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Sustainable Urban Consolidation CentrES for conStruction

Report on good practices in the EU and USA in construction logistics in urban area

Version 1.0

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 633338.

Executive Summary

SUCCESS has chosen to target the construction industry as a major impacting sector on city logistics which has un-exploited potentials of improvement of the efficiency of goods, waste and service trips in EU cities, by answering the challenges pinpointed by the European Commission and in particular by improving urban freight understanding and introduce more resource-efficient, more environmental-friendly, safer and seamless supply chain innovations.

The deliverable D6.1 is part of the WP6 ("Replicability and Take up") which aims at demonstrating the potential of the solutions developed by SUCCESS to be replicated and transferred afterwards. It consolidates 22 good practices observed mainly in European countries and USA to improve knowledge and understanding of the construction supply chain and logistics.

It targets construction companies, local authorities and academics with the intent of promoting practices that can improve the supply chain management and logistics in the construction sector. For this reason, the deliverable is structured after this section as a ready-to-print document. Best practices include relevant information to understand at a glance the purpose, benefits and main characteristics of the proposed practices. Criteria should help the decision makers select the most appropriate best practice(s) that fit their own needs. The best practices are structured by areas of interest (clusters). At the end of the document, tables provide another reading of the best practices and identify theirs links with the construction logistics processes (defined in WP3), the categories of benefits (defined in WP2) and the type of decision makers.

The deliverable targets also the partners in the SUCCESS consortium to support the design of new solutions (WP4) and the identification of potential improvements to experiments in the pilot sites during the project (WP5).

The collecting effort was shared among the project's partners. Construction and research partners were in charge of identifying potential good practices into their own country. LIST (as Task leader) and ITL (as WP leader) identified potential good practices in other European countries and in the US. The Scientific Advisory Board was also consulted to support the identification of good practices. Three experts select the most relevant practices according to their coverage on the construction logistics processes, the available data and the most interesting practices to support the SUCCESS objectives. The selected good practices were then detailed following a common template. We acknowledge that other good practices exist and that the document is only a subset of the existing best practices. For this reason, we intend to release during the project new versions of this document with additional practices. Further investigations in US and Asia should bring some interesting findings.

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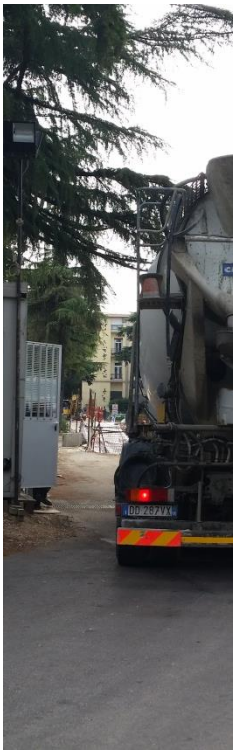
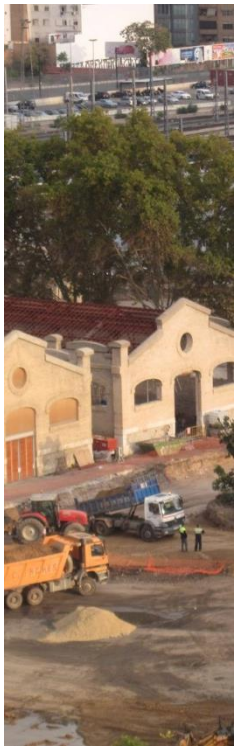
Good practices guide: Construction logistics and supply chains

April 2017





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Introduction

Objectives

Construction companies and local authorities should use this document as a guide that provides insights into alternative or desired ways for improving supply chain management and logistics in construction. We acknowledge that other good practices exist and that the document is only a subset of the existing best practices. Because each city and each organisation is different, the adopted practice should be adapted to the local context before its use.

Methodology

The collection of best practices followed a two-stage iterative approach. A first iteration consisted in identifying practices that could be considered as best practices. The practices have been observed mainly in Europe (including SUCCESS pilots) and USA to ensure a wide spectrum of initiatives. A second iteration consisted in selecting the most valuable practices and detailing each of those on the basis of literature review, interviews and consultations.

Results

SUCCESS covers a collection of 22 good practices.

To simplify identification of the practices, they are classified by area of interest named hereafter cluster:

- Logistics operations
- Policies
- Advanced technologies
- Integrated supply chains

The collected best practices concern business, organizational, governance, regulatory, and policy aspects and contribute to reach some of these benefits:

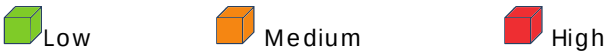
- Reduce material and replenishment costs
- Reduce construction site operating costs
- Reduce negative impacts on the environment
- Improve safety on the construction site
- Improve wellbeing for residents

Additional information on these benefits is available in another deliverable of the project (D2.2 - KPIs and methodologies for construction logistics.)

A best practice is illustrated with an example and includes relevant information to understand at a glance its purpose, results, main characteristics and key considerations. It is associated with three criteria that should guide the decision maker to select the most appropriate best practice or the set of best practices that fits its own needs. During a workshop, experts assess the best practices according to the following criteria:

- Cost: How much does the implementation of the practice cost?
- Time: How long is the implementation of the practice?
- Difficulty: How difficult is the implementation? This indicator depends on the level of maturity of the organisation (i.e. the extent to which the organisation is able to effectively achieve its business goals).

The evaluation is made on a three point scale composed of the following values:



At the end of the document, synthetic tables provide another reading of the best practices and identify theirs links with the construction logistics processes, the categories of benefits and the type of decision makers.

Logistics operations

The high fragmentation of the construction sector results in a large number of stakeholders. While the construction sector is characterised by a traditional low orientation towards collaboration, the main contractor is responsible for the overall coordination of the construction project and has to follow the day-to-day operations to coordinate the various stakeholders' activities at the construction site. It is often observed that productivity on construction sites suffers from a fragmented supply chain. Good logistics requires a global vision on practical challenges whereas the trade sub-contractors are focused on their own activities. The temporariness of the collaboration creates additional challenges that the main contractor faces. To address these challenges and ensure optimal productivity, the construction site manager has to deploy adequate, easy and quick solutions.

LO1 - Logistics team

LO2 - Access management

LO3 - Waste management

LO4 - Secure area

LO5 - Scaffolding tower

LO6 – Construction & demolition waste manual

Credit: CMB

LO1 - Logistics team

Paris, FR

Processes addressed

- Delivery
- Material Reception & Expedition
- Material Handling & Equipment Management
- Waste Management
- Return Management
- Entrance & Exit Management

Objective

A construction logistics team aims at improving the operations on site when it comes to coordinate material flows for all the sub-contractors.

Context

Logistics activities are usually included in the daily activities of the construction staff. However due to the size and complexity of the Paris pilot's site, Vinci appointed at the beginning of the project a dedicated logistics team to fulfil the support functions on the worksite and improve the collaboration between different stakeholders.

Cost

Time

Difficulty

Best practice description

Two logistics managers (management team) working for Vinci coordinate the logistics team composed of two logistics contractors: one responsible for managing deliveries and the other one responsible for the waste management.

Management team

The logistics managers have the following responsibilities:

Managing the delivery requests

The logistics managers review each delivery request posted on the delivery area booking system to identify potential inconsistencies. They approve whether a delivery or pick-up is possible and generate the daily delivery schedule.

Managing storage areas

The logistics managers ensure the good use of the storage areas. Different storage areas are located on the site. The buffer stock zone is used to store materials which have just been delivered. Time storage on these zones should not exceed 24 hours. The definitive stock zone is used to store materials until they are used. The waste stock zone is used to place the bins. Depending on the work progress, there are mostly on each floor 11 buffer stock zones, 37 definitive stock zones and 3 waste stock zones. Considering the 7 floors of the building and the ground floor, the construction site has 88 buffer stock zones, 296 definitive stock zones and 24 waste stock zones.

Delivery team

The team is composed of two managers and four warehousemen. Their role includes the following key responsibilities:

Managing entrance and exit

The managers give instructions to the driver to park the vehicle. A warehouseman is appointed to manage the traffic outside the site.

Managing deliveries and pick-ups

The warehousemen unload materials and move them to a buffer stock at the requested floor.

Managing deliveries requirements

The managers print out the daily delivery schedule with the delivery notes to control inbound and outbound goods. If there is an error in the nature or quantity, the delivery note is modified and signed by the sub-contractor.

Housekeeping to keep the site safe, clean and tidy

The team ensures the site is effectively clean and tidy to make the worksite safe and secure.

Materials stored on a buffer stock zone
Source: Vinci Construction France

Waste team

The team is composed of a manager and several warehousemen in professional reintegration.

Managing waste disposal

Each afternoon, the team empties the bins located at each floor in the dumpster located on the delivery zones and sorts materials if needed.

Actors

- The logistics contractors execute operationally logistics activities that the main contractor monitors.
- The sub-contractors share with the main contractor upcoming deliveries and ask for delivery authorization.

Key considerations and results

Benefits

- Increases the rate of planned deliveries (67% in May 2016)
- Reduces truck waiting time (outside and inside the site)
- Improves construction site punctuality
- Reduces loading / unloading time
- Reduces material waste
- Reduces rework in connection with material issue
- Reduces time dedicated to logistic activities
- Reduces costs of unsorted bins
- Reduces congestion on construction site
- Reduces rate of obstructing vehicles
- Reduces time for Looking for material/equipment

Problems occured

- Availability of the storage zone is not known because the time of storage is not defined. This issue is minor on the site because of the availabilities of many storage zones but could become major if there is a lack of storage space.

Critical success factors

- The main contractor who has a global view should manage the initiative.
- The contract should mention financial penalties for non-compliance with the site rules.

Lessons learned

- Such initiative should be agreed at the beginning and be integrated in the overhead costs of the project.
- Difficult to quantify the financial benefits of the logistics team (costs is about 2% of the total construction cost)

Transferability

- A logistics team has already been implemented on other projects. It can be considered when the construction project is large enough and in urban zones where deliveries are sensitive to absorb the cost related to the logistics team.

Bins at each floor
Source: Vinci Construction France

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LO2 - Access Management

Verona, IT

Processes addressed

Entrance and Exit Management

Objective

To avoid accidents and diminish congestion (on the construction site and in urban area), by easing the entrance and exit of large vehicles.

Context

Borgo Trento context is extremely complicated. Indeed the construction site is located inside Verona city center, where the traffic congestion is very high. Moreover, the construction site is inside the Hospital "citadel", where the interferences with hospital people and vehicles is constant.

Cost

Time

Difficulty

Best practice description

Access: The entrance and exit gates are distinct. Both are located on the Goffredo Mameli Street.

Entrance gate: each arrival (trucks or human) is tracked. The situation is checked by authorities in order to avoid illegal workers. For this, a guard at the site entrance is in charge of tracking trucks. People use an electronic card in order to access the site. The management of vehicles' entrance is done in a way that the vehicles do not arrive at the same moment of the day.

Speed limit: Transit of vehicles in the streets surrounding Borgo Trento site was regulated at 30 km/h at the beginning of the project, but it is now regulated at 50 km/h (normal speed limit). Inside the construction site the speed limit is 10 km/h, which is lower than what current legislation imposes for construction sites (30 km/h).

Exit gate: A temporary traffic light regulates the vehicles when they leave the construction site to facilitate the reinsertion in the traffic. This traffic light avoids creating queues of vehicles inside the construction site and regularizes the flow on the Strada Statale. It also contributes to diminishing the interferences with hospital people and vehicles implied by the localization of the construction site (inside the Hospital "citadel").

Entrance gate
(Source: CMB)

Actors

- This practice has been developed in coordination between the main contractor and the municipality technicians. The use of a traffic light was a note included into the Services Conference on the executive project made by the Municipality of Verona. The expected results were:
  - to decrease the negative implication on congestion due to a construction site inside the city centre and the related externalities;
  - to decrease the congestion on site and simplify the vehicles exit from the construction site.
- To educate all the subcontractors, the communication of the speed limits, the behaviour to adopt inside the construction site, and the existence of the streetlight were included into the PSC (Piano Sicurezza e Coordinamento) that was signed by the subcontractors.
- A coordination meeting was performed at the construction site entrance anytime a new stakeholder arrives at the construction site in order to explain in a more direct way the various rules included into the PSC.

Policy Framework

This practice is imposed by the Piano Sicurezza e Coordinamento (PSC), which is the document that the project coordinator, on behalf of the client, must produce before starting the working activities on the construction site (art. 100 of the Testo unico sulla sicurezza sul lavoro).

Key considerations and results

Benefits

- Reduce Truck waiting time (outside and inside the site)
- Reduce Number of accidents
- Reduce Congestion on construction site
- Reduce Congestion outside the construction site
- Reduce Rate of obstructing vehicles

Critical success factors

The collaboration with the municipality

The respect of the PSC by the subcontractor

Transferability

The exit management, the use of the streetlight and the exit and, the speed limit inside the construction site are practices that can be easily replicated in all construction projects.

Exit gate

(Source: CMB)

EUROPE

- **Processes addressed**
- Ordering
- Waste Management
- Return Management

Objective

The purpose of this practice is to improve the activities required to manage waste through the implementation of various types of measures such as the reverse logistics, the management of space and bins for waste storage or the dedicated waste management team.

Context

Waste management activities are usually included in the daily activities but can vary a lot from one construction project to another. This document summarizes the best practices collected from the four pilots studied during the SUCCESS project: Paris, Verona, Valencia, and Luxembourg. These practices can be implemented either individually or all together in order to maximize the benefits.

Cost

Difficulty

Quality

Best practice description

Dedicated Waste Management Team (Luxembourg, Paris)

For the Luxembourg and Paris pilots, a dedicated logistics team was appointed at the beginning of the project. (In Luxembourg, this team is composed of 4 people working full time.) This team is, amongst other activities, in charge of transporting wastes inside the construction site, as described below:

- Sub-contractors put waste they generate in specific bins (770 L) available in each storey. The colour of the bin refers to a specific type of waste: wood, plaster, iron, rubble or unsorted bins.
- At the end of the day, the waste team transports the bins to the deliveries areas where dumpster are located.
- The waste team controls the bins and sorts waste which are not in the appropriate bins. They clear out the bins into dumpster before putting back the bins on the different storeys of the building for the day after.
- The waste team could also be in charge of the cleaning of the construction site.

Containers located on each storey
(Source: Vinci)

Space for Waste Storage (Luxembourg, Valencia)

The Valencia Parque Central Phase 1 site has special conditions such as a large area, thus it makes possible to assign a waste management area with different procedures and containers for required activities such as:

- Storage and classification material area
- Machinery, equipment and repair workshop area
- Workshop area for concrete works and welding operations
- Clean point (recycling point)

The Luxembourg pilot' site provides one 1.1 m3 cardboard bin as well as four 7.5 m3 dumpsters. They are filled by all the sub-contractors/suppliers during the day and are emptied every morning at 5 AM. The same driver can also come back to the construction site at 6.45 AM, 8 AM and 11 AM by if necessary.

The common rules regarding waste management that should be applied on all working sites are the following:

- Minimize the possible use of raw materials
- Reduce waste
- Reuse surplus or extracted materials
- Recycle waste produced
- Recover energy from waste
- Minimize the amount of waste sent to landfill

Dumpster on the delivery area
(SOURCE: Tralux)

Reverse logistics (Verona)

In Verona, in order to better manage the reverse logistics, it is included into the contracts with subcontractors and suppliers a clause that imposes to take care of waste management and the return management of all the materials that are not directly treated by the main contractor (CMB).

This practice derives from the Italian normative that imposes to subcontractors and suppliers who produce the waste to take care of its reverse logistics in times and modes that are more convenient to them. The objective is to have a tidy, clean, and well organized construction site. Moreover, this practice leads the subcontractors and the suppliers to a more responsible waste management.

This management of waste disposal makes everybody more responsible and the construction site cleaner and tidier. By the practice in use, the waste bins are periodically emptied and the material separated by CER code. CER, (Catologo Europeo dei Rifiuti), also known as EWC (European Waste Catalogue), is the classification of the waste types that follows the European Directive 75/442/CEE; the CER code is a sequence made of 6 numbers that defines the waste based on the production process.

Inside the construction site, each subcontractor and the main company have bins separated with respect to different CER codes for different type of materials. Once or twice a day the floors of the construction are cleaned and the waste collected in a dedicated bin of the floor. When it is time to collect the waste from the storey, the person in charge (normally somebody of the subcontractor company) checks the crane availability to bring the bin to the waste collecting area. At that point the dedicated person of the subcontractor company separates the materials stored into the bin into the other bins with respect to the CER code.

Bins used to separate materials with respect to CER codes
(SOURCE: www.seguritototal.cl)

Actors

- The main contractor rents waste containers and organises the pick-up.
- The dedicated waste management team is responsible for cleaning the construction site, centralise collecting / check and transport bins
- The sub-contractors depose and sort waste into containers of various type.
- The waste sub-contractor collects the dumpster on site and transports it to treatment facilities which will optimise waste recycle.

Policy Framework

Construction and demolition waste (CDW) is one of the heaviest and most voluminous waste streams generated in EU with about 25%-30% of the total waste. For this reason the EU makes with the Waste Framework Directive (2008//98/EC) a priority. At national level, regulations set waste management practices.

- In Paris, waste have to be strictly managed, in order to comply with the French environment certification *"HQE"*.
- In Verona, the current Italian normative *"Decreto Legislativo 152/2006 – Norme in Materia Ambientale"* imposes the subcontractors and the suppliers to take care of the reverse logistics and of the disposal of the waste they generate.
- In Valencia, the *"Royal Decree 105/2008, of February 1"*, regulates the production and management of construction and demolition waste

The French "HQE"

Key considerations and results

Benefits

- Reduced costs of unsorted bins
- Cleaner site
- Percentage of recycling in French pilot's site: 95,2% (June 2016)

Problems occured

In Paris, it was complicated to estimate the need for waste pick up. To solve this problem, specific time slot for treating waste was define:

- The dedicated team starts transporting bins inside the construction site around 3 PM. The deliveries are concentrated in the morning hours so waste operations can be handled on the delivery areas without any negative impact on the other operations.
- Each morning, the waste sub-contractor comes and pick-up dumpster before the first deliveries. When necessary, he can come back after the last delivery (between noon and 2 PM).

Critical Success Factors

If the main contractor put in place shared waste management arrangements, its cost should be divided between all the sub-contractors and suppliers who contribute to create waste.

Waste team sorting the waste
(Source: Tralux)

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LO4 - Secure area

Luxembourg, LU

Processes addressed

Inventory

Housekeeping

Complaint Management

Objective

A secure area aims mainly at preventing materials and equipments from theft.

Context

Construction sites are easy targets for thieves. Materials, especially copper and other metals and small equipment are their main targets.

The replacement for tools, equipments and materials can cause a huge loss of revenue and productivity if the missing materials and equipments delay the project. The secure area adds another level of security to the locked fence.

Cost

Time

Difficulty

Best practice description

Most of the trades in Luxembourg request to the main contractor a secure area to store their tools, equipments and materials. The secure area is an outbuilding securely locked dedicated to a company. Usually a room with a provisional locked door is enough and cellars are for example suitable areas for this use. Some contractors may ask to install a container.

Because space is a limited key resource on construction sites, the secure area is not suitable for all types of material. Materials to be secured are either materials which can be stolen or those vulnerable to the weather.

It mainly concerns:

- Fragile materials, such as lighting materials. These materials are protected from damage and theft.
- Costly materials, such as lighting and electrical supplies (lights, plug, digicode, radiator, mechanical ventilation. These materials are protected from theft.
- Dangerous materials such as flammable liquids and gas containers. Argonite or form oil are stored in cupboard.

Within TRALUX, the company buys provisional locked door in metal available to any trades. Any sub-contractor can ask for a secure area. Some companies prefer installing their doors. Most of the doors are thrown away at the end of the works and the main contractor can reclaim money if the door is not returned.

TRALUX secures its tools and small materials supplies (screws, silicone…) in one or two storage containers it rents or it has on its own. The service responsible for quality, safety and environment harmonized the practices with a standard to keep the containers organized and tidied.

New provisional locked door
Source: TRALUX

Secure area for the electrician
Source: TRALUX

Actors

- The main contractor grants authorization to sub-contractors who ask for a secure area.
- The sub-contractor or the main contractor provides the provisional locked door.
- The sub-contractor installs the door to the assigned area.

Key considerations and results

Benefits

- Reduce theft
- Reduce damage
- Reduce time for looking for material/equipment

Problems occured

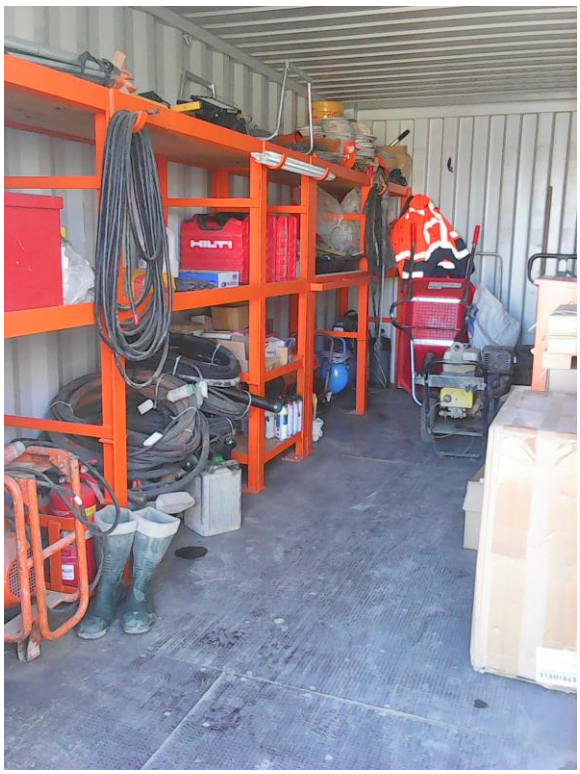
- Copper wiring and other metal are too heavy and voluminous to be stored in a secure area.
- As the work progresses, the secure areas are often moved to another place (three times on average).
- The productivity can decrease if workers need to operate in an occupied locked room.
- Some companies condemn areas with a locked door without the agreement of the main contractor.
- Such facility doesn't completely prevent from theft. Workers authorised on the site can still commit theft. Cameras, security guards and serials numbers are additional security measures.

Lessons learned

- The main contractor should coordinate the assignment of secure areas.
- The assignment of secure areas should be aligned with the overall planning. They should be located in a place that not disturbs work progress.

Transferability

- A secure room is easy to put in place on construction site but it is not suitable for bulky and heavy materials such as cables which are still an easy target for thieves.



Standardized container
Source: TRALUX

LO5 - Scaffolding tower

Verona, IT

Processes addressed

Material Handling and Equipment Management

Objective

The main objective of this practice is to speed up the procurement of materials inside the construction site exactly where it is needed and to avoid congestion on site an in the loading/unloading areas.

Context

A very constrained (in terms of space) construction site, where the loading areas are extremely limited in surface, thus it is necessary to carry directly the unloaded material to the floor in which it will be used.

Cost

Time

Difficulty

Best practice description

The scaffolding towers has, at each floor, a scaffolding cargo deck positioned in order to serve each floor and provide a faster supply of material when needed during material installation.

The materials come from the trucks and are moved to the storage areas or directly to the cargo decks depending on the need and the availability of the crane. The subcontractor foreman knows the correct floor and the correct quantity to be moved.

Each deck has a 150 kg/m2 capacity, and its dimension is linked to the pallet that has to be brought to the floors. Each floor is named according to the number of the floor or the level in meters.

The scaffolding towers lasts until the façade completion (windows installation). This timing is decided during the project design with respect to time needed for the tasks following the façade completion. After the dismantling of the scaffolding towers, dedicated elevators are used.

Pallet transported by crane ...
source: CMB

... to the right cargo deck at the right floor
source: CMB

Without scaffolding cargo decks it would be extremely expensive and space consuming to serve the highest floors with the needed material in case of using external freights elevators. Another solution would be to make use of the crane without the scaffolding decks for all the movement operations, but this would increase the time of the operations that the crane must take care of and it would increase the congestion on site.

Actors

- The Scaffolding subcontractor is in charge of designing the scaffolding tower and of its construction and dismantling.
- The main contractor cooperate with the scaffolding subcontractor, in particular to define their respective responsibilities.
- The construction site foreman cooperates with the subcontractor foreman regarding the storage of material, the storage area, the material handling, the correct floor, and the use of the crane.

Key considerations and results

Benefits

- Reduce time dedicated to logistic activities (Deliveries done through the scaffolding tower)
- Reduce truck waiting time (outside and inside the site)
- Reduce loading / unloading time
- Reduce congestion on construction site
- Reduce rate of obstructing vehicles

Transferability

The use of scaffolding towers made of several scaffolding decks can be replicated in all the construction sites that need this kind of just in time supply. The decision of the use of this practice is taken by the site manager.

Scaffolding tower on the Verona's pilot construction site
source: CMB

USA

Processes addressed

Waste Management

Objective

This practice is focused on the development of a waste management plan, for construction and demolition (C&D) waste reduction, reuse and recycling on New York City Projects. Its main objective is to support design and construction professionals to prevent construction waste.

Context

The guidelines are addressed to all the participants in projects for the NYC Department of Design and Construction (DDC) for developing a C&D Waste management plan with a cooperative effort.

Cost

Difficulty

Quality

Best practice description

Context

Construction and Demolition (C&D) debris is defined as that part of solid waste that come from land clearing and excavation, construction, demolition, remodeling and repair of structures, roads and utilities. At US national level, C&D debris accounts for 25% to 45% of the total solid waste. In NYC, C&D accounts for more than 60% of the solid waste stream.

Construction and demolition waste is managed almost in NYC by private transfer stations and processors. This type of waste is different from residential and commercial waste, commonly called municipal solid waste.

C&D waste goes through several steps from job-site to ultimate destination. Usually, the contractor collects the debris in containers, rented or provided by the hauler. A hauler takes the containers to a waste transfer station and/or processing center. Transfer stations transfer the waste into larger trucks, which take it to landfills outside the city. Some large transfer station companies also process facilities and haul services. Some contractors haul their own waste and recyclables and many recyclers of specific materials will arrange to pick them up at the construction site. The contractor locates separate containers on the job-site, sorting out recyclable materials as they are collecting, and delivering each container to processor when full.

In practice, the design and project management community typically does not know the disposal path of a project C&D waste. Architects, project managers and construction managers delegate the responsibility to the contractor. Their supervision of waste disposal has concentrated on the aspects related to site safety, potentially damaging to constructed areas.

The implementation of a significant waste management program will require the awareness and participation of all parties, because setting goals, defining responsibilities and education involve everyone.

The Construction & demolition Waste Manual is an instrument for the NYC Department of Design and Construction, providing guidelines on how each member of the project's team can act to reduce, reuse and recycle C&D waste.

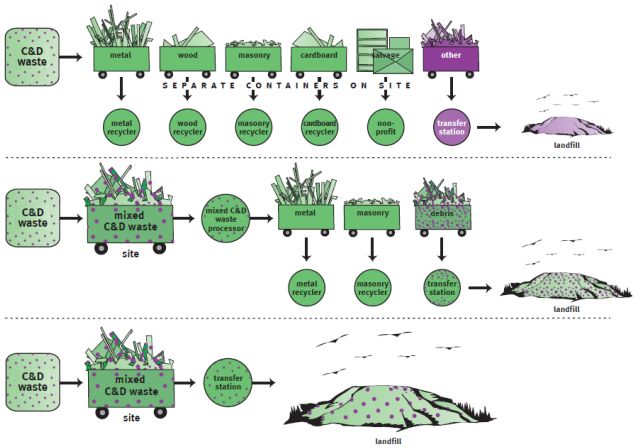


Figure 1: Three Construction & Demolition Waste Pathways
Source: Construction & Demolition Waste Manual, page 1

The strategy for reducing C&D waste is focused on three approaches: Reduce, Reuse and Recycle. The three practices, in conjunction with disposal of non-recyclable materials, make a comprehensive waste management strategy.

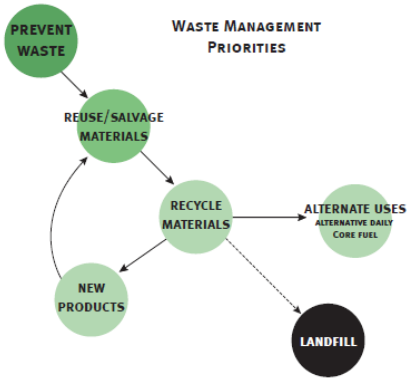


Figure 2: Waste Management Priorities
Source: Construction & Demolition Waste Manual, page 11

The DDC's project managers are responsible for ensuring that the design and construction teams define and implement a C&D waste management plan.

Design Phase Responsibilities

The DDC's design project managers' responsibilities include:

- Make sure that the specifications for all projects include a C&D Waste specification;
- Ensure that the project's C&D Waste management goals are aggressive;
- Start early in the design process to identify opportunities for salvage and/or recycling;
- Instruct the design team to consult the list of Principal Recyclable Materials while developing the project's waste management goals;
- Review and discuss waste management goals as part of the project's progress meetings.

Construction Phase Responsibilities

The DDC's construction project managers' responsibilities include:

- Work with the Construction Manager (CM) and the Contractor for General Construction to develop an aggressive Waste Management Plan (WMP), in accordance with the specification developed by the design team;
- Review the Waste Management Plan submitted by the Contractor, and the periodic reports of recycling practices;
- Keep track of the C&D Waste management, based on the specification requirements and approved Waste Management Plan. Compare recycling progress to the Plan and share results to the Contractor's attention;
- Keep both waste management and the use of quality materials as priorities during the construction. Fix goals and discuss them at job meetings;
- Schedule regular walk-throughs and prompt inspections to catch problems early, which will help prevent waste and ease coordination between trades;
- Collect information from the design team concerning plans for flexibility and future waste prevention measures, such as spare capacities, modular components, etc…

DDC Resources provided by the Office of Sustainable Design and Construction

The DDC's Office of Sustainable Design and construction supports and encourages the implementation of the plan, by providing assistance and services, including:

- Making tools available to project teams;
- Providing direct assistance to help the design team and contractor to set goals and develop a project-specific Waste Management Plan;
- Providing seminars on sustainable design in general, and C&D Waste Management specifically;
- Collecting and analysing data on the DDC's current and ongoing recycling, to monitor the trends, project variations and key markets.

Actors

The Department of Design and Construction, as client and manager, sets and maintain direction.

The DDC's Office of Sustainable Design supports and encourages committed actions to foster the implementation of the plan.

The Design Team of architect, engineers and other consultants takes the initiative in waste prevention and reuse, and sets goals for recycling. The team assists the contractor to develop the waste management plan, including components to recycled, reuse/salvaged; estimated amounts; processors that will receive the C&D waste; on-site procedures and responsibilities; and documentation to be provided.

The Construction team plans and implements the recycling program and practice to prevent and reuse materials on the jobsite. The Construction Manager (CM) and the Contractor for General Construction develop a Waste Management Plan (WMP), in accordance with goals and specifications fixed by the Design Team.

Key considerations and results

Benefits

The DDC can:

- Serves as an educational and informational resource
- Establishes goals and/or requirements for its projects
- Disseminates results
- Traces successes and failures
- Identifies measures to improve the construction and demolition industry

Critical success factors

To succeed, a comprehensive Waste Management Plan requires attention and collaboration of all key actors in the design and construction process. Each group has specific responsibilities for preventing waste and encouraging the recycling of construction. It must be an integral part of the decision-making, with each group planning their strategies and enhancing cooperation and dialog.

Lessons learned

- Support for waste management from the top
- Incorporation of C&D waste issues early
- Planning, clear goals and targets
- Sensitivity to specific project constraints and markets
- Coordination, education and communication

Transferability

- In Sacramento, all new commercial, institutional and multi-family developments must provide a Recycling Information Statement identifying a designated area (which is sized according to a formula) to be set aside for the collection and storage of recyclable materials, a materials flow diagram and an educational program.
- The Town of Atherton has specific diversion requirements by material and project type, for example, demolition projects must achieve a 50% recycling rate if asphalt and concrete are included, and a 15% recycling rate excluding asphalt and concrete.
- Santa Monica requires a Waste management Plan and a 60% recycling rate (no more than 20% of which can be achieved through recycling of clean fill materials). Santa Monica also requires a performance security fee that recycling targets have been met.
- The City of San Jose instituted its Construction and Demolition Diversion Deposit (CDDD) Program. All projects requiring a building permit also require a CDDD Program deposit, which is calculated according to project size and valuation. This includes city construction projects that require building permits and private new construction, alteration or demolition projects, with certain exemptions.
- The City of Oakland requires contractors to prepare a Job Site Recycling and Waste Reduction Plan (JSR and WRP) for any municipal construction or demolition project where the cost exceeds $150,000.

Figure 3: a landfill
Source: Construction & Demolition Waste Manual, page 6

The JSR and WRP must include estimated type and quantity of waste to be generated, on-site material handling procedures, specific processors/recyclers that will be used and materials that will be recovered. The JSR and WRP is reviewed by staff from the Environmental Services Division of the Public Works Agency based on the following criteria: a) reasonableness of materials targeted for recycling; and b) constraints of the job site.

- Seattle has defined its Construction, Demolition and Land clearing (CDL) Program, through which two full-time employees, identifies upcoming projects that are expected to generate significant volumes of C&D, contact the developers and work with them to create a waste management plan.
- During the renovation of New York City Housing Authority (NYCHA) Community Center in New York, specifications for community center renovation or addition projects NYCHA has been developed, to improve C&D management practices. Contractors are required to:

  a) employ processes that generate as little waste as possible due to poor planning, breakage, etc.;

  b) reuse, salvage or recycle as many materials as are economically feasible to; and

  c) take a proactive role in ensuring all subcontractors and suppliers participate in waste reduction and recovery efforts.

  Contractors submit a one page waste management plan as part of the contracting process. The plan aims to:

  a) estimate the types and quantities of waste generated by the job;

  b) identify disposal options and costs;

  c) identify alternatives to disposal for materials, including wood, concrete, asphalt, metal, corrugated cardboard and appliances;

  d) describe material handling procedures; and

  e) identify facilities that will be used for re-use or recycling.

References

Construction & Demolition Waste Manual, Prepared by NYC Department of Design & Construction
http://www1.nyc.gov/site/ddc/index.page

Policies

Policies set regulations, procedures and standards supporting a better integration of logistics into the construction projects to mitigate climate change and increase road safety. They reflect concerns at both national and local levels of policy makers in government, associations and construction industry. Road safety concerns in this case exposure of people to potential construction vehicle accidents which should be prevented by an effective management of transport operations.

PO1 - Construction Logistics Plan

PO2 - Guidelines for construction site management

PO3 - BREEAM labelling scheme

PO4 - Road safety (CLOCS)

PO5 - Signs for truck manoeuvring

PO6 - Safety, Health and Environmental Program

Credit: TRALUX

PO1 - Construction Logistics Plan

London, UK

Processes addressed

Delivery

Waste Management

Objective

The Construction Logistics Plan (CLP) aims at improving freight vehicle movement to and from construction sites in delivering construction materials and removing waste in a safe, efficient and environmentally-friendly way. The initiative is very similar to the Delivery and Servicing Plans which focuses on improving deliveries and minimizing journeys to buildings rather than construction sites.

Context

To answer challenges of the London Freight Plan, planning application should be accompanied by a CLP as it can help to ease congestion and/or encourage modal shift. The construction sector is highly represented in London as it represents around 91,000 companies and employs 200,000 people.

Cost

Time

Difficulty

Best practice description

A Construction Logistics Plan (CLP) is a management tool for planners, developers and all parties involved in the planning process for construction work. CLPs are submitted to the local planning authority at the pre-application discussion stage or at the post-granted discharge of conditions and/or highway design stages. A CLP coordinator is officially named and takes responsibility for the day-to-day management of the CLP.

It describes how a construction project will be run and managed to reduce the negative effects of construction work (congestion, pollution and noise…).

The section 1 - ***Introduction*** includes details of the applicant submitting the CLP. There are two types of CLPs: single development plan where construction is limited to one site and framework where construction is part of a larger development.

The section 2 - ***Site information*** includes the location of the site, size and nature of the development, details of any parking constraints near the site, details of site access including public transport, cycling and footways and any changes to services during the construction phase.

The section 3 - ***Construction details*** includes possible trip generation to identify the number of trips, routing, delivery scheduling, holding areas, permit schemes and access, impact on highway, WRRR, common procurement, consolidation and/or collaboration and off-site fabrication.

The section 4 - ***Traffic management*** includes details of how traffic will be managed during the various stages of construction, type of construction vehicles needed and when, parking arrangements for delivery vehicles and pedestrian, cyclist, bus and general traffic considerations.

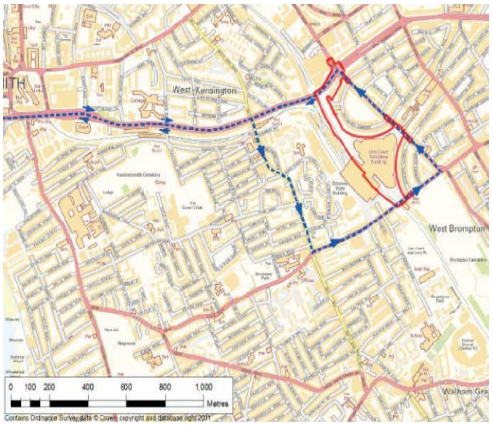
The section 5 - ***Developing and using policies*** includes consideration on waste minimization, use of other modes of transport, vehicle renewal replacement, consolidation and/or collaboration with nearby developers and off-site fabrication.

The section 6 - ***Monitoring compliance, reporting and review*** includes information on contract compliance of main and sub-contractors, site trip generation and reducing negative impact, use of alternative transport modes, benchmarks and targets and adherence to timescale plans for major logistics activity.

River transport to deliver a worksite in Paris
Source: Coalis website

The section 7 - ***CLP management*** includes practical day-to-day overview of how CLP is managed, contractual relationships and obligations of sub-contractors, contractors' handbook including the site map and opening times, the consolidation centre instructions, health and safety information, staff travel plan and drivers' handbook including instructions such as authorized routes, site opening times, booking and scheduling information.

The developer produces the CLP to his needs. The main motivations are reducing trips in peak periods leading to less congestion, less emissions and improved safety. Using of off-peaks for deliveries, alternative modes or consolidating materials are the main initiatives to reach these objectives.



Gates access and routing at Earls Court
Source: CLP_Earls Court

Actors

Transport For London (TfL) developed the guidance to support the CLP elaboration.

The site developer elaborates the CLP to his needs for the site and is responsible for collecting data according to a schedule agreed with the planning authority.

Contractors apply the CLP content.

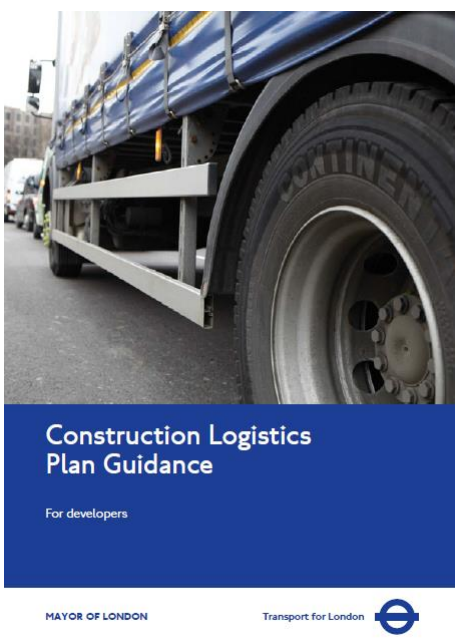
The planning authority, concerned by the disruption at and around the site monitors the CLP application. It nominates a person within the local authority as contact point for ongoing monitoring.

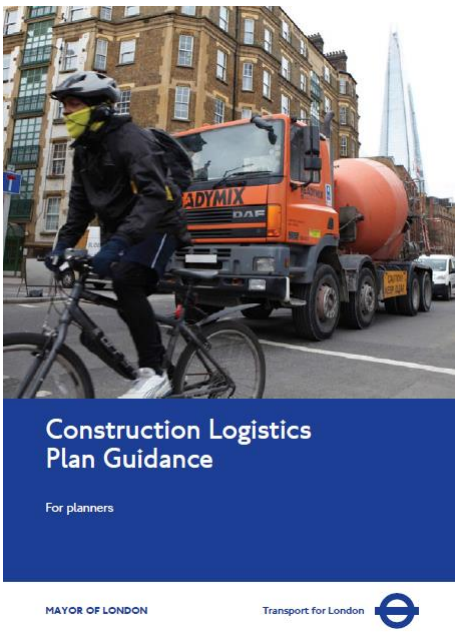
The local authority is responsible for minimizing disruption at and around the site including residents and local economy during the construction stage.

Policy Framework

A couple of national and local policies refer to or require CLPs to be produced. The CLP must clearly refer to existing policies such as:

- The Traffic Management Act (2004)
- The National Planning Policy Framework
- The London Plan (2011) which clearly references CLPs as a way of making better and more efficient use of the road network
- The Mayor's Transport Strategy (2010)
- Local authority policy: London's local authorities develop their own guidance and policies about the use of CLPs and what they need to include.
- The London Freight Plan (2008)





CLP Guidance booklets
Source: TfL

Key considerations and results

Quantitative results

The figure below presents the impact of the Bernard Weatherill House CLP, a new office building in Croydon council in London as possible example of benefits.

KPI	REACHED
Neighbour status	Good
Number of vehicles	↘ 26%
CO_2 emissions	↘ 53.5 T
PM emissions	↘ 2.7 kg
NO_X emissions	↘ 266 kg
Waste recycling	94%
On-time delivery performance	97% (compared to an industry norm of approximatively 85%)

Source: TfL

Qualitative results

Congestion reduction: benefits arise from a more efficient management and coordination of construction vehicles going to and from a site.

Minimize environment impact: benefits arise by minimizing the number of journeys and applying best practice efficiencies such as planning deliveries to maximize vehicle capacities, using cleaner vehicles or using rail/water mode...

Better safety: benefits arise from reduction of trips to reduce the likelihood of collisions.

Improved efficiency and reliability on site: benefits arise from a more cost effective construction logistics activity.

The benefits below are detailed by stakeholders:

Local authorities and resident

- Less congestion on local roads
- Reduced emissions to limit the impact of freight transport on the environment
- and contribute towards CO2 reduction targets
- Fewer goods vehicle journeys lowering the risk of collisions
- Opportunity to reduce parking enforcement activity costs – more deliveries
- should use legal loading facilities so less traffic and parking infringements will occur
- Improved quality-of-life for local residents through reduced noise and intrusion and lower risk of accidents

For building developers and contractors

- Reduced delivery costs and improved security
- More reliable deliveries resulting in less disruption to normal business practices
- Time-savings by identifying unnecessary deliveries
- Less noise and intrusion

For freight operators

- Legal loading areas will mean less risk of receiving penalty charge notices
- Fuel savings through reduced, re-timed or consolidated deliveries
- More certainty over delivery times to help
- increase the productivity of your fleet
- Less journeys will reduce the risk of collisions involving your vehicles

Critical success factors

- The planners should require the developers to submit a CLP but let them decide which initiatives to implement.

- The developers should include the CLP as annex to the contract to ensure the working practices identified in the CLP are followed.

Transferability

Other cities in Europe experiment the Construction Logistics Plan like in Utrecht for the central railway station area.

References

Construction Logistics Plan, Plans guidance > https://tfl.gov.uk
Croydon council website > http://croydon.gov.uk

PO2 - *ÖkoKauf Wien* guidelines for construction site management (RUMBA)

Vienna, AT

Processes addressed

- Sourcing
- Delivery
- Material Reception & Expedition
- Inventory & Storage Management
- Material Handling & Equipment Management
- Waste Management

Objective

The "*ÖkoKauf Wien*" guidelines for construction aims at providing support to authorities when planning and tendering construction works contracts. The guidelines objective is to provide an analytical grid to determine measures to set-up in order to foster more sustainable management of construction sites through procurement contracts.

Context

The guideline is one outcome of the EcoBuy programme of the Vienna municipality, more particularly the working groups dedicated to construction and logistics. The guideline is a follow-up of the initial RUMBA project in which Austrian stakeholders have experimented various measures in favor of a sustainable management of construction sites. The project has analysed measures in several dimensions of construction (construction consolidation center, alternative transport for material deliveries and waste pick-ups, regulation frameworks). In 2015, 10 years after the completion of the RUMBA project, and after subsequent experimentations the "*ÖkoKauf Wien*" guidelines have been issued.

Cost

Time

Difficulty

Best practice description

The **"*ÖkoKauf Wien*" guidelines for construction** is a supporting tool for authorities when planning and tendering construction works in an urban area. The guideline is composed of two main parts: an analytical grid to help authorities determine which measures to set-up according to the context of the upcoming construction project and a textual description of the measures to be included in the tendering requirements.

The proposed measures focus on reducing the environmental impact of the construction site during various phases of the project: during the planning and preparation, then during the tender and construction management. While being economically relevant, the measures contribute to the reduction of pollutant emissions (CO_2 NO_x, PM) and also increase the legal security of construction sites.

Construction sites classification

The guidelines propose to consider inner-cities construction sites as either:

- **Pipe-laying and road construction sites**: these sites are stretched linearly and are highly mobile during the construction phase,
- **Building construction sites**: these sites are more conventional in their organisation,
- General **civil engineering sites**: for specific urban construction purposes that do not fit in the two previous categories. (Examples of such sites are bridges, car parks, tunnels and underground works…).

A linearly stretch construction site
Source: Wikimedia Commons (Mark Ahsmann) CC-BY-SA-3.0

Construction sites sizing

The guidelines consider the size factor of the sites to determine additional measures to apply for important projects. The sizing factor (and more particularly the threshold determining the size factor) depends on the site classification.

- For linear construction projects (pipe-laying and road construction), the threshold is set to **1,000 m of linear length**
- For more conventional construction sites (building construction), the threshold is a **gross volume of more than 20,000 m³**, representing the volume of **60 residential units**. For civil engineering, depending on the nature of the construction, the choice of the most representative factor (linear distance or volume) is left to the project manager.

Measures based on project phases

During the **planning and preparation phase**, the guidelines recommend to set-up an **environmental construction plan**. Such plan shall include three main concepts for planning purpose:

- The **waste concept** describes the measures for waste management, use or handling of hazardous substances, dismantling if any.

- The **logistics concept** describes the planning of mass balances, the space management, interim storage and construction traffic.
- Last, the **construction site equipment plan** lists the required equipment for the environmental management of the site.

Activities areas

During the tender and construction management phase, the guidelines list measures in three activities areas:

In the **transport** activity, the focus is set on measures for improving the transport of material from and to the construction site (space management, access control and record, load covering, accesses cleaning, storage in containers), transport of material within the site (speed limits, construction roads wetting/sealing…) and transport vehicles (engine class restrictions).

In the **construction** activity, measures focus on the equipment of the site (equipment plan, specific equipment for dirt trapping), on the material storage, material processing and material handling on site, on the waste management, on the dismantling and demolition and on the use of cleaner construction machines.

Last in the **environmental supervision of construction work** activity, measures focus on the environmental control and on the stakeholders' information on environmental impact.

Waste sorting station on a construction site
Source: ÖKOTECHNA, RUMBA project Wien 2003

Actors

If the measures of the guidelines are generic and impact many actors of the construction project (construction companies, transport operators; engineering offices), the main stakeholder that will apply the guideline is the contracting authority with the aim to improve the environmental behavior of the companies operating on its construction site. Citizens and neighbors of construction sites will benefit from the effects of the measures selected from the guidelines and applied on construction sites.

Policy Framework

The measures proposed by the guidelines intensively rely on local cities ordinances or national (Austrian) regulations on public construction tenders, urban ecological construction management, air quality, environmental protection (including noise and dust control) and waste management.

The guidelines are not mandatory for setting-up a tendering but rather voluntary for contracting authorities. However, measures selected and implemented in specific construction tender specifications, will be binding for tenderers as any tendering specification.

Key considerations and results

Benefits

By applying the guidelines, a city similar to Vienna in terms of size and urban configuration could consider a saving of 4,000 t CO_2 per year. In pilot projects applying the guidelines, savings of 66% of the drive distance and 33% of the number of trips have been measured. In another major project of 240 ha of urban development, 100% of the material needs for concrete were satisfied by reusing the excavated soil and using a cast-in-place concrete system. This resulted in a saving of 2,000 t CO_2 and a reduction of the construction time. In short, benefits of applying the guidelines can be:

- Reduction of air pollutants (CO2, NOx and PM)
- Reduction of dust nuisance and noise pollution
- Reduction in number of transport trips and distance travelled
- Prevention of congestion and traffic due to Heavy Goods Vehicles
- Reduction of waste output

Transferability

The guidelines are reported to be applied in major projects in Austria. Due to the focus in Austria on regulation, transferability would require an adaptation of the legal references to match the local or national regulations in other countries which may impact the details and wording of some measures.

However most of the measures are generic enough to be at least experimented easily in other context than Vienna and Austria.

References

RUMBA project > http://www.rumba-info.at/projekt_en.htm
ÖkoKauf guidelines > https://www.wien.gv.at/english

PO3 - BREEAM labelling scheme

UNITED KINGDOM

- **Processes addressed**
- Delivery
- Waste management
- Return management
- Housekeeping

Objective

The BREEAM (Building Research Establishment Environmental Assessment Method) aims to minimize the adverse effects that buildings have on the local and global environment, specifically considering the life cycle impacts of the building.

Context

To evaluate the sustainability of buildings, the BREEAM labelling scheme has been developed based on a set of criteria including logistics issues and provides benchmarks targeting a market recognition.

Cost

Time

Difficulty

Best practice description

The BREEAM (Building Research Establishment Environmental Assessment Method), launched in 1990 by the BRE (Building Research Establishment), is the world's leading method for assessing, rating, and certifying buildings' sustainability. Even if it is a voluntary program, it is increasingly used and is more and more recognized as a standard requirement for new construction in the future.

BREEAM assesses the sustainability of buildings with criteria covering a range of issues in several categories (energy, water, health & wellbeing, pollution, transport, materials, waste, land use & ecology and management practices). Each category is divided into a range of issues, which promotes the use of new benchmarks, aims and targets. Credits are awarded for achieving targets and their total determined the final performance rating.

In this best practice, only the criteria ***MAN03 Responsible construction practices*** in the category ***Management*** is of interest for the logistics aspects. The category *Management* addresses management policies and the procedures that need to be put in place to ensure the delivery of a sustainable project. The category *Transport* focused on the development links into public transport and the use of sustainable transport systems is here out of scope.

Briefing paper on carbon emissions assessment
Source: BREEAM

The criteria *MAN03 Responsible construction practices* aims at recognizing and encouraging construction sites which are managed in an environmentally and socially considerate, responsible and accountable manner. It is split into four parts of which two are related to the logistics aspects: Considerate construction and Monitoring of construction-site impacts.

The Considerate construction criteria awards up to two credits where the contractor achieves six actions within a checklist of actions to minimise air and water pollution during construction works. The following actions address particularly logistics.

- Avoid or minimise transport through community areas in the noise and vibration section.
- Minimise dust from vehicle movements, using water sprays if appropriate in the air quality section.

The Considerate construction criteria awards also one credit where an individual(s) is responsible for implementing and maintaining construction practices throughout the works stage. The following practices are examples of considerate construction practices:

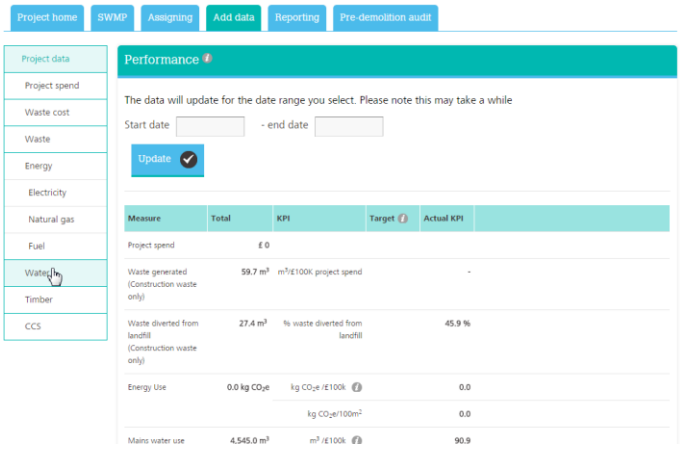
1. Keeping the site clean and tidy:
   a. Ensure no loose materials or debris lying around the site including the perimeter
   b. Vehicles are regularly checked for cleanliness
   c. Implement a 'Tidy Friday' initiative.
2. Reduce the impacts to the community:
   a. Schedule the timing of deliveries to the site to avoid disturbance to local residents
   b. Ensure that any noisy work is carried out at agreed times with adjoining neighbours
   c. Record car registration numbers of all operatives in the event that a complaint was made with regard to nuisance parking.

Monitoring of construction-site impacts criteria awards one credit for monitoring impacts related to the transport of construction materials and waste. The criteria assesses if responsibility has been assigned to an individual(s) for monitoring, recording and reporting transport consumption data resulting from all construction

processes throughout the build programme. To ensure the robust collection of information, this individual(s) must have the appropriate authority and responsibility to request and access the data required. The activity consists in monitoring and recording data on transport movements and impacts resulting from delivery of the majority of construction materials to site and construction waste from site. As a minimum this must cover:

1. Transport of materials from the factory gate to the building site, including any transport, intermediate storage and distribution.
2. Scope of this monitoring must cover the following as a minimum:
   a. Materials used in major building elements, including insulation materials
   b. Ground works and landscaping materials
3. Transport of construction waste from the construction gate to waste disposal processing/recovery centre gate.

Collected data must be used to report separately for materials and waste, the total fuel consumption (litres) and total carbon dioxide emissions (kgCO2 eq), plus total distance travelled (km) via the BREEAM Assessment Scoring and Reporting tool. Several websites are proposed as guidance for CO_2 measuring protocols (www.encord.org and www.ghgprotocol.org). SMARTWaste (www.smartwaste.co.uk), the BRE's environmental reporting tool enables users to capture, monitor and target a project's on-site energy consumption and produce a CO_2 footprint, water consumption and responsible sourcing of timber. Transport data can also be collected.



SMARTWaste tool
Source: smartwaste.co.uk

Actors

- Developers use BREEAM as a tool for delivering sustainability goals on their projects.
- Planning authorities use BREEAM as a tool for demonstrating that required performance standards have been met.

Key considerations and results

Benefits

- Reduce waiting time
- Reduce distance from the production to the construction site
- Reduce time for looking for material/equipment
- Reduce costs of unsorted bins
- Reduce CO_2 and PM emissions
- Reduce number of accidents and related causes
- Reduce congestion on construction site
- Reduce rate of obstructing vehicles
- Reduce noise
- Reduce dust

Transferability

- BREEAM was originally developed in the United Kingdom, but has spread to other European and Gulf countries. It is applied in over 70 countries and some having developed a specific scheme at the national level.
- BREEAM has equivalent benchmarks in other countries, such as LEED (Leadership in Energy and Environmental Design) in the U.S. and Green Star in Australia.

PO4 - Road safety (CLOCS)

London, UK

Processes addressed

Delivery

Objective

The English best practice aims at managing safety beyond the construction site with a dedicated standard for construction logistics named CLOCS (Construction Logistics and Cyclist Safety) Standard.

Context

While regulations to improve construction workers' safety & health exist, regulatory leadership is missing in the area of work related road risk. In response to a number of cycling fatalities involving construction sector HGVs, Transport for London commissioned a report on construction logistics operations in 2013 by Transport Research Laboratory. The report revealed that between 2008 and 2013, 55% of cycling fatalities involved an HGV in London and in 2011, seven of the nine HGV-related fatal incidents involved construction vehicles. Following the publication, an industry-led programme named CLOCS is launched to act on the recommendations and to improve the management of work-related road safety.

Cost

Time

Difficulty

Best practice description

The ***CLOCS Standard for construction logistics: Managing work related road risk*** is a UK standard for use by the construction logistics industry. Implemented by construction clients through contracts, it provides a framework that enables ownership in managing road risk which can be adhered to in a consistent way by fleet operators.

The standard addresses both construction logistics operators and construction clients and contains requirements for quality operations, safety equipment fitted to vehicles and drivers. The requirements presented below are extracted from the standard.

Requirements applicable to both operators and clients:

- ***Applicability.*** It applies to commercial vehicles ranging from all vehicles over 3.5 tonnes gross vehicle weight (GVW) to articulated vehicles over 44 tonnes GVW. All fleet operators shall comply with the standard in the timeframe instructed by the client in agreeing the contract. This shall not be more than 90 days from the start of a contract unless special circumstances apply.
- ***Exemptions.*** Where possible exemptions should not be permitted but the following may be considered at client discretion (unplanned or unforeseen critical delivery, exceptional convey…).

Requirements applicable to construction logistic operators:

Logistic operations requirements

- ***Quality operation.*** Fleet operators shall ensure the transport operation meets the standard of an approved independent fleet management audit.
- ***Collision reporting.*** Fleet operators shall capture, investigate and analyse road traffic collision information that results in injury or damage to vehicles and property. All collisions shall be reported to their client or contracting entity. (cf. CLOCS Manager: reporting system that enables to log, record, monitor and report incidents, collision and near-misses).
- ***Traffic routing.*** Fleet operators shall ensure that any vehicle routes to sites or premises specified by clients are adhered to unless directed otherwise.

Vehicle requirements

- ***Side under-run protection.*** Fleet operators shall ensure fitment of side-guards to all rigid mixer, tipper and waste type vehicles over 3.5 tonnes gross vehicle weight that are currently exempt from fitment.

Side under-run protection
Source: CLOCS website

- ***Warning signage.*** Fleet operators shall ensure that prominent signage is fitted to all vehicles over 3.5 tonnes gross vehicle weight that visually warns other road users not to get too close to the vehicle.
- ***Blind-spot minimisation.*** Fleet operators shall ensure all vehicles over 3.5 tonnes gross vehicle weight have front, side and rear blind-spots completely eliminated or minimised as far as is practical and possible through a combination of fully operational direct and indirect vision aids and driver audible alerts.
- ***Vehicle manoeuvring warnings.*** Fleet operators shall ensure all vehicles over 3.5 tonnes gross vehicle weight are equipped with enhanced audible means to warn other road users of a vehicle's left manoeuvre.

Side blind-spot
Source: CLOCS

Driver requirements

- ***Training and development.*** Fleet operators shall ensure that all drivers (including those exempt or not in scope of Driver Certificate of Professional Competence) undergo approved progressive training and continued professional development specifically covering the safety of vulnerable road users.
- ***Driver licensing.*** Fleet operators shall ensure that a system is in place to ensure all drivers hold a valid licence for the category of vehicle they are tasked to drive and any risks associated with endorsements or restriction codes are effectively managed.

Practical training of risk awareness
Source: CLOCS website

<u>Requirements applicable to construction client:</u>

- ***Construction Logistics Plan.*** Clients shall ensure that a Construction Logistics Plan (CLP cf. best practice PO1) is in place and is fully complied with.
- Clients should approach this in a spirit of partnership with fleet operators, who may have valuable views on how to achieve safety goals.
- ***Suitability of site for vehicles fitted with safety features.*** Clients shall ensure that the condition of sites is suitable for vehicles fitted with safety features and side under-run protection.
- ***Site access and egress.*** Clients shall ensure that access to and egress from the site is appropriately managed, clearly marked, understood and clear of obstacles.
- Vehicle loading and unloading. Clients shall ensure that vehicles are loaded and unloaded on-site as far as is practicable.
- ***Traffic routing.*** Clients shall ensure that a suitable, risk assessed vehicle route to the site is specified and that the route is communicated to all contractors and drivers. Clients shall make contractors and any other service suppliers aware that they are to use these routes at all times unless unavoidable diversions occur.
- ***Control of site traffic, particularly at peak hours.*** Clients shall consider other options to plan and control vehicles and reduce peak hour deliveries.
- ***Supply chain compliance.*** Clients shall ensure contractor and sub-contractor compliance with quality operation and driver licensing requirements.

Actors

Construction Companies require in their contract the CLOCS requirement. With Transport for London, they convince vehicle manufacturers to redesign their product.

The vehicle manufacturers have progressed in designing safer trucks for the construction industry (e.g. Daf Trucks, Dennis Eagle, Mitsubishi Fuso-Canter, Mercedes-Benz, Volvo, MAN, Scania and Iveco).

Regulatory and enforcement bodies (National Commercial Vehicle units and the Industrial HGV Task Force (the Metropolitan Police Service MPS, City of London Police and the DVSA)) conduct road safety police operations targeting non-compliant HGVs, drivers and operators. They enforce the regulations relating to HGVs and make the standard compliant with other existing schemes such as the safer lorry scheme and FORS accreditation.

Last truck generation
Source: Freightinthecity website

London Freight Enforcement Partnership, more than 90 DVSA (Driver and Vehicle Standards Agency) and MPS ensure there is a coordinated, intelligence-led approach to taking non-compliant HGV drivers, vehicles and operators off the Capital's roads.

Policy Framework

The construction industry took the lead on a voluntary basis. CLOCS is providing the tools to assist organisations in achieving a culture shift with regard to work related road safety. A stronger Government or regulatory input would facilitate this culture shift.

However as mentioned above, the CLOCS standard is part of a wider initiative and some regulations impact positively the CLOCS application such as the Safer Lorry Scheme. Since the 1 September 2015 all roads in Greater London are subject to the Safer Lorry Scheme, prohibiting vehicles over 3.5 tonnes gross vehicle weight without side-guards or Class V and VI mirrors fitted from using London's roads. All vehicles compliant with CLOCS will also be compliant with the Safer Lorry Scheme.

CLOCS is linked to FORS (Fleet Operator Recognition Scheme) which is an accreditation scheme with a wider scope than CLOCS since it includes all sectors and improve not only safety. The FORS silver level is automatically compliant with CLOCS.

Implementation process

Following the publication of the report, an event was held in May 2013 attended by construction logistics representatives who publicly demonstrated their commitment to change.

Three key work streams were at the same time defined to take the CLOCS research recommendations forward:

- **Work stream 1:** Improving vehicle safety through design and manufacture of safer new vehicles and retrofitting of appropriate equipment to existing vehicles.
- **Work stream 2:** Addressing the safety imbalance ensuring road safety is considered as important as workplace site safety.
- **Work stream 3:** Encouraging wider adoption of best practice across the construction logistics industry through adopting best in class examples, developing a common set of national standards for the industry and working to create a new 'cultural norm'.

Because of their buying power, a couple of contractors from the CLOCS Champion scheme convinced with TfL the trucks manufacturer to change the design of the vehicles.

One of the steps identified was to develop and promote adherence to a nationally recognised standard for managing Work Related Road Risks (WRRR).

At the time of writing, more than 300 CLOCS Champions including construction clients, contractors and fleet operators are implementing and adhering to the requirements of the CLOCS Standard by signing the Memorandum of Understanding.

Originally focussed on the construction industry, the CLOCS Standard is being implemented beyond the construction sector (e.g. general distribution, local authority, TfL supply chains) since the findings and evidence regarding responsibility of transport safety are applicable to the transport sector as a whole.

TfL has encouraged cities outside of the capital to adopt CLOCS ahead of predicted growth in the numbers of cyclists and pedestrians in urban areas.

Key considerations and results

Benefits

CLOCS is including in a wider initiative to target the most dangerous HGVs. Below the results they obtained in two years from October 2013.

- Reduce number of vehicles from the road because non-compliant (More than 6,030 vehicles)
- Number of vehicles seized (87)
- Number of prosecutions (4,500)
- Number of penalties notices issued for offences (2,134) including:
    - Lack of insurance
    - Driving without the correct licence
    - Unsafe tyres
    - Vehicle not equipped with cycle safeguards
    - Not accurately recording driver hours
- Reduce fatalities and collisions

Transferability

- In 2014, while the University of Cambridge planned for £2 billion of construction work, they decided to implement a similar initiative in asking all its contractors to sign up the Cambridge CLOCS. First voluntary, the initiative became compulsory in new contract along with penalties for non-compliance.

References

CLOCS > www.clocs.org.uk

TfL, Enforcement Partnership to make London's streets safer, October 2013 > https://tfl.gov.uk

City of London police > https://www.cityoflondon.police.uk

University of Cambridge > http://www.environment.admin.cam.ac.uk

PO5 - Signs for trucks manoeuvring

FRANCE

Processes addressed

Material Reception and Expedition

Material Handling and Equipment

Objective

The objective of this practice is to improve the safety on the construction site by defining a standardized gesture (conventional signs) for guiding trucks drivers during their day-to-day manoeuvres.

Context

On a construction site, many accidents occur during driving manoeuvres, and particularly when trucks are moving back. The lack of external help for the drivers as well as the presence of numerous walking persons on a construction site are the cause of a great number of accidents.

Cost

Difficulty

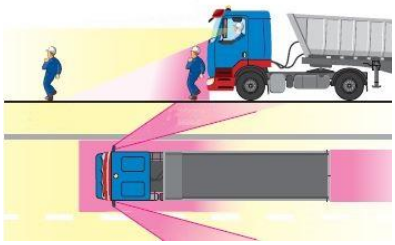
Quality

Best practice description

The French professional agency, Organisation for Prevention of Occupational Hazards in the Construction Industry (OPPBTP) is dedicated to advice, train and inform companies in the construction sector on the prevention of work-related accidents and occupational safety, and improve working conditions. It offers many services and training courses to companies, tailored to their needs. On its website www.preventionbtp.fr, the organism proposes various publications, practical tools and guidance sheets readily available. One of those is a guide on the signs for trucks maneuvering. The content presented below is extracted from this guide.

<u>The main causes of accidents</u>

- An ineffective or not well-adjusted inside rear-view mirror,
- A dirty outside rear-view mirror,
- The blind spots of the trucks,
- Cluttered construction sites,
- Drivers' inattention (mobile phone, CB radio, ...),
- Failure to observe safety rules,
- Pedestrians within the area dedicated to trucks manoeuvres.



Truck's blind spots

<u>The means for avoiding accidents</u>

Technical means

- Cleaned and adapted outside rear-view mirrors,
- Inside rear-view mirror
- Driver assistance systems (such as rear view camera)

Measures to be taken

- By the construction site responsible
  - Evaluate if a signaler is needed for guiding the trucks manoeuvres
  - Appoint a signaler and give him instructions
  - Ask the signaler to wear a class II safety vest, with a different colour
  - Remove or reduce or reverse travels
  - Define area dedicated to trucks manoeuvres
- By the signaler
  - Get known by the truck driver
  - Forbid, if possible, presence of pedestrians into the area dedicated to trucks manoeuvres
  - Always take place and stay in full view of the driver during the manoeuvres
  - Respect **conventional signs**
  - In case of emergency, immediately stop the vehicle by using "STOP"
- By the driver
  - Make sure that his vehicle's glasses and mirrors are clean
  - Ensure a good visibility
  - Ensure the proper functioning of the driver alert and assistance systems
  - Follow the signaler's instructions
  - Stop if the signaler is no more within his field of view

Appointing a signaler

Rear view camera

The conventional signs

To take command	One arm along the side, the other raised above head with the open hand		**STOP**	Cross and uncross the arms	
To reverse 	If the signaler is in front of the vehicle: 'to repulse' gesture If the signaler is behind the vehicle: 'to come' gesture	 	**To make any changes to the direction** 	Point the finger at the direction to take, the other arm make the reverse gesture	
To indicate a distance behind the vehicle 	Arms raised at right angles, hands palms facing each other, then indicate a space by moving arms closer		**To lift the dump** 	One arm at right angle, point up out with the thumb	
To lower the dump 	One arm at right angle, point down out with the thumb		**To stop the dump** 	Cross the arms, and uncross them on the horizontal	
To release command	Arms outspread and stationary, hands palms facing the driver				

- Actors
  - French authorities regulate the support to the driver and make the sign language training an obligation.
  - The association standardizes and transfers a sign language.
  - The company trains their workers to the sign language.
- Policy Framework

  The Art. R. 4534-11 of French Labour Law forces the construction site to help the driver when manoeuvring specifically when visibility is reduced such as manoeuvring back. One or more workers have to orientate the driver and inform people in the manoeuvring area with the voice or with conventional signs. The same measures have to be applied during the unloading of a dumpster.

Key considerations and results

- Benefits
  - Improve safety
- Critical success factors
  - Both the driver and the construction worker need to use a common sign language.
- Transferability
  - The practice is easily transferable and can overcome the language barrier.

References

OPPBTP > www.preventionbtp.fr

USIRF > www.usirf.com

PO6 – Safety, Health and Environmental Program

New York, USA

Processes addressed

- Inventory & Storage Management
- Material Handling and Equipment Management
- Housekeeping

Objective

The Safety, Health and Environmental Program promotes safety, and mitigates and/or controls all hazards associated with the construction at the site.

Context

With the redevelopment of facilities at the World Trade Center (WTC) since 2001, the Port Authority of New York & New Jersey owner of the site's land targets the "zero accident and environmental incident tolerance" through continuous improvement practices.

Cost

Difficulty

Quality

Best practice description

The Port Authority of New York & New Jersey (hereafter named Port Authority) is committed to safe and secure working conditions and employees working safely in the WTC site construction project.

The Program aims to prevent damages to workers, properties, structures and utilities, prevent environmental damage, control and reduce all direct and indirect costs and productivity losses due to accidents and incidences.

To assure the coordination of the project, the Program defines a set of requirements and plans. This best practice focuses only on requirements and plans specific to logistics.

World Trade Center Liberty Park
Source: PANYNJ website

Health and Safety Plan (HASP)

The contractor shall establish and maintain a comprehensive and enforceable Health and Safety Plan (HASP) prior to the start of work. HASPs ensure prompt detection and remediation of unsafe conditions or work practices. They shall be reviewed annually, and updated as necessary or as required upon any changes in the scope of work, existing site conditions regulation, or the intended method of execution. A hard copy and a non-modifiable electronic version of all revisions shall be forwarded to the relevant stakeholders. Submit a comprehensive and enforceable plan prior to the start of work.

Among the list of required plans, three of them are closely related to logistics issues: site logistics, housekeeping and scaffolds plans.

<u>Site logistics plan</u>

The Port Authority Construction Management Team and the contractor shall submit a plan identifying all proposed access routes, staging areas, crane locations, temporary traffic signal controls, worker and pedestrian crossings, vehicular and pedestrian gates for exit and entry, barriers, barricades, lighting, and fencing.

Extract of the site logistics plan of the WTC Vehicular Security Center and Tour Bus Parking Facility
Source: PANYNJ presentation

<u>Housekeeping plan</u>

The contractor shall submit a plan addressing the general housekeeping of the worksite including, but not limited to:

- the appropriate storage and/or security of all new and waste materials;
- the continued maintenance of clear access and egress paths, walkways, and traffic areas;
- the maintenance of all permanent and temporary structures and buildings, maintaining work areas free from accumulations of waste materials, rubbish, debris, or other refuse and/or equipment discarded during the performance of work;
- the removal, disposal and/or control of all rogue water, snow, dust, other transient materials with a potential for release from the WTC Site.

A dedicated resource will be tasked with the responsibility for the removal of debris, scrap material, trash, and other unusable materials on a daily basis at the end of each work shift. The CM and contractor shall review and revise this plan as housekeeping deficiencies are identified, or if control measures are ineffective.

Scaffolds plans

For all temporary construction, including but not limited to, scaffolding, hoisting systems, stairs, etc., the contractor shall submit drawings for record retention. The contractor whose workers will be utilizing the scaffold shall submit a plan to address, erection, use, maintenance, daily inspections, and disassembly of the scaffold. After erection, the contractor signs and seals a letter stating that the temporary inspection has been inspected, complies with the drawings and is ready to use.

Construction protection plan (CPP)

The contractor shall submit for review and approval a comprehensive plan addressing the implementation, enforcement and monitoring of the environmental performance commitments prior to the use of any diesel-powered engines including on-road vehicles.

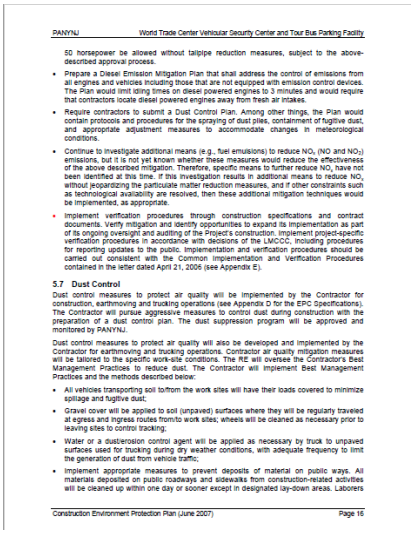
Among the list of required plans, two of them are closely related to logistics issues: diesel emission mitigation and dust control plans.

Diesel emission mitigation plan

The contractor has to submit a plan addressing work zone creation (on-road vehicle staging zones for the off-loading and loading of materials to and from the construction site. Such zones shall be located to minimize the impact of pollutants from diesel engines and vehicles on sensitive receptors and the general public. In addition, the contractor shall ensure that diesel powered engines and vehicles are located away from the fresh air intakes of sensitive receptors as determined by the REO. Diesel engine idling policy: limited to 3 consecutive minutes

Dust control plan

The contractor shall submit a plan addressing all controls and mitigation measures to reduce at all times dust particulate dispersions generated by work activities such as demolition, earth moving… Mitigations measures shall include wheel washing and spraying of dust suppressing agent.



PANYNJ World Trade Center Vehicular Security Center and Tour Bus Parking Facility

50 horsepower be allowed without tailpipe reduction measures, subject to the above-described approval process.

- Prepare a Diesel Emission Mitigation Plan that shall address the control of emissions from all engines and vehicles including those that are not equipped with emission control devices. The Plan would limit idling times on diesel powered engines to 3 minutes and would require that contractors locate diesel powered engines away from fresh air intakes.
- Require contractors to submit a Dust Control Plan. Among other things, the Plan would contain protocols and procedures for the spraying of dust piles, containment of fugitive dust, and appropriate adjustment measures to accommodate changes in meteorological conditions.
- Continue to investigate additional means (e.g., fuel emulsions) to reduce NO_x (NO and NO_2) emissions, but it is not yet known whether these measures would reduce the effectiveness of the above described mitigation. Therefore, specific means to further reduce NO_x have not been identified at this time. If this investigation results in additional means to reduce NO_x without jeopardizing the particulate matter reduction measures, and if other constraints such as technological availability are resolved, then these additional mitigation techniques would be implemented, as appropriate.
- Implement verification procedures through construction specifications and contract documents. Verify mitigation and identify opportunities to expand its implementation as part of its ongoing oversight and auditing of the Project's construction. Implement project-specific verification procedures in accordance with decisions of the LMCOC, including procedures for reporting updates to the public. Implementation and verification procedures should be carried out consistent with the Common Implementation and Verification Procedures contained in the letter dated April 21, 2006 (see Appendix E).

5.7 Dust Control

Dust control measures to protect air quality will be implemented by the Contractor for construction, earthmoving and trucking operations (see Appendix D for the EPC Specifications). The Contractor will pursue aggressive measures to control dust during construction with the preparation of a dust control plan. The dust suppression program will be approved and monitored by PANYNJ.

Dust control measures to protect air quality will also be developed and implemented by the Contractor for earthmoving and trucking operations. Contractor air quality mitigation measures will be tailored to the specific work-site conditions. The RE will oversee the Contractor's Best Management Practices to reduce dust. The Contractor will implement Best Management Practices and the methods described below:

- All vehicles transporting soil to/from the work sites will have their loads covered to minimize spillage and fugitive dust;
- Gravel cover will be applied to soil (unpaved) surfaces where they will be regularly traveled at egress and ingress routes from/to work sites; wheels will be cleaned as necessary prior to leaving sites to control tracking;
- Water or a dust/erosion control agent will be applied as necessary by truck to unpaved surfaces used for trucking during dry weather conditions, with adequate frequency to limit the generation of dust from vehicle traffic;
- Implement appropriate measures to prevent deposits of material on public ways. All materials deposited on public roadways and sidewalks from construction-related activities will be cleaned up within one day or sooner except in designated lay-down areas. Laborers

Construction Environment Protection Plan (June 2007) Page 16

Construction Protection Plan of the WTC Vehicular Security Center and Tour Bus Parking Facility
Source: PANYNJ website

Other requirements

Additional mandatory worksite requirements extend the scope of existing regulations and standards. They are related to material handlings and hazardous chemical storage.

Actors

- The Port Authority established and maintains the WTC site requirements.
- All contractors are required to include the WTC site requirements into their project specific health and safety plans.
- Several committees are defined by the Program to ensure the correct implementation of the requirements.

Policy Framework

The Program highlights that the responsibility for safety and health must be in line with all applicable Federal, State and local standards.

Key considerations and results

Benefits

- Reduce damages to workers, properties, structures and utilities
- Reduce environmental impact
- Control and reduce all direct and indirect costs and productivity losses due to accidents and incidences

Critical success factors

- The effectiveness of this Program is dependent on the active participation and cooperation between the Port Authority, all WTC stakeholders/owners and agencies.
- The careful coordination among all the construction activities is the key for the success of the Program, its implementation and maintenance.

Advanced technologies

Information and Communication Technologies (ICT) are a key enabler to foster collaboration between the various sub-contractors on site and thus increase the visibility along the supply chain. However, the low adoption of the ICT technologies in the construction sector especially in the supply chain and logistics results in a bigger challenge to the digitalisation of this industry. The high number of SMEs whose managers are not familiar with advanced technologies limits the digitalisation process. Even if large companies have realised the interest to use the new technologies to develop their business, to save time and to prevent construction site problems few applications that all stakeholders can use to support the collaboration exist.

IT1 - Sourcing Software

IT2 - Delivery area booking system

IT3 - Defect management

IT4 – Radio-Frequence IDentification

IT5 - Building Information Modelling for construction logistics

Credit: Vinci Construction France

IT1 - Sourcing software

Verona, IT

Processes addressed

Sourcing

Objective

The sourcing software aims at evaluating, selecting suppliers and sub-contractors and awarding contracts more efficiently and transparently.

Context

Procurement is a critical function for every company and implies the collaboration across different offices. In the construction sector, material costs represent 30-40% compared to the other construction costs. To prevent criminal organizations' infiltration and corrupt practices, Italy raises awareness about the transparency of the contracts and public procurement awards. To address these issues, CMB standardizes the sourcing process with the use of a sourcing software.

Cost

Time

Difficulty

Best practice description

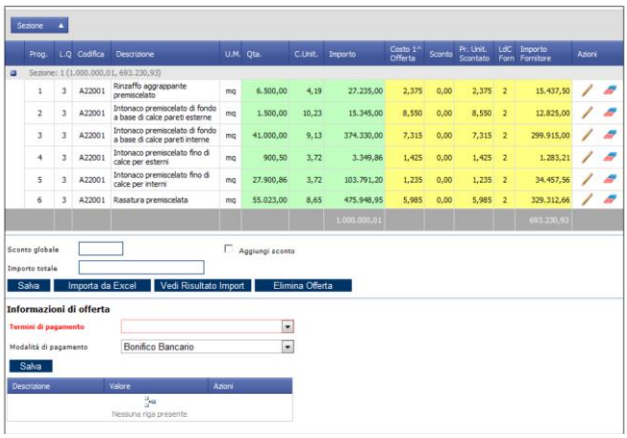
CMB developed for its own use a web-based application to support the tendering process. CMB has used Ge.A. (Gestione Approvvigionamenti) for many years and makes its use mandatory for a transparent purchase policy. CMB manages in Ge.A. about 2,000 contracts per year. The system allows the assignment of sourcing projects to internal decision makers who can better collaborate through an approval workflow and detailed process steps. According to their access rights, the construction manager and the purchase office implied in the process can track, monitor and revise different sourcing project activities leading to more transparency and efficiency into sourcing initiatives across CMB. Emails notify users of actions they should perform in the system. Ge.A. allows users to ensure that sourcing activities are on-time and of quality to match project objectives. The process embedded in Ge A. consists in several steps:

Create a request

The construction manager creates a purchase request in selecting the type of contract which best matches the scope of the activity and in defining the material or service requirements. He can select standards resources (material or service) within a catalogue and has access to a list of vendors classified by resources. He estimates target prices against which he can compare the offers later on. The supply manager validates the conformity of the purchase request.

Call for tenders

The system generates a requirement book including the request for quotation (RFQ), instructions, introduction and executive summary. The requirements book is submitted electronically to the vendors, requiring quotations. The RFQ is an Excel file with an itemized list that the vendors should complete and send back to CMB.



Request For Quotation
Source: CMB

Select the supplier

The system sets the various suppliers' offers into a comparative framework where the prices and the characteristics of the materials or service offered are defined. A set of criteria qualify suppliers' bids and leads to optimal decisions. The suppliers are evaluated according to the technical offer, terms of payment, financial health of the company, delivery time and to the price. The system proposes a comparative view of the quotation against target prices for each requested material or service. Along the negotiation process, the discounts proposed are directly integrated in the system. The sourcing project team ranks the suppliers on the multi-criteria analysis and the construction manager awards the supplier who best matches his needs.

Prepare the contract

Ge.A. automatically generates a draft contract using information already input in the system. The purchase office completes the contract with the selected supplier to secure the mutual agreement. Once the contract is signed, tendering process can close and orders can be submitted.

Actors

- The construction manager defines the requirements to the material or the service, creates the request and selects the awarded company.
- The supply manager (purchase office) validates the request and leads the economic negotiation.
- The purchase office prepares the contract.

Key considerations and results

Benefits

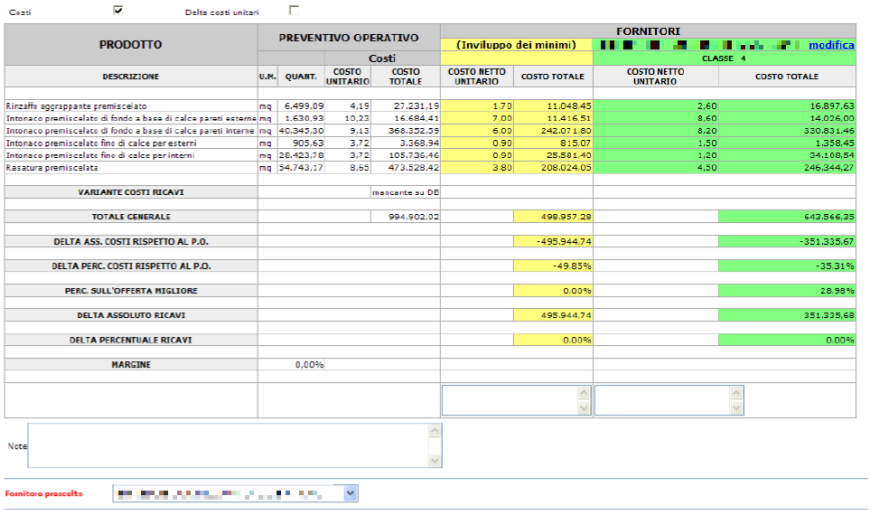
- Increase the efficiency with a standardised process for collaboration
- Reduce costs with fact and market driven decisions
- Reduce costs with an automated and paperless process
- Increase tendering transparency in tracking results and decisions

Problems occurred

- Even if such software is not innovative, the low adoption of ICT solutions in the construction sector makes its implementation difficult.

Transferability

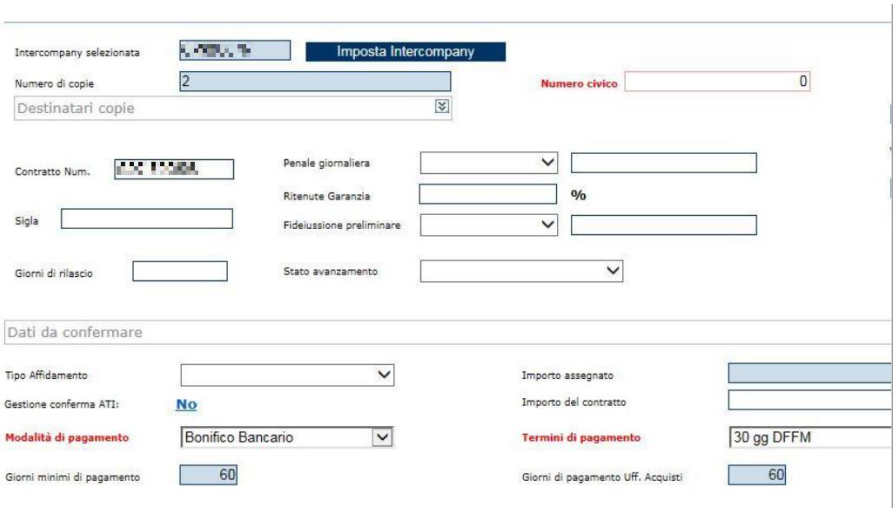
- The system is made in-house but similar software exists on the market and can fit easily the construction sector.



PRODOTTO		PREVENTIVO OPERATIVO			FORNITORI (Inviluppo dei minimi)		[redacted] CLASSE 4 modifica	
			Costi					
DESCRIZIONE	U.M.	QUANT.	COSTO UNITARIO	COSTO TOTALE	COSTO NETTO UNITARIO	COSTO TOTALE	COSTO NETTO UNITARIO	COSTO TOTALE
Rinzaffo aggrappante premiscelato	mq	6.499,09	4,19	27.231,19	1,70	11.048,45	2,60	16.897,63
Intonaco premiscelato di fondo a base di calce pareti esterne	mq	1.630,93	10,23	16.684,41	7,00	11.416,51	8,60	14.026,00
Intonaco premiscelato di fondo a base di calce pareti interne	mq	40.345,30	9,13	368.352,59	6,00	242.071,80	8,20	330.831,46
Intonaco premiscelato fino di calce per esterni	mq	905,63	3,72	3.368,94	0,90	815,07	1,50	1.358,45
Intonaco premiscelato fino di calce per interni	mq	28.423,78	3,72	105.736,46	0,90	25.581,40	1,20	34.108,54
Rasatura premiscelata	mq	54.743,17	8,65	473.528,42	3,80	208.024,05	4,50	246.344,27
VARIANTE COSTI RICAVI				mancante su DB				
TOTALE GENERALE				994.902,02		498.957,29		642.566,35
DELTA ASS. COSTI RISPETTO AL P.O.						-495.944,74		-351.335,67
DELTA PERC. COSTI RISPETTO AL P.O.						-49,85%		-35,31%
PERC. SULL'OFFERTA MIGLIORE						0,00%		28,98%
DELTA ASSOLUTO RICAVI						495.944,74		351.335,68
DELTA PERCENTUALE RICAVI						0,00%		0,00%
MARGINE		0,00%						

Costi Delta costi unitari Note Fornitore prescelto

Comparative view of the suppliers' bids
Source: CMB



Contract generation
Source: CMB

IT2 - Delivery area booking system

Paris, FR

Processes addressed

Delivery

Material Reception & Expedition

Material Handling & Equipment Management

Return Management

Objective

The delivery area booking aims at improving productivity of delivery operations.

Context

A construction site generates a flow of vehicles bringing and picking up materials. The lack of space on site and the cost of material increases the rate of Just-In-Time (JIT) deliveries. To improve performance and decrease congestion, construction companies create temporary delivery areas. Nevertheless, the delivery operations continue to be a critical point in the overall site productivity: double-parked vehicles, occupied delivery areas, crane shared with construction operations. In this context, Vinci decided to request the sub-contractors to book one of the two 500m² delivery areas in advance.

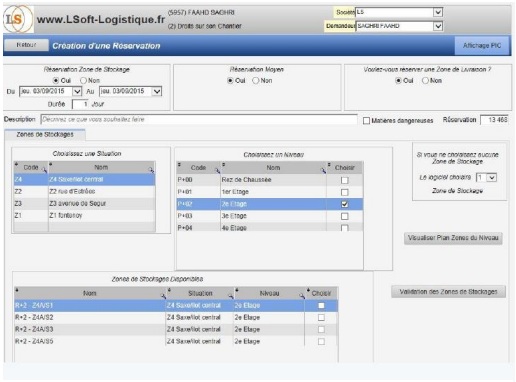
Cost

Time

Difficulty

Best practice description

Delivery access on pilot site
Source: LIST



Booking request
Source: Vinci Construction France

Vinci requests to their sub-contractors to book the delivery area using an online booking system designed for scheduling a delivery area and material-handling equipment.

Sub-contractors create a booking request for every delivery they plan to receive at least two days before with the following information:

- Day and time slot of the delivery (the minimum time slot is 30min)
- Delivery area (two exist on the pilot site)
- Material-handling equipment (lift, forklift truck, or tower crane)
- Storage area
- Nature of material
- Type of delivery vehicles (utility vehicle, 19t truck, trailer truck or arm truck)

It supposes that the carrier and the sub-contractor reach a mutual arrangement for delivery of the shipment.

The booking request is notified to the logistics manager who approves or declines the reservation.

Unpredicted delivery is treated as soon as possible in the best possible conditions.

The system generates a daily delivery schedule with the corresponding delivery notes. The logistics manager checks with his tablet the delivery note on delivery. If the description or the number of packages is not correct, the logistics manager modifies the delivery note. Then the sub-contractor signs the delivery note to confirm delivery reception.

A logistics team is responsible for the unloading in moving the goods from the truck to a buffer stock at the appropriate floor. No later than 24 hours after receiving the delivery, the sub-contractor should move their goods to the definitive storage zone.

Actors

- The logistics contractor provides the IT booking system to the main contractor to ensure coordination between stakeholders.
- The sub-contractor finds an agreement on the date and time of delivery to plan in advance delivery operations.
- The sub-contractor submits a delivery booking request to the main contractor via the IT system to avoid congestion on site and improve delivery efficiency.
- The logistics contractor unloads materials to the buffer stock to improve delivery efficiency.

Key considerations and results

Benefits

- Increase of the number of planned deliveries (up to 70-80% of all deliveries)
- Reduce truck waiting time (outside and inside the site)
- Improve construction site punctuality
- Reduce loading / unloading time
- Reduce time dedicated to logistic activities
- Reduce congestion on construction site
- Reduce rate of obstructing vehicles

Problems occurred

- The logistics managers have to check consistency of booking requests (e.g. time slot of 30 min to unload a heavy vehicle).

Critical success factors

- The main contractor should force all sub-contractors to use the Delivery Area Booking System.
- The contract should mention financial penalties for non-compliance with the site rules.

Lessons learned

- The sub-contractors will adopt the delivery area booking system if it is designed to be efficient and easy to use.

Transferability

- The logistics contractor uses the delivery area system on several sites. Since a construction site generates a lot of deliveries and the delivery involves the collaboration between different stakeholders, a delivery area booking system is easily transferable.

Weekly plan of a delivery area
Source: Vinci Construction France

IT3 - Defects management

Paris, FR

Processes addressed

Complaint management

Objective

The defects management software aims at recording and monitoring the irregularities noticed on the worksite.

Context

Lots of defects can occur on a worksite: untidy workstation, overbooked storage area, materials left in an inappropriate place, lack of adequate cleaning, etc. When not managed offline with direct verbal exchange on the worksite, generic office software (Spreadsheet, Word processing, email) remains commonplace to manage and follow such defects. As a consequence, the information on defects is either not recorded or scattered over several systems. VINCI Construction was looking for a useful tool to index efficiently the defects on the worksite, and to correct them quickly.

Cost

Time

Difficulty

Best practice description

VINCI Construction France (VCF) has deployed a defects management process supported by a software dedicated to the construction business (CONJECT, OPR6). It allows the company to save and monitor all of the reported cases in a single place. The web-based application is available on mobile and tablet devices. The process consists in several steps:

Capture defect

Every Tuesday, the logistics contractor visits the worksite so as to identify defects: lacks of adequate cleaning, tidiness, and other kind of disorder.

Equipped with a tablet, he records the defect on the mobile application of defect management software. The logistics contractor captures the defect with the following information:

- location on the drawing
- photo (possibly with additional mark-up)
- company responsible for solving the defect
- location concerned
- description of a corrective action
- due date for the corrective action
- construction phase

Examples of defect
Source: VCF

Escalate defect

The visit report is synchronized with the web platform and compiled in a pdf report. The report is then transmitted to the site logistics manager.

Notify defect to subcontractors

The logistics manager sends a notification to all the subcontracting companies concerned by the defects.

Repair defect

The subcontractors have to repair the defect within 48 hours, if not the site manager gives a warning. If no corrective action is made, the subcontractors are subject to financial penalties.

Control corrective action

Every Thursday, the logistics contractor visits the worksite to check if the defects have been solved. If the correction of the action is validated, the logistics contractor turns the status of the defect from *unsolved* to *solved* on the software interface. If no corrective action is made, the subcontractor is subject to financial penalties which are the cost of the corrective actions performed by the main contractor.

Weekly statistics

The defect management software generates automatically a final report that VCF sends to the relevant stakeholders. The software computes statistics per subcontractors, technical sections, etc. It also provides dynamic presentations based on Excel files and architectural plans.

Actors

- The main contractor manages the whole process and applies penalties if needed.
- The logistics manager notifies the defect and the corrective action to the subcontractor. He sends a weekly report to all stakeholders with the updated status.
- The logistics contractor visits the site twice a week to detect defects and check for their correction.
- The subcontractors correct the defect within 48 hours.

Key considerations and results

Benefits

- Reduce time for logistics activities
- Reduce time for looking for material and equipment
- Reduce congestion on construction site
- Reduce number of accidents on site
- Reduce the amount of damaged materials

Problems occurred

- Even though financial penalties should be dissuasive, the management has to strongly support the logistics manager to make the subcontractor responsible and execute the procedure as an actual obligation.

Critical success factors

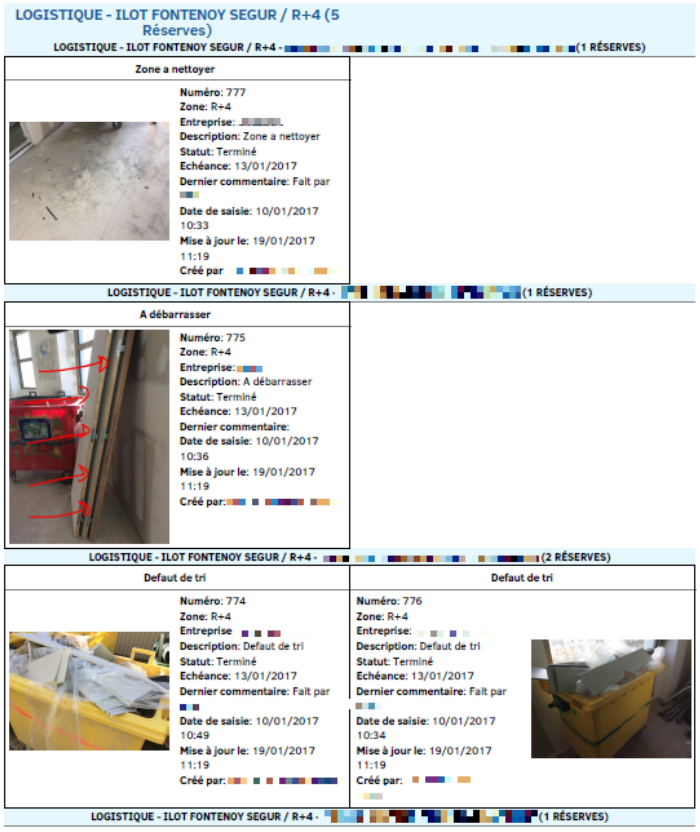
- The subcontractor has to cooperate and react quickly to apply corrective actions.
- The line management has to give warnings and apply sanctions.

Lessons learned

- The systematic approach motivates the majority of the subcontractors to respect the rules upstream, realizing that it prevents from doing the work twice.

Transferability

- The construction-oriented defect management system is easily transferable since it is available on the market. It is the first experience for VCF to use such tool to identify defects during the works operation. It was used during the first phase of the construction phase to identify defects on completed works.



Weekly report (extract)
Source: VCF

IT4 - Radio-Frequency IDentification

EUROPE, USA

- Processes addressed
- Material Reception and Expedition
- Inventory and Storage Management
- Material Handling and Equipment Management

Objective

The purpose of this practice is to put in place an efficient objet tracking system (with help of the RFID technology) to better oversee and control the ordering, storage and use of the components that a company will use on the construction site. In particular, RFID can be used for receiving of construction materials at site, for the identification and tracking of construction components at different phases, and for tracking the history of components throughout project lifecycles.

RFID on Wikipedia

https://en.wikipedia.org/wiki/Radio-frequency_identification

Cost

Time

Difficulty

Best practice description

This best practice aims at improving the inventory and storage of goods on the construction site. It relies on the identification and localization of material, tool, and equipment using RFID. RFID tags can be read at a distance by handled scanner, and do not require the tags to be visible. This enables tags to be read inside a crate, and for a stack of goods to be individually identified, without moving them, and without the need to scan each one individually.

The utilization of RFID can address many different purposes:

Object tracking

Identification of materials (e.g. pipe spools, steel members), tools (e.g. hammer drill, band saw), and workers as they pass by specific locations at job site (e.g. gates) or when scanned by a handheld reader.

Examples of use:

1/ Song et al. [2] attached active RFID tags to pipe spools for storing relevant data (i.e., spool number, purchase order, and piece marked number). As the truck that carries the tagged pipe spools arrives at the job site, it passes through an RFID-enabled portal for automated receipt or materials.

2/ Cheng et al. [3] used RFID tags to store information about how to restore timber components and this information is modified and updated according to the needs of a specific restoration phase. In addition to the data stored in tags, other information (e.g., restoration sequence, evaluated strength capacity) was available via a Geographic Information System (GIS) application, which was accessible online through a handheld PDA reader/writer used onsite.

3/ Ren et al. [4] developed an RFID facilitated construction material management system to obtain up-to-date production and installation information about the pipes in a water supply project. PDAs were used to collect data from RFID tagged fittings and to transfer data to a remote database daily. Production and installation data related to the pipes (e.g., manufacturer, scheduled installation date) were stored in tags on the fittings. According to the data collected on site via RFID, comparison of the actual situation with the baseline schedule was made based on usage of fittings and changes on site

4/ Goodrum et al. [5] tested a tool tracking system at a number of construction job sites, where active RFID was used for keeping an inventory of small tools and for storing pertinent operation and maintenance data on the tools (e.g., hammer drills).

A truck carrying tagged facade elements passes an RFID gate.
(Source: rfidjournal.com)

Object localization

Determination of the exact location of mobile objects (such as materials at the jobsite), and fixed objects (such as buried cables).

Examples of use:

1/ In Atlanta Airport, RFID markers were used to track cables and pipes buried around five feet. The marker's serial number, type of cable, location, owner, and material (e.g., copper, fibre) information was stored in passive tags (Swedberg [6]).

2/ Dziadak et al. [7] also tried to locate the position of non-metallic buried assets using passive RFID with other technologies such as Global Positioning System (GPS). It was suggested that additional data such as the type of the buried pipe (i.e., metallic/non-metallic), its dimension, material in the pipe (e.g., gas, water) can be stored directly in the tags.

Object information (gathering)

Gathering status information (e.g. manufactured, delivered, installed) or lifecycle information (e.g. manufacturer information, installation instructions, maintenance records) of components at different phases during construction

Examples of use:

1/ Ergen et al. [8] stored the lifecycle information related to engineered-to-order precast components (e.g., manufacturer and owner information) in active RFID tags.

2/ Motamedi and Hammad [9] used RFID tags to store lifecycle maintenance data (e.g., date, inspection results) of fire safety equipment in the facility maintenance phase. The goal was to provide historical information for inspectors and maintenance/repair personnel without accessing any central database.

3/ Use of RFID tags to identify components at different phases for tracking component's status information, and thus project's progress information. After the status data is collected at site, it is integrated into a schedule or a Building Information Model (BIM) for monitoring the general progress of the construction.

Using a handheld RFID reader
(Source: www.confidex.fi)

Object information (tracking)

Tracking quality-control test results and inspection results (e.g., concrete maturity tests)

Examples of use:

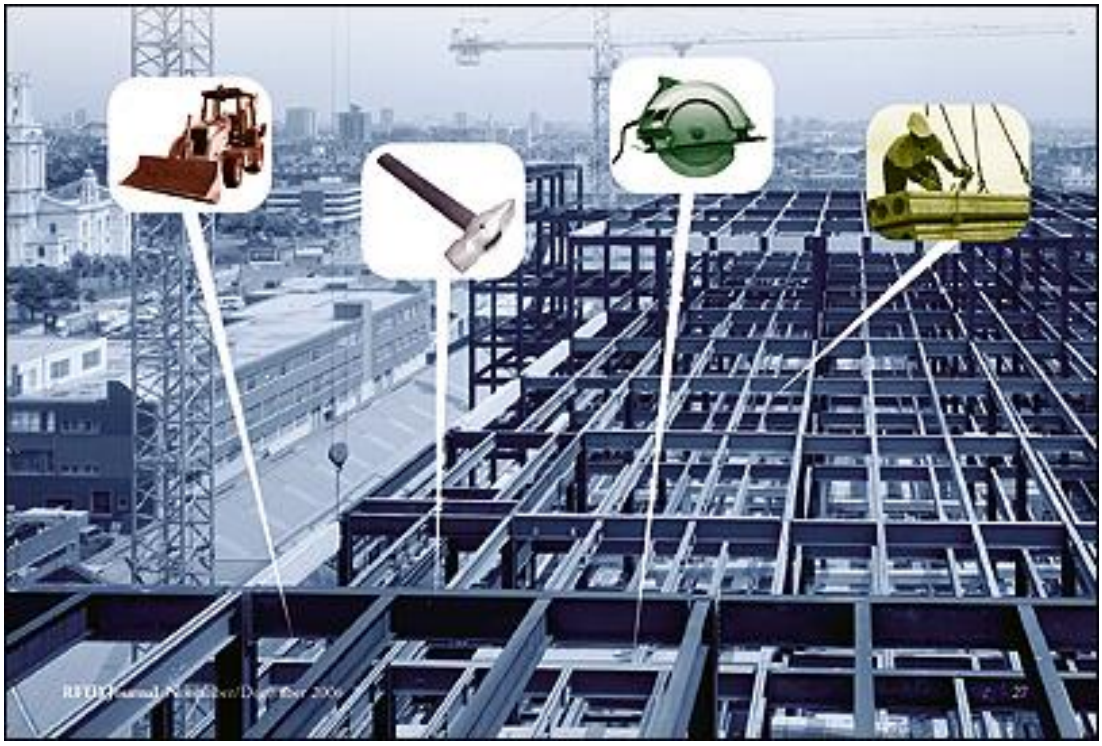
1/ Yabuki et al. [10] suggested a method that distributes data among RFID tags, PDAs, and the Internet to continuously provide quality inspection data at the necessary level. When basic information about a facility or a member was needed at the field, data in RFID tags (e.g., latest measured data) would be accessed. But when more detailed information was needed about a facility or a member, PDAs preloaded with related information (e.g., digital photographs and sounds), would be used. Finally, all the inspected data, document and drawing files were made available on a local server.

2/ O'Connor [11] described how a company used RFID to detect concrete's temperature and estimate its strength without having to wait for the results of conventional testing methods. Therefore, active RFID tags integrated with temperature sensors were embedded in the test cylinders. Data, such as the tag number, location, and its depth within the concrete was written in tags and temperature was stored periodically in tags. The software that runs on handheld computers used the tag data to calculate the maturity of concrete.

Actors

Depending on the kind of utilization of the RFID technology, various actors can be involved. The following are examples of roles and responsibilities associated with some part of the RFID-based process:

- The supplier or manufacturer, in charge of attaching the RFID tag to each piece of material.
- The workers, involved in the localization, storage or inventory of materials, through the use of RFID readers at the plant or before installation on site.
- The main contractor, responsible of the installation of RFID-enabled portals at the entrance of the construction site.



The RFID in Construction
Source: https://www.rfidjournal.com/

Contextual framework

- ISO/IEC 18000 is an international standard that describes a series of diverse RFID technologies, each using a unique frequency range.
- ISO/IEC 20248 specifies a digital signature data structure for RFID and barcodes providing data, source and read method authenticity.
- EN 300 220 (Parts 1-3) Electromagnetic compatibility and Radio spectrum Matters (ERM):
- Short-Range Devices (SRD); Technical characteristics and test methods for radio equipment in the frequency range 25MHz to 1000MHz frequency range with power levels ranging up to 500mW (1997-2005).
- EN 300 330 (Parts 1-2) Electromagnetic compatibility and Radio spectrum Matters (ERM): Short-Range Devices (SRD); Technical characteristics and test methods for radio equipment in the frequency range 9kHz to 25MHz and inductive loop systems in the frequency range 9kHz to 30MHz (1999-2004).
- EN 300 440 (Parts 1-2) Electromagnetic compatibility and Radio spectrum Matters (ERM): Short-Range Devices (SRD); Radio equipment to be used in the 1GHz to 40GHz frequency range (2001- 2004).
- EN 302 208 (Parts 1-2) Electromagnetic compatibility and Radio spectrum Matters (ERM): Short-Range Devices (SRD); Radio Frequency Identification Equipment operating in the band 865MHz to 868MHz with power levels up to 2W, with 200kHz subbands and a mandatory "listen before talk" (LBT) function (2004-2005).

Key considerations and results

Qualitative results

- Reduced labour time by improving the material identification and tracking processes
- Reduced inventory costs through "just in time" delivery to site
- Reduced re-purchasing cost by eliminating missing components
- Improved productivity by increasing tool availability

Problems occured

According to [12], the following are the main obstacles that still restrict the development of RFID:

- Price of the technology
- The RFID Technical standard
- RFID technology is not mature enough
- Personal and enterprise ethical and privacy issues

Critical Success Factors

- Combining RFID with GPS or BIM
- Distributing the RFID investment cost proportionately among the parties involved in the construction supply chain

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IT5 – Building Information Modelling for construction logistics

USA / Hong Kong

Processes addressed

- Sourcing
- Ordering
- Inventory & Storage Management
- Material Handling & Equipment Management
- Planning & Scheduling resources

Objective

Extract information from BIM to optimize construction logistics and supply chains.

Provide feedback from the supply chain and logistics directly into the BIM.

Context

Building Information Model (BIM) is a growing technology in the Architecture Engineering and Construction businesses aiming at consolidating information about a building (including construction information) in a single place so-called model. As a single place of information, the correct exploitation of such model can improve construction logistics and in particular materials logistics.

Cost

Time

Difficulty

Best practice description

Several researches in the recent years have experimented the **use of Building Information Models (BIM) as source of information to improve the logistics** of the construction site [4]. In all cases, additional tools or algorithms to the BIM software were used to identify optimization of the construction site logistics along multiple dimensions (resources ordering, on site storage location, suppliers sourcing…). BIM is seen at the next fundamental technology supporting the digitalization of Architecture Engineering and Construction businesses. **It is currently used mainly in the design phase** of construction projects to build 3 dimensional plans (3D BIM). Due to its extensibility BIM can easily integrate additional information such as schedule (it is then referred as 4D BIM) or schedule and costs (5D BIM). As an emerging technology BIM is not yet fully stabilized, in particular with regards to exchange standards, although the IFC format seem to be the future standard for BIM exchanges. In the construction phase, the operational use of BIM is quite limited so far.

Some experiments of **BIM usage to improve the construction material logistics of buildings** in urban area have been reported by researchers in Hong Kong and in the USA between 2013 and 2015. The reported cases were **building construction projects in dense urban areas:**

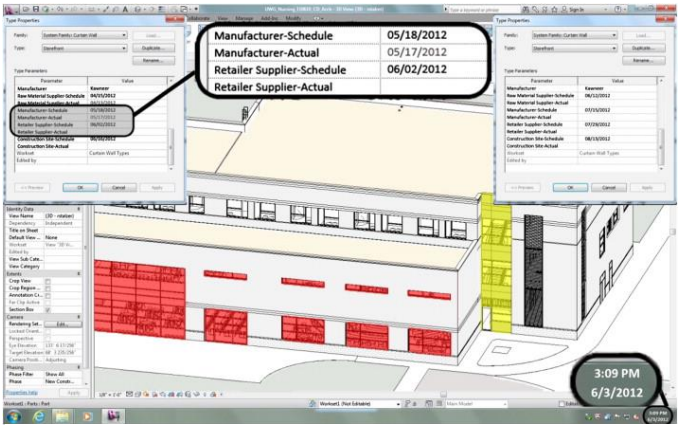
- A building in Hong Kong, [1]
- A university building in Carrollton, Georgia, USA [2]
- A 10 story building (precise location not mentioned) [3]

In these examples, the researchers had access to the BIM model of the building under construction and developed prototypes to **optimize** the logistics of the construction material either with regards to **sourcing** or with regards to on-site **storage** or material **handling** taking into account costs and schedule parameters.

Method

Researchers accessed the 4D BIM models of the buildings (as-planned models). From these models they extracted the materials lists and mapped it with the scheduled activities. They were then able to have a spatial and time representation of the materials needs on the site. In general they had to extend the BIM models with additional information (meta-data, parametric rules …) so as to run their experiments.

Sourcing and ordering optimisation and transport delays impacts in BIM models



Visualising the impact of transport delays on the BIM's plans
Source: [2]

In the university case [2], the researchers combined the BIM with a Geographical Information System (GIS) to determine the optimal suppliers, depending both on the suppliers' location and their abilities (warehouses capacities, transportation modes, products characteristics, costs…).

Next depending on the choice of the supplier, for each material they determined the optimal number and planning of material orders to guarantee a minimal logistics cost while limiting the schedule impact.

Then after each order and during the delivery process, they used real-time transportation information from the GIS module to estimate delays in deliveries.

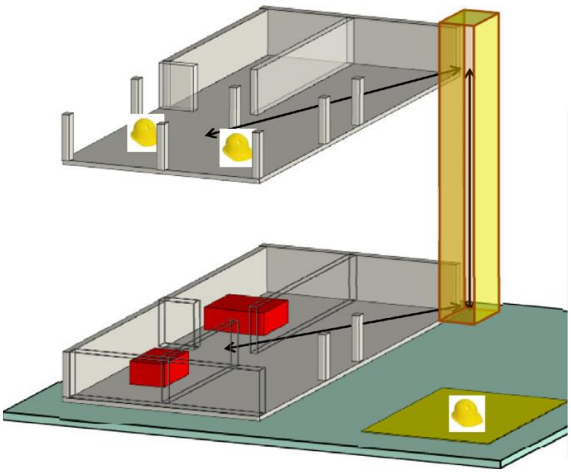
Last they input the delays back in the BIM to update the BIM schedule information and have a visual representation of the transport delay impact on the model.

On-site material storage and handling optimisation

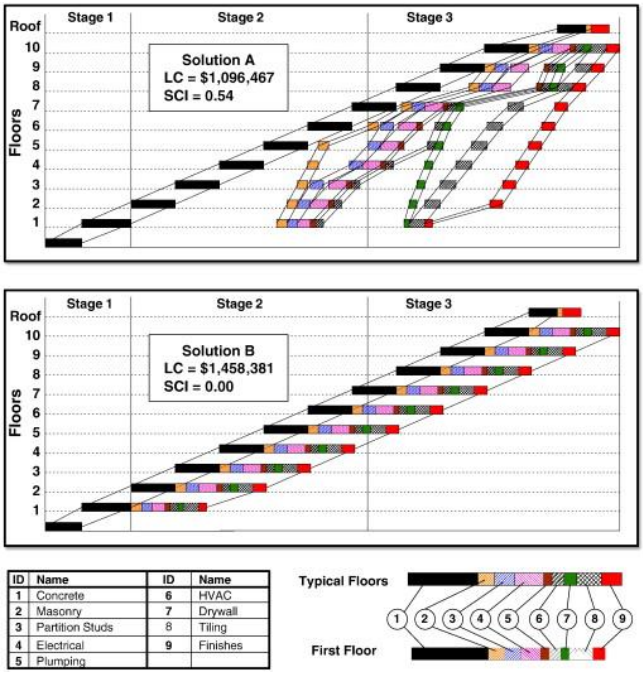
In the two other cases [1], [3], the researchers developed optimization algorithms to determine both the optimal number and time of material orders and the optimal daily storage location the materials on-site.

They extracted information from the BIM to identify the availability and location of spaces in the building during its construction. It allowed them to consider the option of on-building storage so as to optimize the site storage capacity.

In one case [3], the optimisation considered several in-building locations options impacting logistics costs and schedule criticality. Researchers provided storage plans and activity storage plans for the two extreme options (low logistics cost / high schedule impact vs. high logistics costs no schedule impact).



Identification of interior storage areas based on BIM information
Source: [3]



Two optimal solutions for material logistics on a 10 floors building under construction
Source: [3]

Automated ordering

The Hong-Kong [1] case was also innovative by proposing a suppliers coordination module that monitored resources consumption. For certain type of material, this module placed automatic orders when the material fell below pre-determined thresholds, taking into account the supplier's delivery time, the cost of ordering and the available storage capacity on site.

Actors

- **Architects** and **engineers** provide the initial BIM model and the updated versions.
- **Construction companies** (main contractor and subcontractors) continuously feed the BIM with their latest information in particular in case of tasks delays.
- **Material suppliers** and **carriers** make available their availabilities and delays in manufacturing and transport of materials, or better provide them directly in the BIM.

Key considerations and results

Benefits

The cases reported have proposed optimization solutions for construction logistics of specific buildings. It is however not mentioned clearly whether and how the proposed solutions have effectively been implemented by the construction companies during the construction projects, and if additional iteration were required. By integrating 4D BIM and GIS one can obtain visual feedback of logistic issues impacts on construction plans. By complementing 4D BIM models with additional data and running specific algorithms, one can automate the design of optimal logistics plans on construction sites.

Critical Success Factors

- Use BIM Application Programming Interfaces (**API**) and BIM **open formats** (like IFC) to access and exchange data in the BIM.
- Combine BIM with **track and trace** technologies (RFID, GPS…) for materials both outside the site and inside the site, avoid a tedious daily data update or data input that would be necessary to keep the model up to date.
- Develop a **data sharing** culture among the stakeholders of the construction project to enable collaboration around BIM models.

Transferability

- While having demonstrated the technical feasibility, the cases are still experimental and would need to demonstrate their replicability on a majority of projects. The cases have designed prototypes that are not yet integrated in major BIM systems. Factually, the proposed practices are design approaches (as opposed to "live" approaches) in the sense that they do not seem to be continuously updated during the construction project.
- Replicating these cases requires BIM skills and awareness of the construction project stakeholders.

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Integrated supply chains

Construction projects consist of various and often uncoordinated supply chains operated by several stakeholders. It may include the main contractor, suppliers, sub-contractors, clients, designers and so on. These stakeholders vary with the different stages of the project. During the planning, design and construction phases, the main contractor has a limited vision of the supply chains due to the wide variety of actors. To improve collaboration between the organisations involved in the various supply chains, professional and academic of the construction sector tend to adopt traditional supply chain management practices and to apply them with some adaptations given the specificity of the industry.

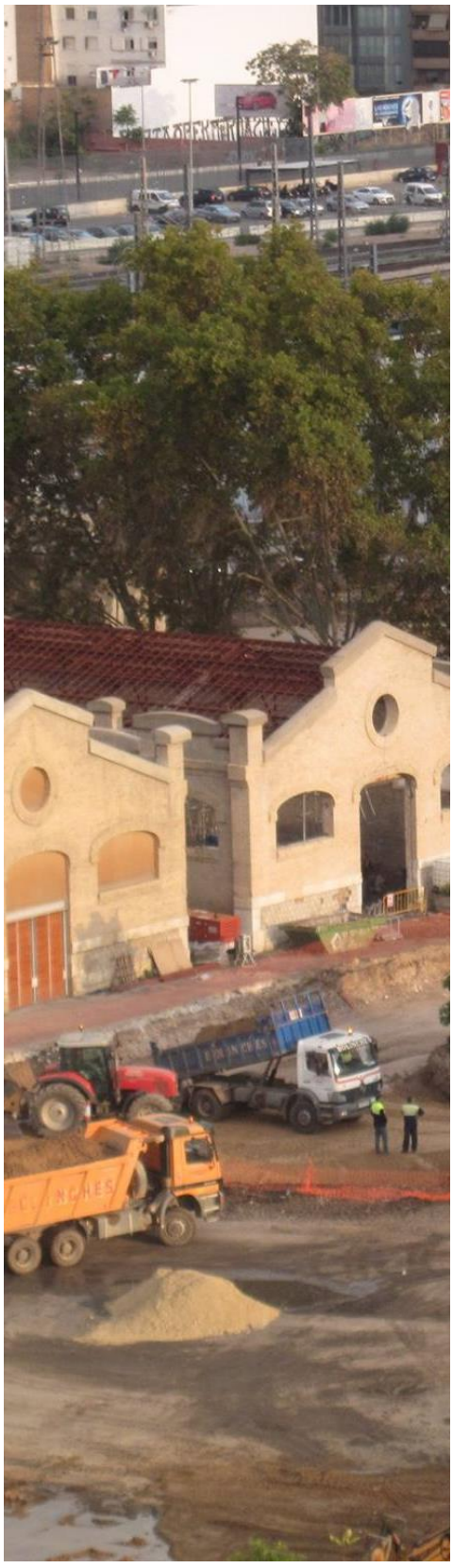
SC1 - Construction Consolidation Centre

SC2 - Framework agreement

SC3 - Database of qualified suppliers

SC4 - Just-In-Time delivery

SC5 - Supply Chain Operations Reference model



Credit: FEVEC

SC1 - Construction Consolidation Centres

Stockholm, SE / London, UK

Processes addressed

- Delivery
- Material Reception and Expedition
- Material Handling and Equipment Management
- Waste Management

Objective

Construction Consolidation Centres (CCC) serving urban construction sites represent a promising logistics practice to optimise freight deliveries at construction sites, to reduce congestion, to reach liveable conditions for humans, an improved working environment and to reduce energy use and emissions.

Context

Construction logistics in cities often lacks of coordination between the actors of the supply chain, resulting in a huge, scattered and non-coordinated number of deliveries to the sites, creating congestion and pollution. Through the introduction of CCCs the aim is to acquire a more efficient and effective logistic process by reducing the number of transport deliveries as well as increasing the time efficiency, standard and service of the required transports.

Cost

Time

Difficulty

Best practice description

Context

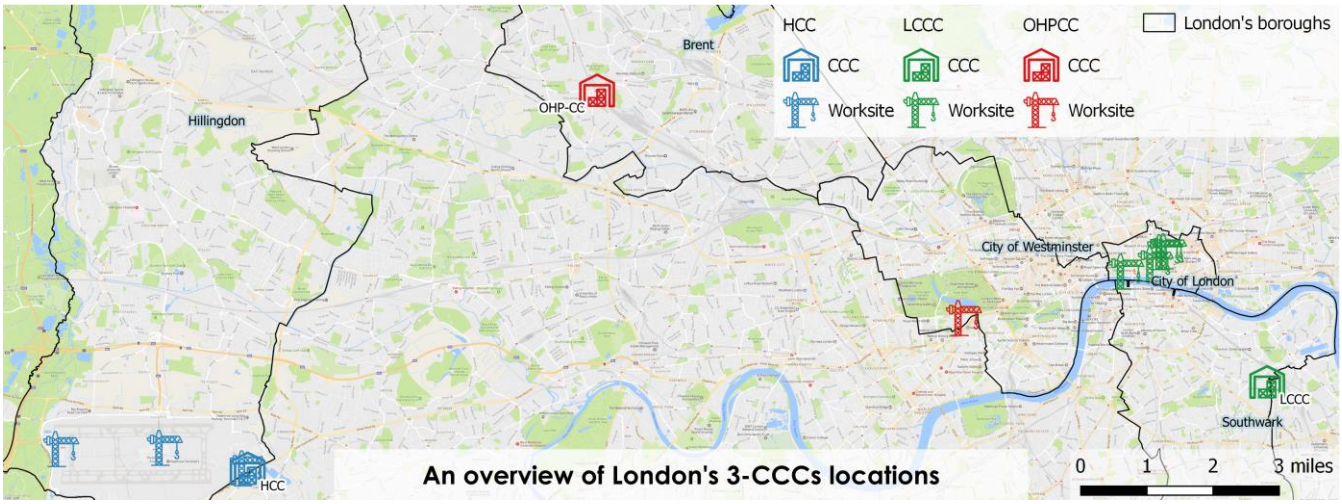
Through the introduction of Construction Consolidation Centres (CCCs) serving inner city's construction sites, London (UK) and Stockholm (SE) obtained positive results in term of coordination among the actors of the construction industry supply chain and contributed to social impacts: safer, less-pollutant and less-congested city environments.

Stockholm: this practice aimed at eliminating non-coordinated delivery vehicles "touring" the site in search of their delivery point. Indeed, a new housing district called Hammarby Sjöstad with 8,000 new apartments and thousands of new office spaces was under construction in a former harbour area in Stockholm. The access possibilities for deliveries were restricted, due to both geographical reasons and pre-existing buildings. A Logistic Centre (LC) was set up to minimise the impact of the largest ongoing urban development in Sweden on the early residents. The Hammarby Sjöstad Logistics Centre started to operate in spring 2001 and continued to operate until the building project was complete (2010). The CCC was located at the entrance of the construction-site. It consisted of 10 people working at the CCC (office and storage area of 8,000 sq. m.), 8 goods vehicles (Euro IV standard) were used for deliveries within the construction-site as well as a website and a supervision system. A sub-contractor was responsible for the operation of the centre, which included fleet purchase and operation, employment of drivers and other staff, warehouse and office management, and web supervision system. Without the Logistic Centre (LC), this construction site would have received over 400 uncoordinated deliveries per day, or roughly 700 tons of construction material per day during peak periods into the area. At the same time, the area was supposed to work as a good place to live in. The LC offered three different services: Co-transportation of goods, Temporary material storage and Smart traffic guidance system.

London: the main objective was to deliver in the safest and most efficient manner the right materials to the right site at the required time in an active partnership with trade contractors and project managers. In London, three CCCs were operational: the London Construction Consolidation Centre, the One Hyde Park Consolidation Centre and the Heathrow Consolidation Centre. In detail:

- The London Construction Consolidation Centre (LCCC), was a 5,000 sq. m. facility located in South Bermondsey, approximately three miles south of the City of London. The LCCC served four large construction sites in the City of London.
- The One Hyde Park Consolidation Centre (OHP-CC) project started in 2006 and was completed in 2010. It consists of 86 apartments, which overlook Hyde Park and Knightsbridge in London. The construction consolidation centre was located in Wembley. It had 8,000 sq. m. of internal and 3,000 sq. m. of external storage space.
- The Heathrow Consolidation Centre (HCC) was set up to serve the ongoing construction work at Heathrow Airport's terminals 1-4. It was located in a 20,000 sq. ft. hangar at Hatton Cross near the eastern end of the Heathrow Airport.

When the three selected consolidation centres were operating, each one had specific features, but a common managerial scheme can be found. First, logistics operations at the three-construction consolidation centres (3-CCCs) were outsourced to a third party contractor. The 3-CCCs were appropriately located distribution centres, where multiple bulk building material deliveries were stored and through which were



transported and channelled to construction sites. Each of the 3-CCCs was a one-stop point of delivery for all suppliers of a given construction site. The 3-CCCs were warehouses equipped for material handling, with short term stock policy. As a normal CCC, they were a useful distribution buffer for their construction sites.

Contractors working on the construction sites placed orders for their material requirements with their suppliers (manufacturers, wholesalers, specific sub-contractors, agents…) in the normal way. They specified that the delivery was made to the CCC, not to the construction site.

Contractors on the site call-off material from the CCC. At the CCC operatives pick and make up consolidated loads and deliver to site in a just-in-time basis. This way full vehicle loads serving several contractors in one delivery can be made up.

Actors

Stockholm: Hammarby Sjöstad involved trade contractors, the CCC subcontractor and workers. The City was involved at the start of the CCC for its governance.

London:

- The London CCC involved a partnership among five companies: one of them with the role of site developer (Stanhope PLC), the promoter of the consolidation centre (Transport for London (TfL), a local government body responsible for the transport system in Greater London, England), the major contractor (Bovis Lend Lease), the logistics provider (Wilson James Ltd.) and a company that acted on behalf of TfL to manage the involvement of stakeholders in the project.
- The One Hyde Park Consolidation Centre involved a partnership between a constructor (Laing O'Rourke, an international engineering enterprise) and a logistics provider (CSB Logistics Limited).
- The Heathrow Consolidation Centre involved a partnership among the construction manager (Mace, an International Construction Company), the logistics and business services provider (Wilson James Ltd.) and the client (BAA, Heathrow Airport Holdings).

Policy Framework

Stockholm: Hammarsby was a 5-year project and the choice of the City was originally to fund the initiative (almost 95% of the cost of the facility). Once operational and the benefits of the CCC to its users became better understandable and valuable, allowances and charges have been introduced by the City. The companies that delivered the goods should have paid the charge. The result was that the public share of funding reduced to 40% by the end of the project, suggesting that there was an increasing willingness to pay for the service.

London:

In the case of LCCC, the project cost was split among public and private stakeholders, TfL funded £1.85 million (~ 2,17 M€), while the developers and construction companies funded the other £1.35 million (~ 1,58 M€).

For the HCC, the annual running cost was about £2 million (~ 2,35 M€).

Key considerations and results

Benefits

Stockholm:

Quantitative results: reduction of 90% in energy use and 90% in emissions (CO_2, NO_x, PM) for deliveries from consolidation centre to site.

Qualitative results:

The project objectives were fulfilled, although the 80% reduction in small volume, direct deliveries was achieved only at peak times. The principal impacts were:

- a significant reduction in energy use, CO2 and other air-borne pollutants;
- a significant reduction in noise levels;
- a reduction in vehicle distances from 64 kilometers a day to 26 kilometers a day per vehicle;
- a percentage increase of vehicle load factor from approximately 50% to 85%; and
- a reduction on stop time from approximately 60 minutes per trip to six minutes.

London:

The three construction consolidation centres were intended for rapid flow of material from suppliers to the construction sites, but also to reduce the number of deliveries going directly to the construction sites and thereby reducing traffic congestion and vehicle emissions. The key aim of these three projects was to understand and demonstrate the potential benefits and impact reductions that they could provide. They also provided a comprehensive, independently verified set of data concerning the distribution of construction materials in an urban area. Thereby leading to an understanding of the commercial business case and viability of the construction consolidation centre. The three construction consolidation centres also provided the opportunity for partners at the leading edge of the construction industry to collaborate in using a consolidation centre in conjunction with efficient logistics management techniques.

	London CCC	**One Hyde Park**	**Heathrow Consolidation Centre**
Reduction of congestion	68% construction vehicles deliveries 20% in driver's working day	66% construction vehicles	40% congestion
Delivery reliability (correct type and quantity delivered within 15 minutes of the scheduled time)	97%	93%	99%
Construction site productivity (reduction on site handling & fewer shortages)	30 minutes per day per worker From 6 to 0.4 % of tasks incomplete	From 66% to 76% task completion	*N/A*
Environmental impacts	70-80% CO2 emissions	*N/A*	40% distance travelled

Problems occurred

Stockholm:

- The construction companies were unwilling to experiment a new organization, and considered only the additional costs but not the benefits. As a consequence possible initiators of logistics centre see a large risk in investing in the idea.
- Lack of cooperation between the industry's actors

Critical success factors

Stockholm:

The viability of the consolidation centre was crucially dependent upon support from the private sector, and in this regard, seems to have been more successful than a number of other schemes that have been 'imposed' on users

London:

Operations at a Construction Consolidation Centre
Source: Transport for London, directory of CCCs

- A construction consolidation centre should be close enough to the motorway network or major roads in order to reduce the impact of construction vehicles on local roads and to reduce haulers' turnaround times.
- A clear organisational structure is necessary to lead the development and operation of a construction consolidation centre
  - Ensure no time increase between order placement and delivery due to CCC operations
  - Ensure sufficient throughput to guarantee financial sustainability
  - Implement managed call-off processes to improve stock planning and availability without reducing supply chain efficiency
  - Ensure CCC's knowledgeability of products to avoid delivery errors.
- Companies involved in the realization of a construction consolidation centre should adopt a collaborative approach with the other participants
  - suitable checking and sign-off processes to prevent disputes between parties
  - prevent the use of the CCC as a long-term storage facility
  - Determine appropriate legal agreements for materials liability transfers between supplier and CCC operator, when materials arrive at the CCC

Lessons learned

Stockholm:

Significant reduction in the theft of materials. Demonstrable reduction in damage through the reduction in the number of material movements -not quantified. Less pollution – not quantified. Improved site safety and labour productivity through reduced congestion. Expected to result in fewer instances of traffic congestion at the construction site and improved living conditions for new inhabitants as building work continues.

London:

The three construction consolidation centres, during their operation, have significantly contributed to:

- reducing construction vehicle movements in the urban area through improved consolidation;
- reducing road freight traffic levels;
- reducing the environmental impacts associated with construction vehicle activity: carbon emissions, other pollutant emissions, noise pollution…;
- improving production efficiency and productivity in the involved enterprises;
- reducing waste production through the improved storage and handling in a CCC.

Transferability

Stockholm:

Although a permanent logistics centre seemed to be out of the picture, a local temporary centre is and can be of much more need in the future

London:

Since the experiments of the 3-CCCs, private companies have replicated the examples and set up CCCs. in September 2016 TfL has published a guide of 12 operational CCC available in London.

References
Transport for London
https://tfl.gov.uk/info-for/deliveries-in-london/delivering-efficiently/consolidating-deliveries
http://content.tfl.gov.uk/directory-london-construction-consolidation-centres.pdf

SC2 - Framework agreement

Luxembourg, LU/ Paris, FR

Processes addressed

- Sourcing
- Ordering
- Delivery

Objective

A framework agreement aims at defining a long-term collaborative arrangement between two parties, allowing an employer to instruct another party to carry out works or provide goods or services, by reference to pre-agreed terms, over a (usually) pre-agreed period of time.

Context

Good supply chain management is based on identifying the right long-term partners to help take your business forward. In that context, clients that are continuously commissioning construction work usually want to reduce costs, procurement timescales, and other risks by using framework agreements.

Cost

Time

Difficulty

Key definitions

Framework agreement

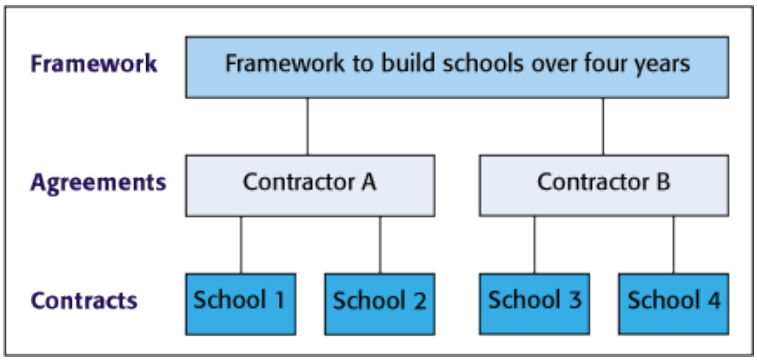
A framework is an agreement with suppliers to establish terms governing contracts that may be awarded during the life of the agreement. In other words, it is a general term for agreements that set out terms and conditions for making specific purchases (call-offs). [Source: Constructing Excellence]

Note that a framework covers the provision of a generic group of goods, works or services (or a combination), for example:

- Goods – office furniture
- Services – design consultancy
- Works – construction of schools.

Call-off

The act of awarding a contract awarded under the framework agreement itself. It does not need to be advertised and tendered;



Example of framework contract with two agreements

Best practice description

A framework agreement allows a client to invite suppliers of goods and services to tenders be carried out over a period of time on a call-off basis as and when required. It results in having a long-term partnership between the client, the suppliers, and other stakeholders. A framework agreement is not intended for use with a single stand-alone contract; it is designed for use where **a number of similar sets of works or services** may be required **from the same provider over a period of time**.

On the one hand this guarantees for the supplier a certain quantity of orders on a specified period. On the other hand the main contractor can negotiate some advantages such as better prices or replenishment lead time. One practical effect of a framework agreement is the freedom to award contracts without the need to re-advertise and re-apply the selection and award criteria. This alone will lead to all parties saving the substantial time and cost of repeat bidding.

A framework agreement can be broader than a single construction project. In that case, when signing framework agreements with material suppliers, a centralized purchasing department gives opportunity of purchasing larger quantities and the companies can thereby cut costs. Another consequence for construction companies is that supplier relationships are moved from the construction site to the central department, thus resulting in a centralized purchasing organization.

A framework agreement can contain various information such as:

- Territory of application
- Commercial conditions
- Volume bonus
- Orders
- Products delivery and pick-up
- Pick-ups / returns of non-used products
- Invoicing and payment
- Order cancellation
- Litigation settlement
- Contracts independence

A framework agreement permit to secure several features such as:

- delays
- insurance
- transport costs
- price revision or stability conditions
- year-end rebates
- specific catalogs
- additional guarantees.

A framework agreement can include several suppliers. When a call-off is required, the client can then select the best contractor (on the basis of its own criteria) or hold a mini-competition to rank the different offers.

Luxembourg pilot

For the pilot's construction site « Les Brasseries de Neudorf », located in Luxembourg, the framework agreements have been initiated either by Tralux (in most of the cases) or by its suppliers. These agreements usually have a duration of three years but their renewal are discussed one time per year.

Actually, Tralux has contracted with 28 material and goods suppliers, 3 sub-contractors, and 38 services providers through a framework agreement. The typical goods and services covered are the more recurrent and the more standardized ones, such as: temporary work, water cooler, concrete, vehicles washing, etc…

Even if a framework agreements already exist (at the national level) for a specific project, a short discussion between each stakeholders is sometimes needed in order to define the specific terms that cannot make part of the general agreement.

Paris pilot

For VINCI Construction France a framework agreement is a contract. The framework agreements concern several company sites, which can be construction sites or office buildings. The area covered by the contract is either regional or national. The parent company (VINCI or VINCI Construction France) negotiates the framework contract so its subsidiaries can benefit from it.

The following basic principles are not negotiables:

- the supplier must commit to United Nations international conventions
- the supplier must solve amicably and quickly the litigations
- VINCI does not contract any commitment on volumes orders
- VINCI does not act as a guarantor for its subsidiaries.
- VINCI does not ask for exclusivity.

The suppliers are selected according to following criteria:

- Financial clauses
- Social and environmental criteria
- Products quality and performance
- Prices.

VINCI Construction France has 576 framework contracts: 390 are at national level, 181 are regional contracts, and 5 are world-wide contracts (especially for the IT purpose for the entire VINCI group). A framework agreement can be signed with VINCI, or with VINCI Construction France, or with a division of VINCI Construction France, depending on the scope and the different kinds of products/services covered.

The main categories addressed are the following:

- temporary work: 182 national contracts (32% of the whole contracts)
- equipment rental and purchase : 99 national contracts (17%)
- vehicles : 21 national contracts (4%).

The secondary works concerned 117 contracts, almost exclusively regional (114 contracts), showing that the relationships with regional suppliers is strong in this field.

For concrete, there is only 1 referenced regional contract. Every construction site negotiates its own prices, terms and conditions with local suppliers depending in the site. For the other construction materials, there are 11 national and 8 regional framework agreements.

At VINCI, The contract are renegotiated to a potential renewal every 3 years.

Since 5 years, VINCI Construction France has carried out a resilient purchasing strategy, in order to increase its competitiveness. Thus VINCI Construction France is often at the root of the framework contract. However, it happen sometimes that regular suppliers request for a framework contract to perpetuate their commercial relationships with VINCI.

Actors

Who	Role
Main contractor	• Initiate of the framework agreement • Establish the terms and conditions of the framework agreement
Sub-contractor	• Can be the contractor of a framework agreement initiated by the main contractor, or, the initiator of one or more framework agreement passed with suppliers • Establish the terms and conditions of the framework agreement
Supplier	• Can be the contractor of a framework agreement initiated by the main contractor or one of the sub-contractors • Establish the terms and conditions of the framework agreement

Policy Framework

A framework agreement is usually not a contract except if the agreement places an obligation to purchase. A contract is made based on the terms and conditions defined in the framework agreement for any order placed during its life.

In the public sector the maximum length of a framework agreement is four years unless there are justifiable exceptional circumstances.

In all cases, the framework agreement should follow the EU procurement rules, like any contract.

Key considerations and results

Benefits

- Faster ordering process
- Negotiated prices
- Secured purchases
- Long-term partnerships
- Capacity to change order at the last moment
- Reduction of surface needed for the storage

Problems occured

- The confidentiality of the prices negotiated within a framework agreement is not always respected.
- On the construction site, the person at the origin of an order is generally not aware of all the terms and conditions negotiated in the framework agreement and that should apply to its order.

References

Constructing Excellence > http://constructingexcellence.org.uktools/frameworkingtoolkit/what-is-a-framework/
EU procurement rules > https://ec.europa.eu/growth/single-market/public-procurement_en

Contact

For more information, please contact Ammar Herbi > **ammar.herbi@vinci-construction.fr**

SC3 - Database of qualified suppliers

Valencia, ES

Processes addressed

Sourcing

Objective

The main objective of this best practice is to support the sourcing process by providing to the construction company a database of suppliers showing their respective quality certifications.

Context

Valencia Parque Central pilot has identified more than 1400 different activities, which often rely on multi-disciplinary teams working at the same time on the construction site. A relevant database of suppliers is thus very important when there is a joint venture between different companies and several partners that are working for different organizations, and at different phases of the project.

Cost

Time

Difficulty

Best practice description

The joint venture in place at Valencia Parque Central pilot has a broad portfolio of suppliers which, given their extensive activity and predominant role in the sector, has to comply with the highest quality standards. In order to know in advance capabilities and expertise of these suppliers, the Project Management team relies on a database of suppliers which contain aspects such as:

- quality standard certification (ISO 9001, ISO 14001, CE label…),
- ranking based in previous experience,
- availability,
- costs …

This database has been designed taking into account the organizational structure, the works, the limitations and constraints, in order classify the suppliers according to their quality certifications (and taking into account the most significant construction procedures). The database is regularly updated (by the Purchasing Department), through periodic surveys and / or according to specific needs.

Regarding suppliers selection process, the ISO certificate is a key selection criteria. In addition, the following considerations also apply:

- Management planning of the procurement of all necessary materials in advance in order to optimize the construction processes.
- All the necessary materials, which are planned to use for the execution of works, meet technical specifications and requirements provided in the Special Technical Specification of works as well as the current rules of application and general construction specifications.
- Material suppliers usually collaborate with companies that composed the Joint Venture, Pavasal-Dragados, so they are evaluated within quality procedures implemented in enterprises and disposing of the materials with the required quality.
- The materials used in the planned execution of the works come from sources nearest supply site, thereby improving transport, achieving a saving in the cost of materials and fuel and reducing emissions.
- All providers have to provide CE marking of products and quality certificates.

RELACIÓN DE SUBCONTRATISTAS PROPUESTOS PARA LA REALIZACIÓN DE LAS OBRAS			
ACTIVIDAD	SUBCONTRATISTA	GARANTÍAS DE CALIDAD	CLASIFICACIÓN
JARDINERÍA, ARBOLADO Y REDES DE RIEGO.		MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001	K-6-e
INSTALACIONES DE FUENTES		MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001	-
IMPERMABILIZACIONES		MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001	C-7-d
RESTAURACIÓN DE EDIFICOS HISTÓRICOS		MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001	K-7-e
RED DE DISTRIBUCIÓN DE GAS		MARCADO CE ISO-9001 ISO-14001 MARCADO CE ISO-9001 ISO-14001	H-2-c
INSTALACIONES ELÉCTRICAS		MARCADO CE	I-6-e

An example of categorized suppliers
Source: Pavasal-Dragados

When a provider can't be identified with the database, vendor selection is done following criteria such as: quality, certifications, references, availability, cost ... among others.

Actors

The joint venture (Pavasal / Dragados) is a combination of construction companies that manage the "Valencia Parque Central" project. It has to follow local, regional and national regulation as it is developed in the city of Valencia. For this reason, mobility ordinance regarding freight and transit in the city is mandatory. It also follows public tender process rules.

Policy Framework

Regarding relationship with sub-contractors and suppliers, it is mandatory to fulfill article 24, Occupational Risk Prevention Act concerning the coordination of business activities.

Every sub-contractor and freelance will sign document Security and health Plan (section 4 from article 7 R.D. 1627/97).

Quality Standards

- ISO 9001:
  ISO 9001 sets out the criteria for a quality management system. This standard is based on a number of quality management principles including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement. Using ISO 9001 helps ensure that customers get consistent, good quality products and services, which in turn brings many business benefits.

- ISO 14001:
  ISO 14001 sets out the criteria for an environmental management system. This standard can be used by any organization regardless of its activity or sector to provide assurance to company management and employees as well as external stakeholders that environmental impact is being measured and improved.

- CE Marking:
  CE Marking on a product is a manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety and environmental protection legislation, in practice by many of the so-called Product Directives. The Product Directives contains the "essential requirements" and/or "performance levels" and "Harmonized Standards" to which the products must conform. Harmonized Standards are the technical specifications (European Standards or Harmonization Documents) which are established by several European standards agencies (CEN, CENELEC, etc.).

Key considerations and results

Qualitative Results

Valencia Parque central Phase 1 has been planned taking into account especial characteristic of the working site, but it also pays especial attention to delivery of goods (stock and timing) looking at supplier nearest location when it is possible. Besides, the ISO quality standards required to the suppliers reduces the number of quality tests on site and improves the construction logistics due to the reduced number of materials returned. Due to the location of Valencia Parque Central and access points, there are no issues related to congestion.

Transferability

Using a project management approach that include Quality Management has several advantages. One of the most important one is to have a list of sub-contractors and supplier that comply with different quality standard. It also permits to improve the group of subcontractors and suppliers according to ISO criteria and quality standards, such as:

- Meet your needs and expectations
- Comply with applicable regulations

SC4 - Just-in-time delivery

Sophiehaven, DK

Processes addressed

- Ordering
- Delivery
- Material Reception & Expedition
- Inventory & Storage Management
- Planning & Scheduling Management

Objective

Just-In-Time deliveries aims at increasing efficiency and decreasing waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs.

Context

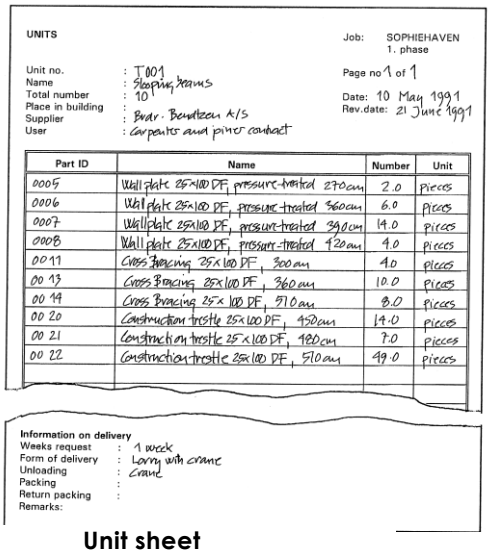
Traditionally, organizations overstocked materials prior to their use resulting in an expensive and inefficient use of finance and space resources. The practice became obsolete in the 1950s with the Just-In-Time concept pioneered by companies like Toyota. In the construction sector, the delivery is included in the purchase price encouraging the trade to order full truckload to save money. It results in overstocking material on site. Convinced of saving potential in JIT approach, a group of Danish companies launched the Byggelogistik project in 1989. Three years later, the Danish Building Research Institute (SBI) joined the group to study the increase of productivity in the experiment.

Cost

Time

Difficulty

Best practice description



UNITS

Job: SOPHIEHAVEN
1. phase

Unit no. : T001
Name : Stopping beams
Total number : 10
Place in building :
Supplier : Bnar. Bendtzen A/S
User : Carpents and piner contract

Page no 1 of 1

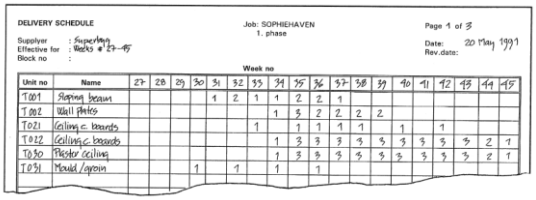
Date: 10 May 1991
Rev.date: 21 June 1991

Part ID	Name	Number	Unit
0005	Wall plate 25x100 DF, pressure-treated 270cm	2.0	pieces
0006	Wall plate 25x100 DF, pressure-treated 360cm	6.0	pieces
0007	Wall plate 25x100 DF, pressure-treated 390cm	14.0	pieces
0008	Wall plate 25x100 DF, pressure-treated 420cm	4.0	pieces
0011	Cross Bracing 25x100 DF, 300cm	4.0	pieces
00 13	Cross Bracing 25x100 DF, 360cm	10.0	pieces
00 14	Cross Bracing 25x100 DF, 510cm	8.0	pieces
00 20	Construction trestle 25x100 DF, 450cm	14.0	pieces
00 21	Construction trestle 25x100 DF, 480cm	7.0	pieces
00 22	Construction trestle 25x100 DF, 510cm	49.0	pieces

Information on delivery
Weeks request : 1 week
Form of delivery : Lorry with crane
Unloading : Crane
Packing :
Return packing :
Remarks:

Unit sheet

Source: Byggelogistik project



DELIVERY SCHEDULE

Job: SOPHIEHAVEN
1. phase

Page 1 of 3

Date: 20 May 1991
Rev.date:

Supplier :
Effective for : Weeks # 27-45
Block no :

Week no

Unit no	Name	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
T001	Stopping beams					1	2	1	1	2	2	1								
T002	Wall plates								1	3	2	2	2	2						
T021	Ceiling c. boards							1		1	1	1	1		1		1			
T022	Ceiling c. boards								1	3	3	3	3	3	3	3	3	2	1	
T030	Plaster ceiling								1	3	3	3	3	3	3	3	3	2	1	
T031	Mould /groin				1		1		1		1									

Master delivery plan

Source: Byggelogistik project

The Just-In-Time (JIT) approach originates from the manufacturing industry. The main objectives are obtaining low-cost high quality products and on-time production as well as eliminating waste and stagnant stock. It has been tested several times in the construction sector. JIT concept is usually implemented together with a Construction Consolidation Centre (CCC). For example in Hammarby, the CCC made up deliveries on a consolidated basis in "work packs" as requested by the sub-contractors.

Other experiences have however been completed without CCC. Sophiehaven located in Denmark has tested JIT deliveries on housing schemes through the Byggelogistik project. Byggelogistik concept reduces cost by eliminating various types of waste (materials, labour time and transportation) to make the whole building process more effective. Materials are considered delivered when the workers lay their hands on them in the exact quantity as the first step in the construction. The concept also included in transportation costs packing, temporary storage, on site transportation, on site losses and breakage, and low effectiveness due to badly and impedingly delivered and stored materials.

A two-level logistics is applied with a master delivery plan for the overall logistics and a JIT consumption approach for the daily deliveries.

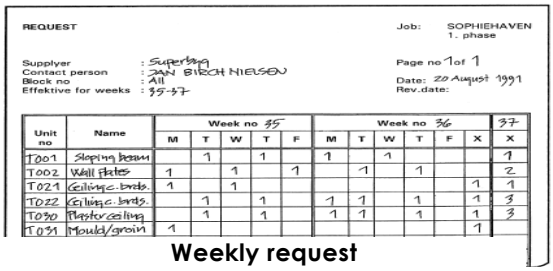
A detailed planning is fully completed before the construction starts to quantify materials and specify in units. A unit is a set of materials that a sub-contractor needs for a specific task. A unit sheet identifies the list of materials, the type of packing, the handling equipment, the point of use and identification number. As a consequence, weekly deliveries can be scheduled from the start, covering the entire construction period, and all materials may be ordered bindingly.

Based on the progress and activities of the next three weeks, weekly requests specify the quantity of units to deliver every day for the two coming weeks and globally for the third week. The dealers receive the requests as final request for the first week and as a notice for the coming weeks.

Then, the dealers (three big dealers in Denmark) order and store the materials to be sorted and packed in units ready for transportation as the work progresses. Their warehouses are used as storage area for the construction site. Few materials are delivered directly in units packed by the manufacturer. To reduce the costs of external transportation, deliveries including all units from the dealer are consolidated regardless of contractor, and to minimize the costs of internal transportation, units are delivered as close as possible to the point of use.

The dealers' drivers are considered as part of the construction staff to make the same drivers familiar with the activities on the construction site and choose the best sequence for the unloading.

All mistakes such as label upside down or wording are registered and shared in a weekly report. Important errors are reported back immediately to the parties involved.



REQUEST

Job: SOPHIEHAVEN 1. phase

Supplyer : Superbyg
Contact person : JAN BIRCH NIELSEN
Block no : All
Effektive for weeks : 35-37

Page no 1 of 1
Date: 20 August 1991
Rev.date:

Unit no	Name	Week no 35					Week no 36						37
		M	T	W	T	F	M	T	W	T	F	X	X
T001	Sloping beam		1		1		1		1				1
T002	Wall plates	1		1		1		1		1			2
T021	Ceiling c. beds.	1		1								1	1
T022	Ceiling c. beds.		1		1		1	1		1		1	3
T030	Plaster ceiling		1		1		1	1		1		1	3
T031	Mould/groin	1										1	

Weekly request

Source: Byggelogistik project

Actors

The project was undertaken by the main contractor and around ten sub-contractors.

- The main contractor's staff participated in the whole planning of the project to select more appropriate materials and solutions and to negotiate cheaper prices with the producers due to early notice. The main contractor appointed a production manager to follow the day-to-day operations, provide the materials required, coordinate the individual sub-contractors' works and followed up on the cooperation with the wholesale dealers to manage sorting, packing and delivery.
- A Steering committee composed of sub-contractors' representatives monitors the process, solves the issues and note the productivity gains.

To not overreach the experiment it was decided to restrict the logistics to a minor number of sub-contractors. This decision caused a great deal of trouble. Those not participating were repeatedly in the way of those who were. In the second phase all sub-contractors participated and this problem was solved.

Key considerations and results

Benefits

- Decrease net building cost (↘ 9%)
- Decrease labour costs (↘18%)
- Decrease material costs (↘3,6%)
- Decrease in inventory management costs (and inventory level)
- Reduce storage space
- Save rush orders
- Reduce damage and theft of materials
- Free up skilled workers for more productive work
- Improve site safety

Problems occured

- The level of planning uncertainty caused by external influences (bad weather, environmental factors and site topography…) and internal factors (progress behind schedule, design correction…) makes JIT deliveries more difficult to implement.
- The multiplicity of stakeholders makes the JIT implementation difficult.
- The short-term horizon of the collaboration between stakeholders makes JIT implementation less attractive.
- The JIT implementation requires a warehouse: stock in a CCC or dealers' warehouses.

Critical success factors

- The JIT implementation relies on many stakeholders along the supply chain: the suppliers for their flexibility, the sub-contractors for their cooperation, the designers for the users' stability and the main contractor for their overall leadership. A heavy involvement from the management is mandatory.

Lessons learned

- All stakeholders must clearly feel the added value of such initiative even though the savings and costs may not be evenly distributed from the start. (NB: The savings were not equally distributed and no attempt was made to redistribute costs and savings between the participants.)

Transferability

- So far, any method has been developed to fully adapt and implement the JIT on construction.
- Most of the studies conclude on the transferability of JIT in the construction industry with some modifications.
- Byggelogistik concept has only been investigated in the social housing sector but the participants of the experiment believe in its applicability in other sectors of the construction industry and think that the effort related to the planning will increase with the complexity of the construction project.
- Within CMB, the foreman and his assistant plan the activities on a weekly and monthly basis. Based on the average performance rates of all the activities (eg. Progress in m² per man per day), they can estimate the material requirement to be ordered thus avoiding congestion on storage and delivery areas.

References

Danish Building Research Institute, Bertelsen S. and Nielsen J. > http://sbi.dk/en

SC5 - Supply Chain Operations Reference Model

Tornby, SE

Processes addressed

- Sourcing
- Ordering
- Delivery
- Inventory & Storage Management

Objective

The SCOR model (Supply Chain Operations Reference Model), as a common supply chain analysis tool, aims at improving practices in order to reduce costs, increase profitability, and reduce the environmental impacts of a construction project.

Context

With the high increase of the cost of the house production, several initiatives from the automotive industry have been applied to the construction sector. The SCOR model as another way to improve the sector and more particularly the logistics activities has been applied on building in Sweden.

Cost

Difficulty

Quality

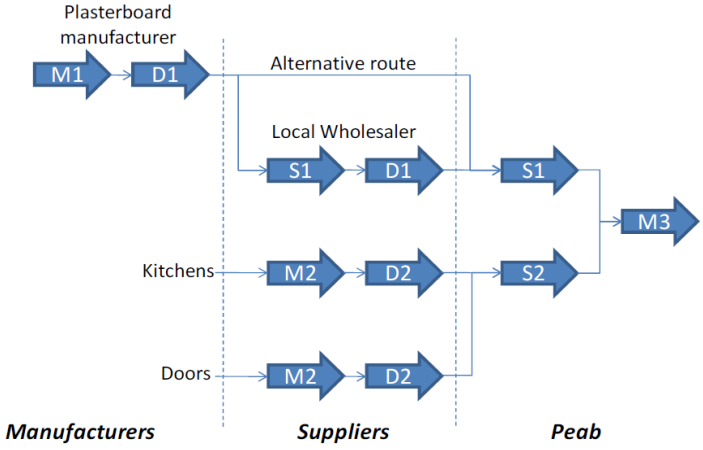
Best practice description

The SCOR model (Supply Chain Operations Reference Model) is a process reference model which allows improving and communicating supply chain management practices among partners. It consists of on six processes (Plan ***P***, Source ***S***, Make ***M***, Deliver ***D***, Return ***R***, and Enable ***E***) hierarchically structured in three levels of process details. It contains more than 150 key indicators that measure the performance of the supply chain operations.

The SCOR model has been partially applied on the Tornet building (2007-2009) with the construction company Peab in mapping flows of standards products (plasterboards, doors and kitchens) at the levels 2 (detail sub-processes) and 3 (provide process element details) during the construction phase.

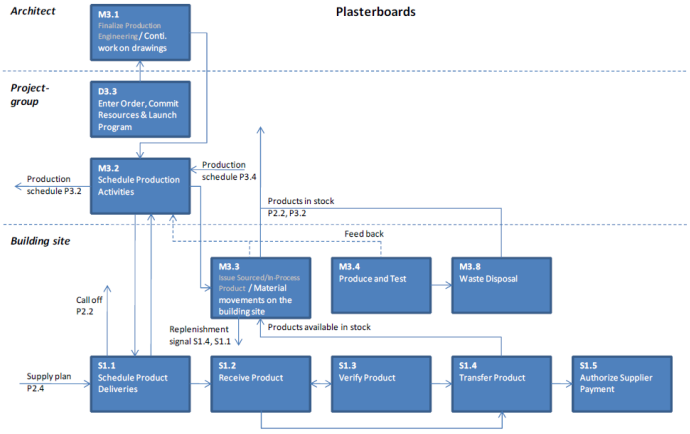
The mapping of the material flows from the supplier to the construction site at the level 2 allows the visualisation and identification of possible problems. The mapping at the level 3 of the activities at the construction site enables deeper analysis. Mapping of the plasterboard supply chain shows that Peab is using unnecessary intermediaries which imply extra costs: Peab buys plasterboards to the retailer for small orders whereas the company buys directly to the supplier for the larger orders.

Peab orders mainly by mail instead of using the purchase and procurement system which can give EDI-discount (Electronic Data Interchange) when ordering materials. With SCOR, Peab identifies that a potential saving on this material, which corresponds to a total discount of 24 % compared to the retailers' prices, could be obtained.



SCOR mapping at level 2
Source: Tornet case

Calculations of some SCOR metrics capture current performance and allow quantifying how successful Peab achieves its operations. The reliability, one of the five SCOR performance attributes was measured with the *RL.1.1 Perfect Order Fulfilment* metric which is also split into 4 metrics (*RL.2.1 Percentage of ordered Delivery in Full*, *RL.2.2 Delivery Performance to Customer Commit Date*, *RL.2.3 Documentation Accuracy* and *RL.2.4 Perfect Condition*). The analysis of the metrics on the doors and kitchens reveals that the deliveries have often been incomplete and usually behind schedule resulting in additional deliveries and administration costs and delays in the production. It forced Peab to keep the received doors in stock leading to decrease the space and increase time for looking and risk for damage products.



SCOR mapping at level 3
Source: Tornet case

Note that the study concludes on the opportunity to consolidate standard products such as plasterboards, wood products and isolation in a warehouse delivering the construction sites that Peab builds in the region for economy of scale, increase delivery precision, decrease time looking after materials.

Actors

- It is up to the construction company to undertake this type of analysis.

Key considerations and results

Benefits

Depending on the results of the analysis, potential benefits could be:

- Improve construction site punctuality
- Reduce loading/unloading time
- Reduce number of intermediate storages
- Reduce distance from the production to the construction site
- Improve construction site and logistics productivity
- Reduce cost of waste
- Reduce the negative impact on the environment

Problems occurred

- The use of SCOR model is not straight forward since it is not designed and maintained for the construction sector.
- The lack of access to documentation and the low IT adoption in the construction sector make the SCOR application quite difficult. In this case study, data was collected from delivery notes, calls-offs, order acknowledgement, and directly from the construction manager.

Critical success factors

- Without good data quality, a correct analysis is difficult.

Transferability

- The SCOR model needs some adaptations to fit the construction sector. Based on 5 case studies, Swedish researchers develop a new version: the Builder's SCOR model (BSCOR) which is adapted to the construction sector and structured on 3 processes (Source, Build and Plan).

Synthesis

- **Mapping between the construction logistics processes and best practices**

		Sourcing	Ordering	Delivery	Material Reception and Expedition	Inventory and Storage Management	Material Handling and Equipment	Housekeeping	Waste Management	Return Management	Planning and Scheduling	Complaint Management	Entrance and Exit Management
Logistics operations	LO1			X	X		X		X	X			X
	LO2												X
	LO3		X						X	X			
	LO4					X		X				X	
	LO5						X						
	LO6								X				
Policies	PO1			X					X				
	PO2	X		X	X	X	X		X				
	PO3			X				X	X	X			
	PO4			X									
	PO5				X		X						
	PO6					X	X	X					
Advanced Technologies	IT1	X											
	IT2		X		X		X			X			
	IT3											X	
	IT4				X	X	X						
	IT5	X	X			X	X				X		
Integrated Supply chain	SC1		X		X		X		X				
	SC2	X	X	X									
	SC3	X											
	SC4		X	X	X	X					X		
	SC5	X	X	X		X							

▪ Mapping between the categories of benefits and best practices

		Reduce material and replenishment costs	Reduce construction site operating costs	Reduce negative impact on the environment	Improve safety on the construction site	Improve wellbeing for residents
Logistics operations	LO1	X	X		X	
	LO2			X		X
	LO3		X	X		
	LO4	X				
	LO5	X				
	LO6		X	X		
Policies	PO1		X	X	X	X
	PO2			X		X
	PO3	X		X	X	X
	PO4				X	X
	PO5				X	
	PO6			X	X	X
Advanced Technologies	IT1	X	X			
	IT2		X			X
	IT3				X	
	IT4	X	X			
	IT5	X	X			
Integrated Supply chain	SC1		X	X		X
	SC2	X	X			
	SC3		X			
	SC4	X	X		X	
	SC5		X	X		

▪ Mapping between the beneficiaries and best practices

		Main contractor	Local authority	Logistic operator	Construction stakeholder	Other
Logistics operations	LO1	X		X	X	
	LO2	X	X	X	X	
	LO3	X		X	X	Waste Management Team
	LO4	X			X	
	LO5	X			X	Foreman
	LO6	X		X	X	
Policies	PO1	X	X		X	TfL
	PO2	X		X	X	
	PO3		X			Developer
	PO4	X	X		X	
	PO5	X	X	X	X	
	PO6	X	X		X	
Advanced Technologies	IT1	X			X	Purchase Office
	IT2	X		X	X	
	IT3	X		X	X	
	IT4	X		X	X	Manufacturer
	IT5	X			X	Architects
Integrated Supply chain	SC1	X	X	X	X	
	SC2	X			X	
	SC3	X			X	
	SC4	X			X	Production Manager
	SC5	X				

Cost, Time and Difficulty to implement best practices

		Cost	Time	Difficulty
Logistics operations	LO1			
	LO2			
	LO3			
	LO4			
	LO5			
	LO6			
Policies	PO1			
	PO2			
	PO3			
	PO4			
	PO5			
	PO6			
Advanced Technologies	IT1			
	IT2			
	IT3			
	IT4			
	IT5			
Integrated Supply chain	SC1			
	SC2			
	SC3			
	SC4			
	SC5			

Conclusion

This document aimed at drawing up a holistic list of good practices from various experiences in urban construction logistics and supply chains. Thus, experiences were observed from different geographical extents in Europe, in the United States and in other regions (e.g. in Asia). These experiences were observed from different perspectives; among others we analysed the impact on construction logistics processes, the categories of benefits to expect when implementing the practice, the easiness to implement the practice and the main stakeholders benefiting from the practice. The collected practices were classified in four clusters depending on their main thematic (organization, technology...).

We hope that the different actors of the construction sector (contractors, logistics operators, legal authorities, developers...) will be inspired by one or several practices to improve their current and future construction projects. Authorities and developers may be interested by policies practices, contractors and logistics operators may find inspiration in logistics operations' practices, and all will be interested by integrated supply chain and advanced technologies practices. Since practices are proposed from quick-wins (fast, cheap and easy) to long term approaches, the capacity of stakeholders to mobilise resources is not discriminant. Thus, whatever their maturity, organisations can implement practices matching their capability level.

Though, this work does not aim to be exhaustive in the scope nor in the details of the practices. Organisations are invited to follow the references or to get in touch with the contacts detailed for each practice to get more information on the practice or the way to implement it. Aware that such catalogue is only a first step, we aim to complement future versions of this deliverable with new and updated practices. Organizations are invited to forward to the SUCCESS team any information on additional good practice that could be reported in this list. A potential issue of this deliverable is its knowledge density and the subsequent difficulty for organisations to identify which practices are worth to implement (in which order, which time frame and at which cost) depending on their own context. To cope with this issue a future deliverable or a future version of this deliverable could propose a guided approach to qualify and quantify such context so as to identify the priority practices for each one.

Annexes

List of the twelve construction supply chain processes

Category of processes	Distribution Network Processes	Construction Site Processes	Reverse Logistics Processes	Support Processes
Name of the processes	1) Sourcing 2) Ordering 3) Delivery	4) Material Reception and Expedition 5) Inventory and Storage Management 6) Material Handling and Equipment Management 7) Housekeeping	8) Waste Management 9) Return Management	10) Planning and Scheduling Resources 11) Complaint Management 12) Entrance and Exit Management

Table 1 Construction supply chain processes

The *Sourcing* process aims to select suppliers for acquiring materials and services that are needed in the construction site.

The *Ordering* process aims to acquire the needed materials, equipment, and services.

The *Delivery* process aims to transport the goods from suppliers to the construction site.

The *Material Reception and Expedition* process aims to manage at the arrival of the vehicle, its loading for delivering materials or its unloading for collecting waste and returning materials, and the activities involving the trucks from the entrance to the exit of the construction site.

The *Inventory* process aims to specify the size and placement of stocked goods to avoid overstock or shortage. The purpose of storage management process is to provide an operational management of the storage, the assignment of the storage location for the materials.

The *Material Handling and Equipment Management* process aims to move materials within the construction site by using the right equipment to guarantee the continuity of the activities.

The *Housekeeping* process aims to minimize the degradation and pollution of materials and maximize safety for workers in keeping the site clean and tidy.

The *Waste Management* process aims to collect construction waste / demolition debris / packaging waste, recycle and sort material. Minimizing waste, maximizing reuse, recycling or reprocessing. Organize and sort waste following legislation. Organize the disposal of waste that has been collected and sorted.

The *Returns Management* process aims to organize and perform unused and unsuitable material exit and return to sub-contractor or supplier and give returnable packaging back to the supplier (e.g. Pallets)

The *Planning and Scheduling Resources* process aims to schedule and plan the activities and the needed resources such as workforce, equipments, and spaces. Planning is the process of identifying all activities necessary to complete the project while scheduling is the process of determining the sequential order of activities, assigning planned duration and determining the start and finish dates of each activity. Planning is a prerequisite to scheduling because there is no way to determine the sequence of activities until they are not defined.

The *Complaint Management* process aims to address complaints, non-conformities, and resolve disputes.

The *Entrance and Exit Management* process aims to grant rights to authorized people and vehicles to the construction site while maintaining safety in and out the worksite and efficient operations on the worksite.

SUCCESS team

The project consortium includes European partners from France, Luxembourg, Italy and Spain representing a university, research centres, construction companies, public administrations and professional associations.

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