# Prevention of waste during construction

1. **Reading instructions**

Appendix 16

In the industry standards in Chapter 5, a number of basic requirements for preventing waste are set. This appendix describes expanded requirements which can be set, actions which can be taken and a process to prevent the occurrence of waste during construction and, to some extent, demolition. The appendix has several target groups and some aspects are familiar to some groups but not to others.

[The action chapter (Chapter 4](#_bookmark0)) contains a check list of actions divided over different actors, together with an explanatory section relating to specific actions and a section about the methods to be used in identifying further actions.

Chapter 5 describes how to work with an action plan to maintain the work to prevent waste during an entire construction project.

# Introduction

Prevention of waste means that actions are taken before a substance, material or product has become waste, which leads to a reduction in:

* + the quantity of waste, including through the reuse of products or extension of a product's lifetime,
	+ the negative impact on the environment and people's health through the generated waste, or
	+ the quantity of hazardous substances in materials and products.

The definition can be found in Chapter 15, Section 2 of the Swedish Environmental Code and is based on Article 3 of the framework directive for waste1.

Prevention of waste can more practically be defined as actions to reduce the quantity or hazardousness of waste. Preventing waste is only to a small extent about actions taken during the waste stage and often affects several actors and several stages in the construction process. The work to reduce the amount and hazardousness of waste is never more effective than the weakest link in the chain.

The recommendations are based above all on experience from the UK, from the development project "Reducing construction waste – A method for preventing waste during construction”2 but also on a large number of other sources.

How much waste arises during new construction is dependent upon a number of factors and it is difficult to give rules of thumb for normal quantities. According to the National Agency for Public Procurement, the quantity of waste occurring during new construction is around 25-30 kg waste per square metre3. However, the quantity varies considerably between different construction projects.

1 2008/98/EG

2 Att minska byggavfallet – En metod för att förebygga avfall vid byggande, Tyréns AB, Stockholms Läns Landsting NKS-förvaltningen, Skanska Healthcare, Stockholm 2012, [www.tyrens.se](http://www.tyrens.se/)

3 [https://www.upphandlingsmyndigheten.se/hallbarhet/stall-hallbarhetskrav/bygg-och-fastighet/lokaler- nybyggnad/](https://www.upphandlingsmyndigheten.se/hallbarhet/stall-hallbarhetskrav/bygg-och-fastighet/lokaler-nybyggnad/)

# Strategies and basic knowledge

Waste costs money, time and space. Waste is also material we have already paid for once. By reducing the quantities of waste in an effective way, the costs are reduced throughout the entire chain – purchasing, labour costs for material handling and waste management costs.

Resource consumption and environmental impact are also reduced.

Here we describe a number of overall strategies for reducing the quantity and hazardous of waste:

* + Resource efficiency – choosing resource efficient alternatives during design and production, or reducing surface requirements, for example by designing housing for compact living.
	+ Extended lifetime – for the building itself and for materials and resources included in the building. In practice this can involve everything from creating a flexible building that can cope with changes over time to using second-hand products and choosing high quality products. Reconditioning and maintenance or dismantling and reinstallation in a new location are other examples.
	+ Increasing use in/of the building – for example if an office building is designed so that it can also be used as the venue for courses in the evening, the total use is increased.
	+ Design the building for reuse by choosing materials and products that can be dismantled and materials that can be separated from each other.
	+ Act to ensure efficient use of material resources at all stages (design, purchasing, transport, storage, construction and demolition).

In practice, this means that actors in a construction project need to:

* Take the above strategies into account during the planning, design and demolition of buildings.
* Avoid materials that are difficult to recycle or which contain hazardous substances and instead ideally to choose recycled material.
* Use second-hand/reconditioned products where possible and appropriate, but also to sort products for reuse during demolition or renovation.

During the development project “Reducing construction waste”, which was carried out in 2012, a number of sources of waste during construction were identified:

* Wastage during dimension or quantity adaptation
* Blasting and excavation
* Ancillary equipment (tools, fences, moulds, scaffolding)
* Packaging including pallets
* Damaged material
* Surplus material following completion
* Construction errors – demolish and rebuild
* Damage to completed sections

These sources of waste can be used as the starting point for identifying actions to [reduce waste. See also Section 4.3](#_bookmark4).

The Centre for Circular Construction (Centrum för cirkulärt byggande) is a platform aimed at facilitating more effective use of resources during construction.4 A project is being run on the platform to develop solutions that make it possible to reuse interior construction products on a large scale. A prestudy has shown that the products below are particularly suitable for large scale reuse. There is a large turnover of products during new and reconstruction, they are expected to contain low levels of hazardous substances, they have a standardised design and are relatively easy to dismantle and reinstall.5

* Doors, including fire doors, steel doors, entrance sections and interior doors in wood and glass.
* Internal walls, including glazed sections, glazed sections with frames and modular walls.
* Ceilings, including acoustic panels.
* HVAC and sanitation products such as WCs, hand basins, mixers and slop sinks.
* Floors including textile flooring (tiles).
* Lighting, including ceiling luminaires, spotlights and power rails with accessories.
* Gratings and ironwork such as spiral staircases, accessibility ramps, storage area gratings and wire mesh gates.
* Fittings and door automation equipment.

The Centre for Circular Construction is developing tools to support reuse in the construction sector, including for inventory.6

# Actions

## Action list divided by actor

The tables below contain lists of actions, divided by actor, which different actors can take to prevent waste. The lists do not claim to be exhaustive, but provide [a palette of actions that can be taken to prevent waste](#_bookmark2). [The following section (4.2](#_bookmark2)) describes several of the actions in more detail. Chapter [4.3](#_bookmark4) describes a method that can be used to identify more actions.

|  |
| --- |
| **Actions linked to requirement setting** |
| **Actor: Property developer** |
| * Appoint a waste prevention manager
 |

4 ccbuild.se/

5 The project was led by IVL Svenska Miljöinstitutet, and other project parties were Vasakronan, Fabege, LINK arkitektur, White Arkitekter, Tenant & Partner, NIRAS, Kompanjonen, Brattöns Återbruk, the Swedish Construction Federation and Chalmers Industriteknik.

6 https://ccbuild.se/testa-stodverktyg-for-aterbruk/

* Set requirements according to industry standard
	+ Design for a circular economy (Section 5.3.1 in the main report)
	+ Manage material and waste for a circular economy (Section 5.3.1 in the main report)
	+ Inventory for a circular economy (Section 5.4.1 in the main report)
* Additional requirements which may be set
	+ Requirements for expertise in the prevention of waste or skills development activities for designers and contractors
	+ Financial incentives
	+ Requirements according to environmental certification system. See Appendix 19
	+ 3D design
	+ Requirement to draw up an action plan for the prevention of waste (see Section 5.2 below)
	+ Use of second-hand or reconditioned products where possible.
	+ Requirements for maximum quantity of waste per square metre. The National Agency for Public Procurement has a maximum of 20 kg per square metre in its recommendations.7

|  |
| --- |
| **Actions linked to design** |
| **Actor: Property developer** | **Actor: Designer** |
| * Design a flexible building that lasts over time (see Section [4.2.3](#_bookmark3) for more information).
* Design commercial premises so they can be used for several purposes (e.g. premises for meetings in the daytime and for courses in the evening).
* Assess the possibility of retaining all or parts of the existing building, e.g. the frame during rebuilding
* Design on the basis of resource efficiency, e.g. design housing for compact living.
* Consider the quantity of blasting and excavation that needs to be done, and have a plan for the reuse of
 | * Appoint a waste prevention manager
* Design in 3D in order to reduce the risk of errors and clashes.
* Design for a circular economy (Section 5.3.1 in the main report)
* Document actions that have been carried out and if possible how much waste these are considered to have saved, e.g. in the design report or in a separate list.
* Document information of significance in the technical description and tender specification.
* Undertake skills development within the prevention of waste.
* Think in a modular way to replace parts of the building.
* Choose products with long lifetimes.
* Make product choices that facilitate repair and maintenance.
* Choose solutions that facilitate reuse and recycling during demolition.
* Investigate the possibilities of using reused products and materials. Choose second-hand or reconditioned products if possible.
* Assess the possibility of retaining all or parts of the existing building, e.g. the frame.
* Design on the basis of resource efficiency, e.g. design housing for compact living.
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7 [https://www.upphandlingsmyndigheten.se/hallbarhet/stall-hallbarhetskrav/bygg-och-fastighet/lokaler- nybyggnad/](https://www.upphandlingsmyndigheten.se/hallbarhet/stall-hallbarhetskrav/bygg-och-fastighet/lokaler-nybyggnad/)

|  |
| --- |
| **Actions linked to design** |
| **Actor: Property developer** | **Actor: Designer** |
| soils within the construction site.* Follow up
 | * Consider the quantity of blasting and excavation that needs to be done, and have a plan for the reuse of soils within the construction site.
* To avoid wastage:
	+ Use standardised solutions and standard dimensions.
	+ Adapt the design to the dimensions of specific products.
* Choose prefabricated solutions where possible.
* Design to make dismantling easy.
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| --- |
| **Actions linked to production preparations and production** |
| **Actor: Property developer** | **Actor: Contractor** |
| * Set requirements for reporting of actions to prevent waste before the work begins.
* Set requirements for expected material and waste quantities and compare with actual quantities.
* Follow up
* Expanded inspection during environmental rounds. See Appendix 13.
 | * Appoint a waste prevention manager
* Manage material and waste for a circular economy (Section 5.3.1 in the main report)
* Document actions that have been carried out and if possible how much waste these are considered to have saved.
* Expanded inspection during environmental rounds. See Appendix 13.
* Undertake skills development within the prevention of waste. Choose products with long lifetimes.
* Make product choices that facilitate repair and maintenance.
* Choose solutions that facilitate reuse and recycling during demolition.
* Investigate the possibilities of using reused products and materials. Choose second-hand or reconditioned products if possible.
* Maintain work machines and tools so that they last for longer
* Collaborate with reuse actors during demolition.
* Evaluate the choice of building method, including on the basis of total material consumption.
* Choose prefabricated solutions where possible.
* To avoid wastage:
	+ Use standardised solutions and standard dimensions.
	+ Order made to measure.
* Finish designing before the construction begins so that there are reduced risks of incorrect construction.
* Reuse material between construction sites if possible.
* Choose rental solutions instead of temporary constructions.
* Plan purchasing, logistics and warehousing carefully.
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| --- |
| **Actions linked to production preparations and production** |
| **Actor: Property developer** | **Actor: Contractor** |
|  | * Create framework agreements with suppliers for just-in-time deliveries and return of unused material.
* Utilise products from surplus or incorrect orders.
* Work with the entire material handling process; deliveries, storage, packaging and the possibility of returning surplus material.
* Reduce damage to materials by collaborating with material suppliers and transporters.
* During environmental rounds, focus on reducing the quantity of damaged material that becomes waste by using the check lists in Appendix 13.
* Ensure that packaging material included in return systems is returned for reuse, e.g. pallets and cable drums. Ensure that there is a designated place for standard pallets.
* Have a plan for handling surplus concrete in concrete trucks, e.g. casting of Jersey barriers.
 |

## Some actions in more detail

This section describes some of the actions in the previous section in more detail. The descriptions are partly based on experience from Skanska UK, partly from WRAP8 and partly from workshops within the context of the development project "Reducing construction waste" (Att minska byggavfallet)9. In this project, concrete actions to prevent construction waste during new construction were linked to the following areas:

* On company level
* Overall project control mechanisms
* Design of buildings and construction methods
* Logistics and materials handling
* Purchasing
* Reduce the amount of construction errors and damage to completed sections
The examples of actions below are stated on the basis of this division.

### On company level

Actions that can be carried out on company level and not merely in individual projects are described below:

8 [www.wrap.org.uk](http://www.wrap.org.uk/)

9 Joint development project for Skanska Healthcare, SLL Bygg and Tyréns AB, 2012.

* + - * Skills development of key groups within the company (for example architects, designers, logistics managers, purchasing managers, project managers and environmental managers)
			* Start a strategic development dialogue with suppliers the company has framework agreements with.
			* Set requirements in framework agreements (for example as regards expertise, the possibility of retrieval of unused material and how material is packaged).
			* Work with statistics and monitoring of materials and waste.
			* Work with forums for experience feedback. One example of increasing the feedback of knowledge regarding the outcome of actions to prevent waste can be to start a meeting forum for waste coordinators from each construction site. This contributes to increasing competence and a feeling of responsibility for waste within the company and often generates concrete ideas regarding how the quantity of waste can be reduced.

### Overall project control mechanisms

##### 4.2.2.1 Financial incentives

Can economic or other incentives be used to reduce material consumption and waste quantities?

For example, set requirements for transparent reporting of material costs. Subcontractors who submit prices for labour and materials include in the price a supplement for materials that become waste. By collaborating to reduce waste and share in the gains, prices can be reduced without the subcontractor's profit being affected.

Here it is important to consider how the incentives function, so that they do not lead to deteriorations in other areas.

### Design of buildings and construction methods

There are major opportunities to affect waste during the design of the building. Some examples are provided below of how the quantity and hazardousness of waste can be affected in the design and planning stages:

* Take the user perspective as a starting point – how will the building be used, how often will it be rebuilt, change activities, be renovated etc.? Should this affect the choice of solutions in any way, for example for electricity, ventilation, drainage, ceiling heights and room divisions? A reduced need for rebuilding reduces future waste.
* Choose prefabricated solutions where possible. This can be particularly effective for repetitive parts in terms of waste reduction as manufacturing is carried out in a controlled environment where it is easier to detect stages giving rise to wastage and to streamline material use.
* Investigate the possibilities of using reused products and materials. If the project is preceded by demolition, you can investigate which products can be reused from the demolition. It is even possible to have a procedure for investigating which materials/products could consist of reused materials, e.g. internal doors.

### Logistics and materials handling

Experience from countries such as the UK show that it is important to work with the entire material handling process in order to reduce the amount of waste. How materials are delivered to the construction site, how they are stored and packaged and the opportunity of returning excess material are aspects that affect how much waste arises.

Planning and management of these issues should begin in the design stage. Planning material handling issues at an early stage facilitates the continued process.

##### Logistics centre – store materials in one place

A logistics centre is a warehouse where deliveries with large trucks can be made. From there deliveries can be made to the construction site at the right time of the quantities of materials required – just-in-time deliveries. If space is limited on the construction site, or if it is difficult to access with heavy vehicles, the logistics centre can be placed to advantage a little way from the construction site where traffic access is better. This also significantly reduces the number of journeys to the construction site. If there is space, the warehouse can be within the construction site.

The advantages of a logistics centre and just-in-time deliveries include:

* + - * + Constructors and installers being forced to plan in another way, and can therefore state more accurately how much material is required and when. However, systems and procedures must be created for this. Experience from countries including the UK shows that this reduces material consumption in a construction project.
				+ Material not needing to be stored to any large extent on the construction site. This reduces damage to the material and in certain cases also reduces the risk of accidents. It also makes it easier to find the material.
				+ It being easier to agree with suppliers that they will take back surplus material and reusable packaging when these can be collected in an organised manner from one location which is easily accessible with a large vehicle and where they are already delivering other material.
				+ It being possible to locate a local prefabrication workshop for certain installations in the logistics centre. This also reduces the risk of accidents during the construction project because it reduces the number of people on the construction site.

##### Measure the material flow and waste

It is normal to measure the amount of waste that arises during a construction project. But there is often less knowledge and poorer control of the material flow. By measuring all material coming into the construction project and following this up in relation to the estimated quantities, significantly better control over the waste is also gained. It then becomes possible to relate the waste figures to the total material quantities, which leads to the waste statistics becoming more relevant to follow up and easier to communicate.

### Purchasing

There is a close connection between materials handling and purchasing. It becomes easier to set requirements for subcontractors and material suppliers if you know how the material handling process will work as early as the procurement phase.

Material-related aspects to take into account during procurement of material suppliers, in order to prevent waste:

* Optimisation of material resources, for example opportunities for ordering made-to-measure materials.
* Packaging – single-use packaging or reusable packaging? Is there a return system? Packaging should be designed so that it protects the goods but does not generate more waste than necessary.
* Packaging that can be reused, for example pallets – Set requirements for suppliers to deliver construction materials on pallets which are part of Retursystem Byggpall and ensure that empty pallets are collected according to Retursystem Byggpall, or alternatively that the supplier always takes back pallets.
* Packaging from a user perspective: Is it possible to package the material so that it is easier to install or assemble? For example when packaging luminaires, everything required for installation can be packed together instead of coming in several separate packages.
* Possibility of returning unopened items.
* Work to reduce damage to materials by collaborating with material suppliers and transporters.

Different actions work for different types of material. If you are uncertain about which actions are appropriate, this is an excellent area in which to initiate development dialogues with interested material suppliers. Identify some types of products where you consider that it may be interesting to work with alternative forms of ordering and packaging. Investigate which suppliers want to be involved in developing this area.

The selection of relevant products can be made on the basis of environmental or health impact, how difficult it is to improve the packaging or where there are major installation-related advantages.

Procedures for how orders should be carried out are also an area worth examining. Examine reordering of materials and subcontractors so that the preventative aspects are also included here.

It is important to follow up supplier and (sub)contractor commitments.

### Reduce the amount of construction errors and other damage

Work is continuously underway within the construction industry to reduce the amount of construction errors. Here, the work to prevent waste integrates into the existing process.

Aspects which specifically contribute to increasing the amount of waste within this area are:

* Construction errors that lead to it being necessary to demolish and rebuild.
* Damage to material which is being stored and transported.
* Damage to completed sections or details in the building due to other works taking place adjacent to these or to construction stages being carried out in the wrong order.
* Starting to build before the drawings are complete.

A large part of the planning regarding logistics on the construction site and preparations for the production process takes place during the design phase. Careful detailed planning positively affects several of the points above, which also affects the quantity of waste produced. It is therefore important to have expertise in the prevention of waste involved when carrying out detailed planning of work phases and drawing up work instructions.

Having a well-organised workplace has also been shown to contribute to reducing the amount of waste that arises on construction sites.

## 4.3 Method for identifying more actions

This section describes a procedure for identifying and selecting actions to prevent waste. The method can be used if you want to identify more actions to reduce [waste than those already described in sections 4.1](#_bookmark1) and [4.2](#_bookmark2). This is a chain of four steps. See figure 1.



#### Figure 1. Procedure for identifying actions

The procedure is described below in more detail, and Table 1 shows an example.

##### What waste arises and why?

Each construction project is unique in many ways, but there are also major similarities between different construction projects. Taking previous experience as a starting point is extremely useful. Begin by thinking about the waste that arises and why.

Estimate the waste which can be expected to arise, and in what quantities.

##### Possible solutions for reducing the waste

Continue by identifying *possible solutions* for reducing the quantity of waste that arises from each specific cause.

What can be done to reduce the quantity of wastage that arises during dimension or quantity adaptation? For example, the design of the building can be adapted to standard dimensions so that fewer materials need to be cut, prefabricated solutions can be used to a greater extent and so on.

##### Identify possible actions

Identify actions on the basis of analysis of the possible solutions drawn up in the previous stage.

One step in this analysis is to link the possible solutions to the actor who has the opportunity to have an impact on them. On the basis of this, you can then sort the possible solutions and more easily identify actions which it is possible to implement.

##### Choose actions

Prioritise between the actions and select those actions which should be implemented. One important success factor is to begin with the waste types or actions which can give major gains in the form of reduced costs, waste amounts and environmental impact for just a small amount of effort.

Initially, you should avoid the waste streams where gains are uncertain or where the actions require complicated considerations or risk leading to suboptimal results.

The table below shows an example according to the chain above for plasterboard (not exhaustive).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **What waste arises** | **Why waste arises** | **Possible solutions** | **Who has the opportunity of having an impact** | **Possible actions** | **Prioritised actions** |
| Plaster | Wastage during making to measure | Adapt to standard dimensions | Architect/designer | Skills development | … |
|  | Damage during storage | Work with logistics and warehouse conditions | Project manager/logistics manager | Plan logistics and warehouse conditions in time |  |
| Metal components | … |  |  |  |  |
| Carpet | … |  |  |  |  |

#### Table 1. Example of analysis of actions to prevent waste

##### Factors that can impact prioritisation of actions:

* The content of hazardous substances in different types of waste
* Other environmental impacts from different types of waste
* The quantity of different types of waste
* Purchase costs of different materials and costs for material handling
* Cost for waste management
* Costs and labour required to implement the actions

# Process for preventing waste in construction projects – Plan to prevent waste

To draw up an action plan that continues throughout the entire construction project is one way of maintaining the work to prevent waste. The process recommended here is based on the idea that all actors should be involved and contribute ideas and knowledge regarding the actions which should be implemented.

## Process, requirements and responsibilities

The process is based on the drawing up of an initial overall version of the action plan for prevention of waste, during the programme phase. In other words, the first version of the action plan is drawn up by the project owner. This should ideally be part of the environmental programme or the environmental plan. Appendix 17 contains a template that can be used as the basis for an action plan.

The project owner should:

* + - Draw up the first draft of the action plan for the prevention of waste (part of [the environmental programme) (see template for action plan in Appendix 17, and Section 5](#_bookmark5).2 below)
		- Set requirements for prevention of waste in the programme/procurement as described below.
		- On an ongoing basis, follow up the work with the action plan
		- Evaluate the work after each phase together with relevant actors.

The action plan is then updated in the design phase and during the production preparations by the designer and contractor respectively. Requirements are set in tender specifications for managing and participating in the work of updating the action plan and implementing the selected actions.

Recommendation for formulation of requirements in tender specification:

* + - The designer/contractor shall identify actions for the prevention of waste, and update the Plan for preventing waste with these actions and methods for following up. The designer/contractor shall then implement and follow up the selected actions and report the latter to the client.

## Developing an action plan

The prevention of waste means that a number of different actors must reach agreement and coordinate their actions. Coordination and communication are crucial in achieving a good result, and good planning and anchoring of the actions are important. The procedure is described below. Document in the action plan.

##### Situational analysis – investigate the expected material and waste quantities

Attempt to establish figures for the expected material and waste quantities. The results from this investigation are useful during both identification and prioritisation of actions.

##### Identify affected actors

Important actors are:

##### Architects and designers

Architects and designers affect the amount and hazardousness of waste through material choice and design selection.

##### Buyers

Buyers also have significant impact as regards product choice. Buyers also play an important role regarding setting requirements for avoiding hazardous substances, how deliveries should take place, the design of packaging and systems for the retrieval of surplus material.

##### Logistics managers

The planning of logistics for a construction project has a significant impact upon how much waste arises.

##### Construction management

The construction management are responsible for ensuring that objectives and requirements set are complied with. The action plan for the prevention of waste needs to be established with the construction management.

##### The environmental manager or the person designated as responsible for prevention of waste

A coordinator is required to be responsible for issues relating to the prevention of waste and to follow them up throughout the contract/project. Preventing waste is an environmental issue, but it affects many other areas. In certain projects, the material coordinator may be the environmental manager. In other projects it can be the purchasing manager or logistics manager.

##### Carry out skills development

If expertise in the prevention of waste is low among the actors involved, some form of introductory skills development project is required. This can involve study visits, inspiration workshops etc.

##### Draw up actions, prioritise and decide on a method for follow up

Draw up a list of actions in collaboration with the other identified actors, for example in a workshop within the framework of existing technology area meetings. For example, use the list in [Section 4.1](#_bookmark1) or the approach described in Section [4.3](#_bookmark4). Prioritise between actions, link them to the project schedule and decide which should be implemented. Also decide who is responsible for each action, how they should be followed up and who should follow them up.

##### Identify points for handing over information and plan communication

Identify points in the construction process where it is important that information on the actions is transmitted. Appoint people responsible for ensuring that the information is transmitted. Important handover points include:

* + - between prestudy and design stage
		- between design stage and purchase
		- during the procurement of contractors and subcontractors and when these are introduced in and to the project
		- during the procurement of material suppliers
		- during the procurement of waste contractors and when these are introduced into the project
		- between project management and product management

The number of people who need to understand how the construction project is organised, and the aspects of the preventative work which affect them, increases throughout the entire construction process. In the production phase, many contractors and installers must be informed. Plan for how this information should be conveyed and what skills development is required. Also include the experience feedback aspect.

##### Coordination and anchoring of the action plan

If actions have been developed in collaboration with affected actors, much of the anchoring work has already been done. It is still important to anchor the action plan with the project management, both in the client’s and executor’s organisations.

## Implement the plan and follow up

Implement the actions in the plan and follow up the results. Constantly communicate the results to all involved parties and to the management.

## Evaluation and experience feedback

Evaluate the work to prevent waste after each phase together with affected actors. The results from the evaluation should be fed back both to the contractor's own organisation and to those who were involved in the project.