. In step three, the amount of construction waste is estimated, which is divided over the field and periods. This is done by introducing a method that utilises data from previous projects to predict the amount and composition of construction waste for projects that have yet to be carried out. Next, in step four, the types of waste to be produced and the manner in which they will be separated are determined. In step five, the types of collection systems per field are then established, in other words the type of transport to be used, the units in which the construction waste will be transported, and how and where the construction waste will be stored. For the transport of construction waste, a formula has been established per transport system, which allows the costs per cubic metre of construction waste per transport distance (in metres) to be determined.
In step six, the decisions made in steps one through five are set down in a waste disposal plan. This plan is the document with which the building site process designer can manage the construction waste flows. The plan dictates per period which types of waste separation should be implemented and how final storage is to be organised. The construction waste flows are then graphically presented by field and by period. See figure 1 for a waste disposal plan structure and figure 2 for the design of an instruction sheet.

ESTIMATING CONSTRUCTION WASTE

When designing the waste disposal plan, a three-step method was developed to estimate the amount of construction waste. This method utilises data from previous projects. This method utilises the 'form factor', which is often used for estimating costs [Poortman].
The form factor is the area of outer and inner wall constructions [m^2] divided by the gross floor area [m^2]. The form factor is calculated after a project has been completed and the amount of waste has been measured. The form factor is entered into a database and includes such information as building type and method of construction. The amount of construction waste for new construction can be estimated using this database.

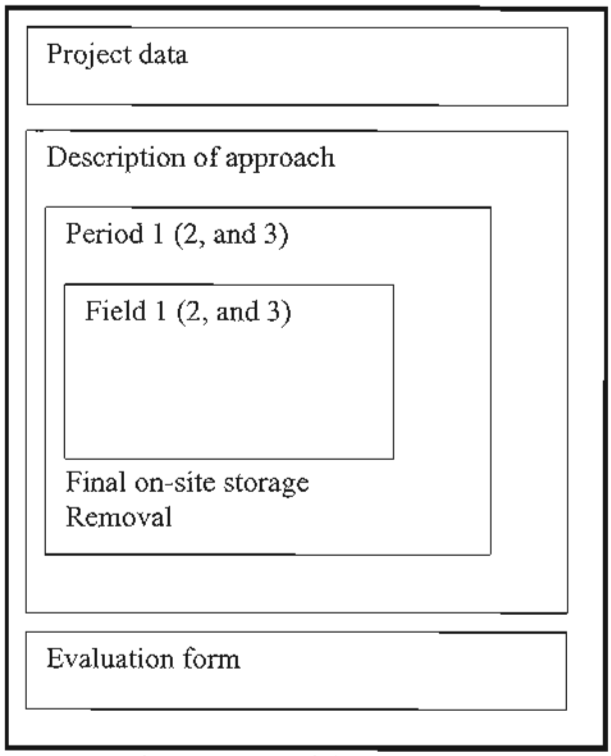

Figure 1. The structure of the waste disposal plan.

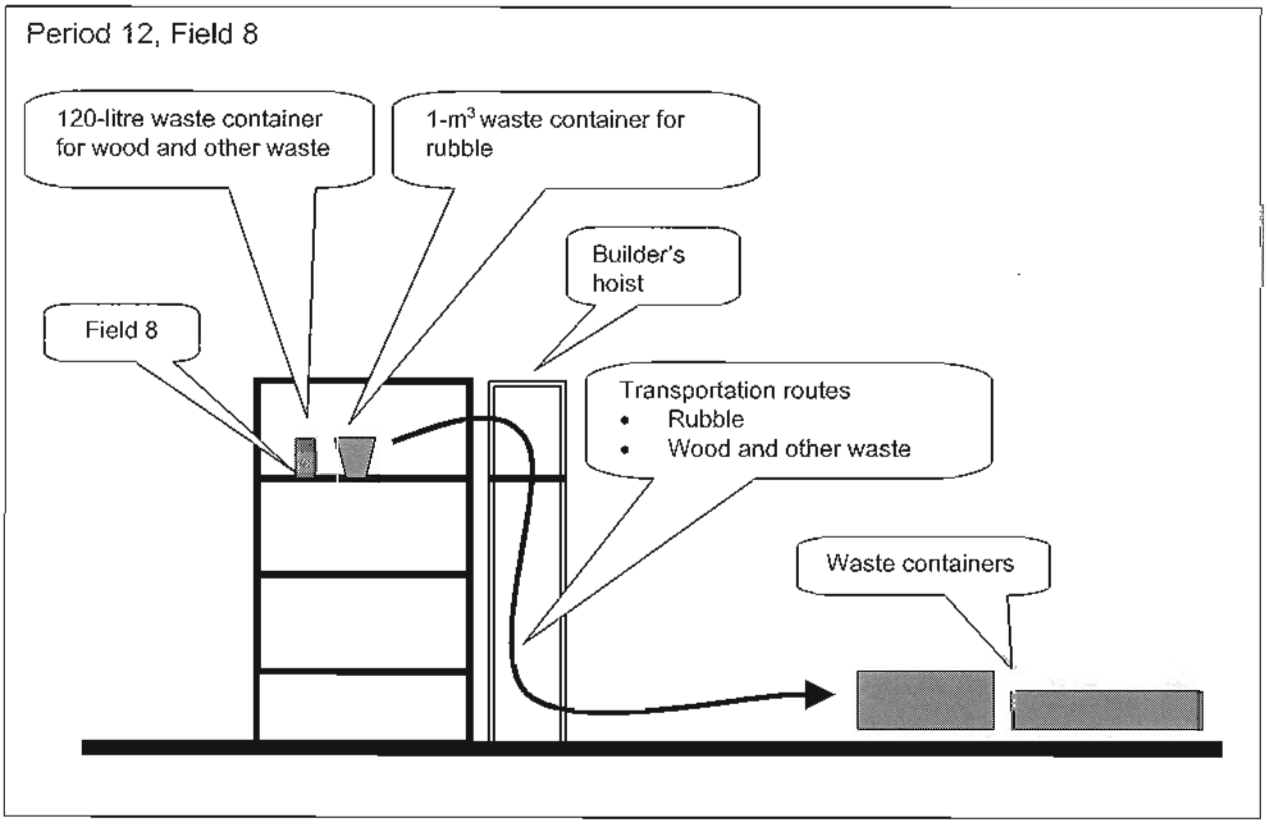

Figure 2. Instructions guiding the waste flow for rubble, wood and other waste for field 8 during period 12.

CONCLUSION

The construction waste flows on the building site can be managed through the development of a waste disposal plan and a set of instructions for the process designer. This also gives an idea of the amount of waste produced and its composition.
The application of a waste disposal plan affords insight into the amount of construction waste generated and its composition, which can be used in future projects to more precisely estimate the amount of waste generated and its composition. The result is the increased reliability of future waste disposal plans.
Of potential interest for future study would be an investigation into whether a cleaner building site leads to fewer accidents and improved construction quality.

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