Validating Freight Electric Vehicles in Urban Europe

DX.X Royal Seaport Construction Consolidation Centre – update report

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Glossary

Acronym	Full description
EFV	Electric Freight Vehicle
EV	Electric Vehicle
FREVUE	Validating Freight Electric Vehicles in Urban Europe

Executive summary

Construction Consolidation Centre is a result of the environmental profiling that defined the ambition of the comprehensive Environment and Sustainability Plan for Stockholm Royal Seaport as: “A logistics centre is to be established for sustainable construction-related transport that can evolve into coordination of deliveries for the entire Stockholm Royal Seaport and is to be linked to sea and rail transports”.

Construction Consolidation Centre (BLC) is an innovation project that will investigate how the City, in an urban development area, can cohesively coordinate and optimise resources with respect to logistics needs for several property developers and contractors within a geographically limited area. Early in the project, a pilot study and analysis regarding volumes were completed as the basis for sizing a BLC, complete with warehouse and transport systems. BLC coordinates all transports from arrival at the project area to the worksite.

The operator for BLC was tendered through a competitive dialogue procedure in accordance with the Swedish Public Procurement Act: The City commissioned the planning and building of the facility, which includes a cold warehouse, waste management site, outdoor warehouse and building site office. The BLC operator uses the facility. In collaboration with the BLC operator and its subcontractors, the City has developed several technical products, services and processes.

BLC coordinates several resources and services that are beneficial to the City, the property developer for housing development and the contractors building in the area. Examples include shared perimeter protection, coordinated waste management, construction site information, groupage traffic, crane coordination, development phase coordination, summer and winter road cleaning, and so on.

BLC has a multi-level training programme to foster understanding and introduce all the project participants, including the developers, contractors, subcontractors and suppliers of materials. By meeting all involved in the project, BLC will be able to provide information about Stockholm Royal Seaport and present details about a safe worksite and the workings of the logistics functions. Consequently, the City will interact with some 15,000 individuals in training programmes through BLC.

Several conferences and workshops about the exchange of experience and in-depth interviews regarding positive and negative aspects were carried out and revealed that collaboration between the developers, contractors, transport firms and suppliers of materials is paramount. The results have been applied and implemented continuously to improve operations. One example is that the City drafted a logistics plan template and carried out a procurement workshop on the topic “procurement strategies for BLC-related innovation projects”.

Our experience to date is that actively steering construction logistics in an urban development area is an extremely complex issue, requiring multi-level collaboration and

understanding of what is to be accomplished. The aim at every stage – from introducing logistics issues early in the planning phase and correct procurement procedures to communication and conduct during production – is to achieve the objective and purpose of coordinated construction logistics, namely sustainable and resource-efficient construction. Continuous follow-up reveals that BLC reduces both transports to the construction site and the amount of waste.

Several reports, theses, and research and development projects have been carried out through BLC. The City has made BLC available as a pilot area to study construction logistics in an urban development area.

The cost for a BLC is estimated at approximately SEK 360 per m^2 GFA (price level 2013) and SEK 30 per m^2 GFA for additional surveillance. This corresponds to about 1-2% of the construction cost and 0.5% of the production cost. While the measured values vary, they do reveal lower costs than estimated for the project.

1. Introduction

Construction Consolidation Centre (BLC) is located in Ropsten in Stockholm. BLC has been in operation since April 2013 and was inaugurated in May the same year. Since its inception in 2013, many of BLC's services have been developed, the facility expanded and the organisation changed. BLC is a development project and subject to constant change. In this document, Fredrik Bergman summarises how the BLC project has progressed from a decision in 2010 to the establishment of a logistics centre to today's fully functioning, constantly changing organisation.

This report is an update for the period January 2011 to June 2016. The report shows how the development/innovation process to establish BLC was applied at Stockholm Royal Seaport. The report also shows the City of Stockholm's objectives and intentions, how business models, estimates and sizing were carried out, how the facility has advanced and how various technical and management-related innovations were applied. Moreover, the report describes the various ongoing research and development projects as well as BLC-related theses.

2. Background

2.1 Environmental Profile Area – Stockholm Royal Seaport

Stockholm Royal Seaport is one of the largest urban development areas in Stockholm and Europe. It includes some 15,000 apartments and 35,000 workplaces. The area in which Stockholm Royal Seaport is being built has industry, energy production, a large port and many residents in Hjorthagen. The area covers land and water areas in the north-eastern part of Stockholm's inner city including four districts: Hjorthagen, Värtahamnen, Frihamnen and Loudden.

In 2009, the City of Stockholm decided in the City Council that Stockholm Royal Seaport should become one of three new environmental profile areas with the vision of becoming a world-class green urban district.

Sustainable transport is a key element in the adopted environmental programme. Therefore, the City of Stockholm wants to improve the prerequisites for environmentally friendly and effective construction logistics based on the experiences of Hammarby Sjöstad Consolidation Center (HSLC).

The document "***Comprehensive programme for environmental and sustainable urban development in Stockholm Royal Seaport***" is the platform for this study. The following quotation from this document describes the need for a consolidation centre and specifies that such a centre is to be established.

"The vision is that Stockholm Royal Seaport will be a world-class environmental urban district and an international role model in terms of sustainable urban development. Experience from Hammarby Sjöstad will be put to use and further developed in the new urban district."

“7.2.10 The amount of construction waste is to be minimised and the construction waste that is amassed is to be sorted, recycled and documented.”

“9.2.11 A consolidation centre is to be established for sustainable construction-related transports that can evolve into coordination of deliveries for the entire Stockholm Royal Seaport and is to be linked to sea and rail transports. Green vehicles are to be used for deliveries. Businesses in the area are to be offered help in minimising their transports through services from the consolidation centre and by drafting a transport plan.”

“Below are appropriate measures for continued efforts to achieve the programme’s targets:

To establish the targets for sustainable transports in the environmental and sustainability specifications for site allocation agreements, zoning plan processes and development agreements in future expansion phases in Stockholm Royal Seaport in terms of infrastructure, housing and offices as well as an action plan for various activities in the urban district.

To develop an action plan for groupage traffic of construction transports during the construction period, and later for coordinating deliveries of goods via a consolidation centre.”

Furthermore, the consolidation centre is mentioned in the document “Environmental requirements for the construction of housing and offices – Stockholm Royal Seaport, phase 2.”

“Waste is to be sorted during the construction phase.”

“A joint construction-waste facility for several contractors is to be arranged.”

“Construction transports are to be based on effective logistics and energy-efficient, environmentally adapted vehicles that use biofuel.”

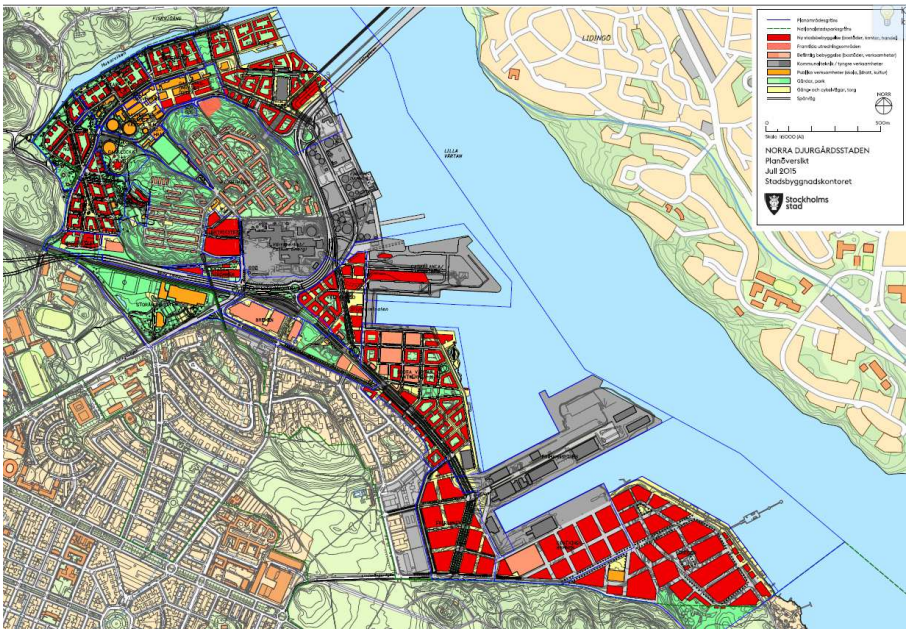

Figure 1: Stockholm Royal Seaport structure plan, zoning conditions 2016 and location of BLC

3. Zoning

3.1 Objective

The objective of the environmental program adopted on 12 October 2010 included:

"9.2.11 A consolidation centre is to be established for sustainable construction-related transports that can evolve into coordination of deliveries for the entire Stockholm Royal Seaport and is to be linked to sea and rail transports. Green vehicles are to be used for deliveries. Businesses in the area are to be offered help in minimising their transports through services from the consolidation centre and by drafting a transport plan."

Based on this objective, a comprehensive ambition was adopted ahead of the procurement of an operator, which distinguishes the project today. The following objective was set:

"The City of Stockholm's objective is that the construction consolidation centre is to be on the cutting edge of construction logistics."

"The City of Stockholm intends to promote construction logistics research with the aim of using the construction consolidation centre to generate growth in the industry."

In 2011, Sonat AB was commissioned by the City of Stockholm Development Administration to perform a preliminary logistics analysis as the base for continued efforts. The analysis was based on other studies and research reports, national as well as international. It highlighted several important aspects for establishing and building a consolidation centre in Stockholm Royal Seaport. The complete consensus is presented below.

"All the sources that the investigation has studied reveal complete consensus regarding the benefit of effective construction logistics. All the sources were in agreement that the following gains arise through effective construction logistics:

- **Improved quality** of physical handling of the goods, which considerably reduces scrapping and minimises faults in materials due to stolen/missing materials.
- **Quality-assured incoming goods,** which increases the ability to immediately report faulty deliveries (quantity, quality, product) and, in turn, ensures effective planning of assembly and tasks.
- **Higher delivery service** to the specific assembly site via various forms of processing within the consolidation centre, such as unpacking, level packing, bundling and night-time deliveries.
- **Reduced material defects** via relevant and prudent use of terminals for materials.
- **Reduced environmental impact**, primarily in the form of reduced transport activities via better steering of incoming transports, and relevant and prudent use of terminals for materials.
- The potential to reduce environmental impact is further enhanced by also steering waste and the flow of returns.
- Reduced **environmental impact by using electric vehicles** as distribution vehicles within the construction site.

- Daily steering of incoming transports and the physical flow at the construction site ensures that **planned schedules for material deliveries** can be maintained.
- The consolidation centre's daily steering of physical flows/traffic **reduces the noise level** and **improves the living environment** for those moving into the area and those living in nearby areas."

The initial logistics analysis addressed all areas as well as sizing of services and the facility.

3.2 BLC site analysis and size

Determining the location for BLC was critical in determining the desired effect. One of two main alternatives was to not have a local BLC but instead procure the services from an operator with external warehouses, making it unnecessary to build a facility. The other main alternative was to build a local BLC situated within the urban development area. The location was to be so central that BLC could be close to operations yet sufficiently far from the area as to minimise all transports into the worksite area. The area had to be big enough to accommodate the need for storage over a two to three-week production period. A port location near Ropsten's entrance parking lot with a renovated quay would also provide the potential for, or at least facilitate, sea transport.

Sizing was carried out based on the preliminary logistics analysis prepared by Sonat AB:

"The distribution of material in weight percentage and average size per truck measured in tonnes is from the Hammarby Sjöstad report. The percentage via warehouse (share of the flow that goes via the warehouse) is our estimate and CC m^2/tonne (how many CC m^2 are required per warehoused tonne of product type) is based on the handling and warehouse solutions described in the section 'Management solutions.'" The estimates assume on average a two-week rotation period for all types of products.

Siffertyp	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Totalt
Totalt materialflöde till NDS	110390	121790	260870	306470	373730	276450	184300	176700	176700	38000	62700	94050	94050	94050	94050	2464300
Varav materialflöde via Logistikcentret	16559	18269	39131	45971	56060	41468	27645	26505	26505	5700	9405	14108	14108	14108	14108	369645
Totalt antal lastbilar till NDS	17252	19033	40769	47895	58406	43203	28802	27615	27615	5939	9799	14698	14698	14698	14698	385119
Totalt antal lastbilar till NDS per arbetsdag	136	140	321	377	460	340	227	217	217	47	77	116	116	116	116	
Varav lastbilar till Logistikcentret per dag	57	59	135	159	193	143	95	91	91	20	32	49	49	49	49	
Totalt kvadratmeterbehov för logistikcentret	3003	3313	7096	8336	10165	7519	5013	4806	4806	1034	1705	2558	2558	2558	2558	
Förslag kvm LC Hjorthagen	3500	3500	3500	3500	3500	3500	3500	0	0	0	0	0	0	0	0	
Förslag kvm LC Södra Värtan / Frihamnen	0	0	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	

Table 1: Square metre requirement and truck flow

The flow of materials is markedly higher during the 2013 to 2016 period with an average requirement of 8,000 m^2 of warehouse. The peak year 2015 required 10,000 m^2. Also in that year, we had a maximum truck transport of 460 truck arrivals per working day, some 200 of which are a matter for the consolidation centre function. Note that these are average estimates."

3.3 In-depth analysis and study

A volume study for an actual housing development of 200 apartments was carried out in 2012 for sizing purposes. A calculation model was created to simulate how the flow of materials and transports would affect BLC and its design.

3.31 Volume scenario for 200 apartments for BLC sizing'

Below are calculations for sizing the warehouse size and the need for turnover rate

	BLC m^3	BLC kg	JIT m^3	JIT kg	Comments
Volumes (kg and m^3) for 178 apartments, excl. electricity and vent.	4,821	9,069	5,451	85,385	178 apartments, total 17,800 m^2
Adjustment from 178 to 200 apartments	5,417	10,190	6,124	95,938	200 apartments, total 20,000 m^2
Kg converted to m^3	5,451		6,444		300 kg per m^3
10% volume increase to cover electricity and ventilation contractors	5,996				10% increase
Volume per week	176		190		8-month construction period = 34 weeks

Table 2: Volume scenario for building 200 apartments

3.32 Volume scenario for 200 apartments for pricing in tenders

Volume scenario calculations for 200 apartments as the basis for quantitative conditions for tender pricing

3.321 Calculation of material volumes

- A list of materials comprising 250 rows of materials for 178 apartments with a total apartment are of 17,800 m^2 was used for input data.
- The rows of materials are expressed in terms of m^3, m^2, linear metres and kg, but all have been converted to m^3. Bulk factor was multiplied by 20% of the total amount. Kg was converted by a factor of 300 kg per m^3.
- The allocation of each row of material to "via BLC" or "direct JIT".
- The material volume in m^3 has been converted to 200 apartments (20,000 m^2)
- The outcome is a total of 6,000 m^3 to BLC and 6,500 m^3 direct deliveries to the construction site.

3.322 Definition of number of entries of trucks to BLC

- Construction period = 8 months/34 weeks/170 working days
- The construction period is estimated from finished foundation to turnkey apartments.
- To convert the volume of material to number of truck entries to BLC, the following parameters were used:
  - 1.14 tonnes per m^2 apartment
  - 3.7 tonnes per truck (statistics from Hammarby Sjöstad)
  - 0.625 m^3 per m^2 apartment
- The above figures equal 2 m^3 per truck
- The result is 88 trucks per week or 3,000 trucks in total to BLC

3.323 Incoming load vehicles division of volume

The 6,000 m^3 estimated to pass through BLC have been divided as follows:

- 270 m^3 as 18-litre parcels, 15,000 pcs
- 4,700 EUR-pallets of an average 0.667 m^3
- 2,600 m^3 other, plaster, reinforcement, insulation, etc.

3.324 Volumes of received goods

- 1.5 orders received per m^3

3.325 Storage and outgoing goods

- Average storage period = 2 weeks
- 2 outgoing deliveries per order received

3.326 Deliveries

At least one am and one pm delivery generates two deliveries each working day * 170 working days = 340 deliveries to deliver the total volume of materials passing through BLC.

3.4 Defining the ground rules

Stockholm Royal Seaport is an environmental project. The construction sites face challenges in terms of the flow of materials and resource optimisation. To realise effects and steer towards higher resource efficiency at the construction sites, a number of fundamental prerequisites were defined:

1. Obligatory affiliation with BLC
2. All incoming transports must be booked in a transport booking system
3. No materials may be stored at the worksite
4. Joint waste management with smaller receptacles at the worksite
5. Joint perimeter protection with gates
6. Groupage traffic of materials below a certain fixed volume

Vehicles larger than 12 metres must apply for permission to access the expansion stage

3.5 Functions, roles and scope of staff at BLC

A number of functions, roles and managers are responsible for implementing the BLC project. As an overall definition, in the contract, the City has defined the service provider for BLC as the operator, the City itself as the orderer and third parties such as property developer and contractors as the customer. In this constellation, the City is both orderer and customer.

3.51 The operator's core services

3.511 Site manager

The site manager is responsible for progress and coordination of all services at the BLC. The site manager is responsible for operations but also for development of the processes and the facility in general.

3.512 Traffic pilot

The traffic pilot controls and coordinates all traffic in and out of the area. All requests for future time slots from individual goods receivers or other orderers of various forms of transports to the area are managed by the traffic pilot.

Via the transport booking system, the traffic pilot receives and approves information about incoming deliveries and the scheduled arrival time of the inbound transport, after which the pilot assigns a time slot. The duration time for unloading, the size or quantity, and whether the material is to be co-distributed by BLC terminal service is determined here by the traffic pilot.

When the transport arrives at the designated gate, this is verified through the time slot code assigned by the traffic pilot and the gate can open. Vehicles or deliveries that require special handling are directed to a check-point designate by the traffic pilot. Every incoming delivery is booked and information is given as to whether it should go via the terminal or not.

The traffic pilot is also responsible for drafting an overall plan for how transports in the area are to collaborate with all involved parties and supporting the terminal so that inbound transport is carried out in an optimum way. Furthermore, the traffic pilot is to proactively find solutions to any traffic issues that may arise.

The traffic pilot or another employee at BLC will regularly perform physical inspections of the transports within the area and monitor the related inflow of transports in order to prevent queues forming around the area.

3.513 Terminal service and warehousing

The operator in charge of the core terminal service will provide physical management services, such as unloading, receiving of goods, terminalisation and coordinated distribution to the respective construction sites. The operator is to provide terminal management for materials.

In providing the terminal service, warehouse staff is to make a quantitative inspection at parcel level when deliveries come to BLC and verify against freight documents for receiving goods. Inspection in terms of visible damage and other possible irregularities will also be performed. All irregularities are to be noted on the freight bill, photographed and reported. As part of the terminal service, the operator will provide warehouse services and physical and administrative withdrawals from the warehouse to the loading area. When needed, goods will be wrapped to prevent them falling and to ensure an orderly delivery.

3.514 Transport services

The operator will plan and coordinate distribution within the construction area using fixed-route vehicles according to a set timetable for optimum transport solutions. The operator will offer a call-off option for deliveries to be made outside the ordinary timetable during normal BLC business hours, so-called express deliveries. The operator will make a minimum of two fixed-route vehicle runs per working day: one am and one pm run. The recipient is to sign for all goods on delivery unless otherwise agreed.

Transport service also includes managing the return of goods to be sent from the construction site to the supplier of the goods.

3.515 Waste management services

Within the core waste management service, the operator is responsible for facilitating and organising effective waste management for each construction site within the construction area.

The operator is tasked with informing, instructing and training the concerned parties about waste management. Documentation at the initial meeting about waste management is to be provided for all concerned parties.

As waste manager, the operator will physically provide and label the waste receptacles/containers. Furthermore, construction waste is to be managed and the operator is to coordinate transports of excess construction waste. The operator must also be able to manage construction waste classified as hazardous waste.

3.516 Accessibility service

The operator is in charge of ensuring access to construction area roads by issuing permits in line with the orderer's instructions to the concerned parties that need to work within the construction area.

3.517 Road maintenance service

The operator is responsible for clearing snow and sanding to prevent slipping. In addition, the operator will handle all sweeping for road maintenance.

The operator will clear snow, sand and sweep the roads, sidewalks and public land areas. Compensation will not be received for snow clearing, sanding and sweeping within the construction consolidation area.

3.518 Bulk material handling and crushing service

The operator is in charge of bulk material handling of crushed material and earth. The operator will receive, weigh and load the material (crushed material and earth) on vehicles. Furthermore, the operator will keep the area neat to allow for effective use of space for handling crushed material and earth.

3.6 Business model

3.61 The business model between the City, the property developer and the contractors

It is vital that the right business model be chosen when conducting a project of this size. To succeed, the business model must be an incentive for all parties involved in the system – both for those using the system and those running the system. The incentive is to maximise the potential to realise the desired effects by participating in, learning about and constantly improving the system.

Agreements regarding compensation and use of BLC are drafted between the City and the property developer, between the property developer and the contractor, and between the operators and contractors as future BLC customers. The business model is based on three compensation models:

1. Joining fee
2. Traffic pilot fee or a “gate fee”
3. Cost per service according to the current price list

3.62 Joining fee

The City of Stockholm builds the facility and is responsible for the orderer organisation in the procurement of the operator. The cost for this is divided among the property developers. The distribution of costs is done per m^2 light GFA. Because the City of Stockholm is the property developer, the City also pays a joining fee that corresponds to 9-10% of the total cost for BLC.

3.63 Traffic pilot fee

The operator is responsible for ensuring that a traffic pilot manages the booking system and updates a joint job site layout plan (APD). The operator invoices the customer the traffic pilot fee. A certain percent of the pilot fee is returned to the City to finance parts of the orderer organisation.

3.64 Cost per service according to the current price list

In the tender process, the City prepared a current price list to define the range of services for BLC. The customer is invoiced for utilised services such as storage, pick-up, delivery, etc.

3.65 Distribution of costs

The services covered by BLC and what is included in the costs for each is described below. The joining fee for the **property developer** replaces fixed costs according to **A**. Running costs for the **property developer** are replaced according to **B**. Running costs for the **contractor** are replaced according to **C**.

Distribution of costs, Construction Consolidation Centre, Stockholm Royal Seaport	A	B	C
Facility with warehouse, terminal space, site office, etc.	X		
Orderer organisation BLC	X		
Safety and surveillance of BLC facility including warehouse	X		
Operation of BLC	X		
R&D activities in construction logistics	X		
Automated drive-through gates and rotary gates, complete with steering	X		
ID06		X	X
Assembly and maintenance of automated drive-through gates and rotary gates	X		
Fencing/gating around workplaces		X	
Access to all services within BLC	X		X
External surveillance	X		
Surveillance of construction site (contractor sheds)			X
Construction logistics training	X		
Information video	X		
Information material, training material, website	X		
Material and delivery booking system	X		
Services according to the current price list BLC		X	X
• *Time slot fee*			X
• *Storage and outgoing goods*			X
• *Access summer and winter*		X	X
• *Waste management*			X
Job site layout plan (APD), overall	X		
Job site layout plan (APD), zoning area	X		
Contractor shed information per zoning	X		
Coordinated construction logistics for public land		X	
Control of work area accessibility		X	
Security check of spaces and fences around the area one to two times per week and report to the Development Administration, including photo documentation	X		
Security check of gate functions and statistics function	X		
Site manager meetings and minutes of meetings, etc.		X	
Coordinate site manager meetings		X	
Follow-up decisions from meetings and maintain an “Activity List”		X	X
Crane coordination		X	
Gate placements and changes	X		
Participate in project execution stage meetings, security rounds, etc.		X	
Check that information about contractor sheds works	X		
Plan contractor shed information equipment – taking down and putting up	X		
NEW Contractor shed waste (household waste within the work area)	X		X
Area controls for leases	X		
Land leases for construction activities within zoning			X

Figure 2: Distribution of costs between fixed and variable costs for the property developer and contractor

3.66 Business model between the operator and the City

3.661 Compensation

In earlier discussions about the structure of the business model between the City and the intended operator, the basis was that the City would assume the greatest risk in this project. Therefore, it was decided that the entire facility, including mobile gate systems and communication equipment needed for operations, would be paid for and installed by the City. Compensation for the operator's organisation and operations would be issued for the services provided according to the current price list fully opened to competition in accordance with the Public Procurement Act.

3.662 Minimum compensation level per year

Production intensity varies in all urban development projects. One target for the City is the production of 500 apartments per year, which was the basis for the tender. A risk that existed, and which still does, is that the production rate could fall below the target of 500 apartments per year over shorter periods. Therefore, it was decided that the operator should be guaranteed minimum compensation from the City of SEK 2 M per year. If income reaches budgeted levels, a six-month offsetting will be carried out in which SEK 1 M will be deducted from income for the traffic pilot fee (gate fee). Surplus amounts accrue to the City, and the operator will be invoiced for these. If income from the traffic pilot fees is less than SEK 2 M per year, the operator will invoice the City for the difference. The operator will also receive compensation for training in the amount of SEK 150,000, of which SEK 75,000 will be deducted every six months.

3.663 Operations costs

Compensation to the operator will include operations and minor repairs. If individual damages, for example, a damaged fence, exceed one half price base amount, the City will compensate the extra cost according to the table below.

3.664 Bonus system

The contract contains a bonus system that provides a bonus of SEK 180,000 per year and a final bonus for a number of affiliated apartments.

§ 6.1 **Årlig bonus**

Bonus utbetalas med som maximalt 180 000 kr/år enligt villkor i bilaga 1 till detta uppdragskontrakt.

§ 6.2 **Avtalsbonus**

Bonus utbetalas i samband med kontraktets upphörande baserat på totalt antal anslutna lägenhetsekvivalenter.

För bostadshus utgör 100 kvm ljus BTA en lägenhetsekvivalent.
För kommersiella lokaler utför 200 kvm ljus BTA en lägenhetsekvivalent.

Anslutna lägenhetsekvivalenter i utvecklingsområde Hjorthagen

<4 250	ingen bonus
4251-4500	600 kr/ lgh-ekv i segmentet
4501<	900 kr/lgh-ekv i segmentet

Utbetalning sker retroaktivt efter uppföljning. Indexreglering sker ej av i § 6.2 angivna bonusbelopp.

Table 3: Incentive for bonus from the contract

In 2015, it was decided that the bonus system would be restructured. It proved difficult to measure the different interim targets for, for example, picking quality or on-time outbound deliveries. Instead, the bonus system focuses on two other aspects – training and customer satisfaction index (CSI). 20% of the bonus is based on training and the remaining 80% on CSI:

Training bonus	Lower level CSI	Upper level CSI	Scale	Potential bonus	Results CSI	Outcome SEK
1. Training bonus, Stockholm Royal Seaport	50	80	Linear	SEK 36,000	67.4	SEK 20,880
2. Communication and information from BLC	50	70	Linear	SEK 18,000	51.9	SEK 1,710
3. Core services	50	70	Linear	SEK 18,000	54.6	SEK 4,140
4. Additional services	50	70	Linear	SEK 18,000	64.7	SEK 13,230
5. The area	50	70	Linear	SEK 18,000	54.6	SEK 4,140
6. Service from BLC	50	70	Linear	SEK 18,000	69.8	SEK 17,820
7. Effects of BLC	50	70	Linear	SEK 54,000	57.4	SEK 19,980
				SEK 180,000		**SEK 81,900**

Table 4: Incentive bonus system after adjustment of parameter

3.67 Budget and pricing 2012

BLC pricing is based on three aspects: actual expenses, income from joining fees for the property developers and income from expected transport flow. In the implementation decision of 23 August 2012, a pricing model was adopted in which investment expenses were estimated at SEK 41 bn for the facility including bonus and annual compensation to the operator. Income was based on seven years between 2013 and 2019, applying the following prerequisites:

- Only the Hjorthagen district is included
- 4,000 apartments join the construction consolidation centre
- 150 inbound vehicles per day, which corresponds to a minimum 35,000 vehicle movements per year through the workplace
- Traffic pilot fee of SEK 85 per inbound transport
- Joining fee of SEK 60 per m^2 light GFA (gross area)

The traffic pilot fee was set at SEK 85 (2013 price level) per inbound transport to the workplace area so contractors would have greater incentive to reduce their direct transports and increase co-distribution via BLC's terminal facility. Thereafter, the joining fee was calculated taking into account the traffic pilot fee and actual income and costs for the investment.

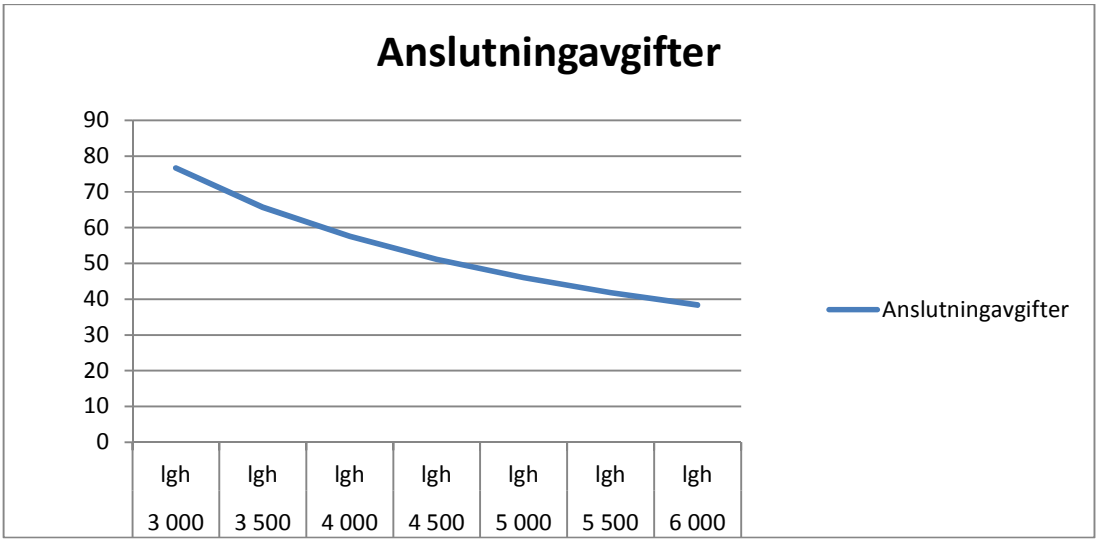

Figure 3: Describes the relationship between expenses, income and joining fee in relation to the number of built apartments

3.68 Budget and pricing 2013

During the third quarter of 2013, it was decided that a revised implementation decision would be presented. A new decision was adopted in December 2013. The reason for this was

increased expenses relating to the facility in particular, but also to operations. The primary change was:

- Facility cost, SEK 10 bn
- Costs for surveillance were redefined at approximately SEK 20 bn
- Gates and steering, including operations, SEK 20 bn.
- The area was expanded and now also included Södra Värtahamnen up until 2023.
- Contractor shed information and communication, SEK 10 bn
- Operations organisation for BLC, SEK 7 bn
- Higher risk cost, SEK 10 bn

The pricing was maintained with the change in the form of a 5% mark-up per year to cover unforeseen expenses, change in the expansion rate and price adjustments for procurement and operation. In total, the project has a cost increase of SEK 104 M and an income increase of SEK 96 M for the Hjorthagen and Värtan districts within Stockholm Royal Seaport.

3.69 Costs for the property developer

The cost estimate between the property developer and the contractor was assessed in autumn 2012 to average approximately SEK 365 m^2 light GFA. This excluded surveillance which today is added to the joining fee. The estimates are based on the expansion of a zoning with 670 apartments, an expansion rate of three years and a volume study of 200 apartments to determine the scope of inbound storage, warehousing, inbound transports into the area with both fixed-route vehicles and direct deliveries. Below is a compilation of the estimate presented at meetings in 2012 and 2013. When the cost of SEK 49 per m^2 for security work within the construction area, winter and summer road maintenance and waste management costs were excluded (since they are always included), the cost for BLC is SEK 316 per m^2. This makes up approximately 1.8-2% of the construction cost, or 0.5% of the production cost.

The distribution of costs between the property developer and the contractor is then one quarter for the property developer and three quarters for the contractors according to the model. In conjunction with the start-up in 2013, it was discussed whether BLC should be in charge of surveillance of the area, which would be added to the joining fee. This cost today is approximately SEK 30 per m^2.

The table below presents a cost estimate for BLC per m^2 during a construction project. We start with a number of vehicles per day, which refers to measured vehicle movements for the first expansion area (Norra 1) without BLC. Then we take into account the length of the expansion stage, which varies between two and three years. The fixed cost is set as well as the pilot fee per gate opening. The estimate is based on the volume study for the number of assumed direct transports to the construction site as well as storage and terminal services

.

Antal fordon/ dygn N1 (670 lgh) Utbyggnadstid år för DP	100 3 kr/m2	100 4 kr/m2	100 5 kr/m2	150 3 kr/m2	150 4 kr/m2	150 5 kr/m2	200 3 kr/m2	200 4 kr/m2	200 5 kr/m2
Fast kostnad	60	60	60	60	60	60	60	60	60
Lotsavgift 85:-/fordon	84	112	140	126	167	209	167	223	279
BLC	130	130	130	130	130	130	130	130	130
Framkomlighet	15	15	15	15	15	15	15	15	15
Avfallshantering (20 kg/m2)	34	34	34	34	34	34	34	34	34
Totalt per m2	**323**	**351**	**379**	**365**	**407**	**449**	**407**	**463**	**518**

Figure 4: Expected total costs for BLC

Consideration as to how much the property developer and contractor are each to pay is important. The property developer who contracts with BLC with its principal contractor will have such a liability for costs that the incentive to improve the construction site's logistics and achieve the intended effects of BLC will be the highest possible. It is open to discussion as to whether the distribution presented above is correct.

3.7 Business model

3.71 Contract between the City and the property developer

The contract signed by the City and the property developer includes a "Development Agreement" and a "Joining BLC Agreement". The "**Development Agreement**" describes BLC and it is evident that this is obligatory. It contains a brief description of the scope and explains that there is a separate agreement for joining. The "Joining BLC Agreement" contains the terms for BLC usership, costs for joining, other costs, how the costs are distributed as well as the rights and obligations of the contracting party.

The following is included in the Development Agreement for BLC:

"3.10 Construction Consolidation Centre (BLC) in Stockholm Royal Seaport
A local Construction Consolidation Centre, referred to as BLC, has been established for Stockholm Royal Seaport. BLC aims to create sustainable, resource-efficient construction within the urban development area. All property developers in the urban development area must join BLC. Appendix 8:1, Fact sheet 12, presents the services and distribution of costs. Appendix 8:2 contains the price list for pilot and joining fees. More information is available at the BLC website, www.ndslogistik.se.
The terms for joining will be determined no later than before construction starts.

3.11 Shared costs
For information on shared costs for work on public land and services of a general nature for the development phase carried out by the City or BLC within the workplace area and which are invoiced to the Company, refer to Memorandum of Implementation specification, Shared work, Appendix 6.

Shared costs can vary in nature and scope depending on the prerequisites in a specific area and phase.
The work will be carried out in collaboration and dialogue between the concerned companies in the area and the City."

3.72 Agreement between BLC and customer

A customer agreement must be signed to use BLC. The customer agreement is drawn up between BLC and the property developers and between BLC and the contractors. The City of Stockholm Development Administration, the orderer of BLC, also has a customer agreement since the City is also a property developer. The agreement covers economy, compensation models, services, regulations, insurance, obligations, price changes, etc.

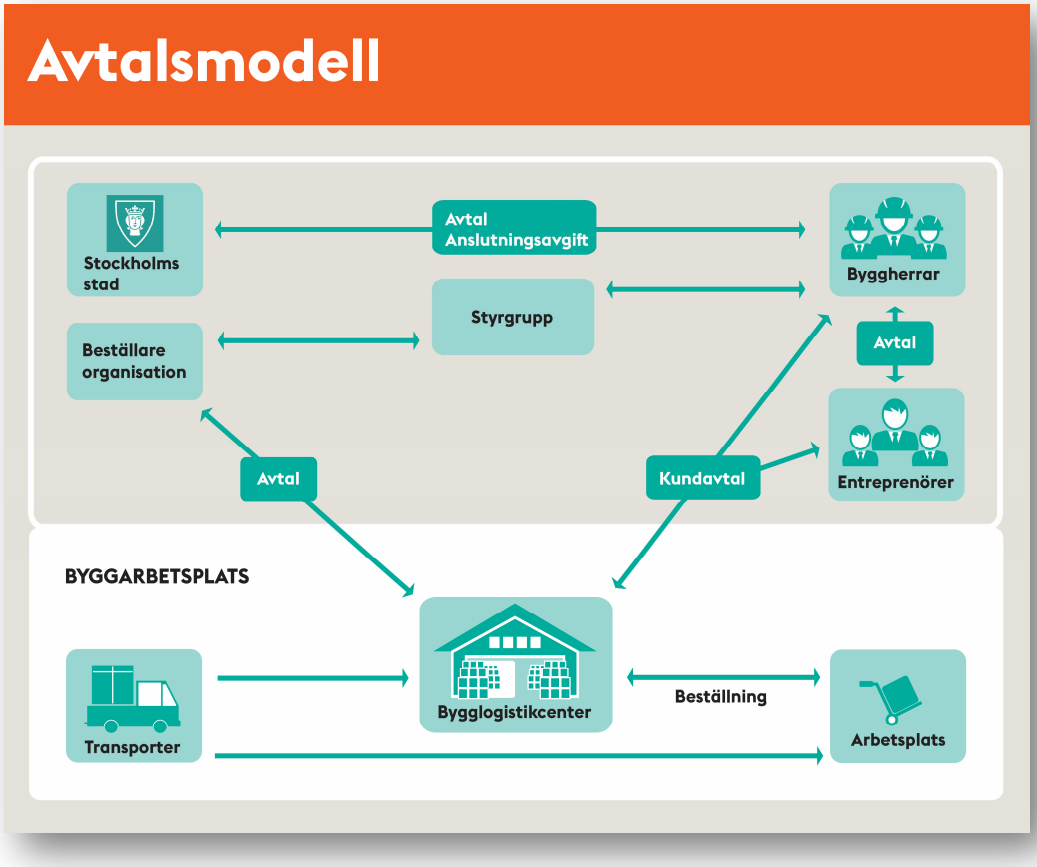

Figure 5: Contract model BLC

During January and March 2012, tender documentation was drafted for the procurement of a BLC operator. Because the City had no previous experience of such a service procurement process, the City opted to apply the competitive dialogue procedure for the tender. A preliminary qualification process was carried out, involving application rules and a

description of the assignment. Below is a description of the City's expectations from the candidates.

To demonstrate this, the candidate is to:
- briefly describe the company's business concept, objectives, services and organisation
- describe the company's physical and administrative resources as well as the company's geographical location
- describe the company's capacity in terms of expertise
- describe the areas in which the company works with subcontractors and specify who these contractors are
- describe the company's IT support and functionality available to support the implementation and follow-up of the defined services
- describe the company's experience in supplying the defined services:
- Traffic planning
- Warehousing
- Transport (delivery vehicles, loading and unloading)
- Waste management

Specifically developed services within construction logistics
- describe the company's routines for development and constant improvement of the assignment in terms of:
- Streamlining costs
- Delivery service
- Reduced environmental impact
- describe the possibilities and innovative ideas the company foresees in order to develop the range of construction logistics services
- describe the company's routines for establishing good forms of collaboration with key customers

3.73 Dialogue process

The paragraph below is an excerpt from the application rules for the dialogue process:

"The dialogue will be held individually between the orderer and each individual supplier (tenderer) and only address the supplier's proposals and solutions. A supplier is entitled to present several different solutions. The orderer reserves the right to gradually exclude solutions or suppliers during the course of the dialogue. This means that all solutions proposed by a supplier may be eliminated during the process. However, it is the orderer's ambition that the final phase will result in three realistic solutions from three different suppliers. The decision to eliminate a solution is to be documented by the orderer. However, the dialogue is not binding for the supplier. The dialogue will be held in Swedish."

To describe the assignment, the number of vehicles and handling of goods were simulated in the request for tender:

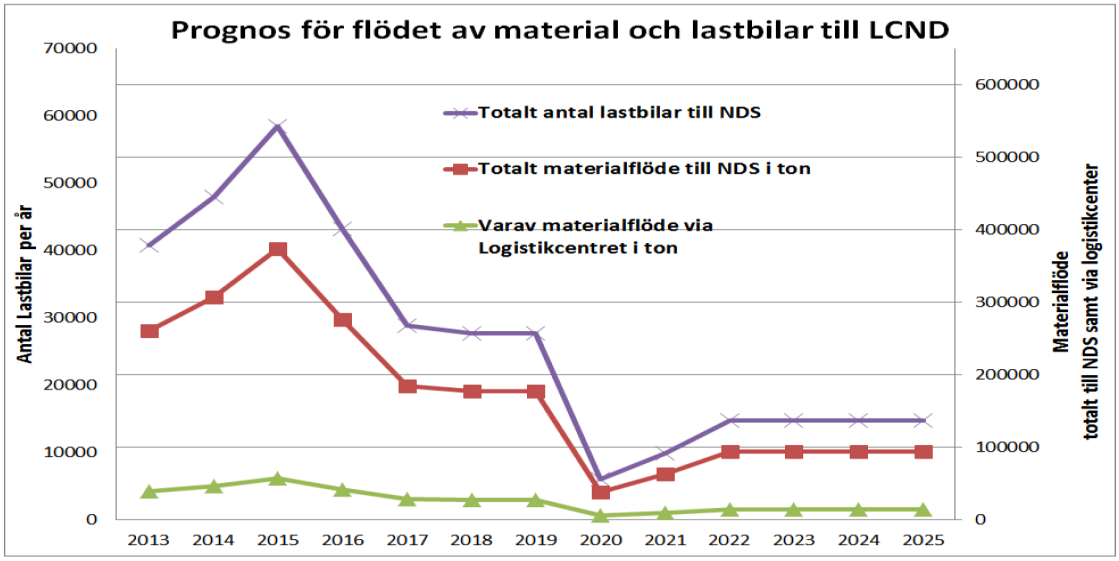

Diagram 1: Forecast for the flow of materials and trucks during the preliminary study 2011.

3.8 Tender

3.81 Qualification

During spring 2012, an initial qualification of six received bids was carried out. Three companies were chosen to advance to phase 2, during which two interviews with each company were conducted about how the tender documentation should be prepared. The tender documentation was then drafted and sent to the three qualifying companies.

3.82 Dialogue phase and tender documentation

The City of Stockholm made presentations and the three candidate suppliers that had advanced to the dialogue phase presented their bids. Presentations regarding focus areas in terms of the terminal, facilities and IT structure were also held. The agenda for one of the focus areas is presented below.

During the dialogue process, it was ascertained that the layout of the facility had to be amended for optimum functionality. This was also confirmed during the planning phase. It was established during the dialogue phase how the tender documentation should be drafted with a current price list and how suppliers were to be compensated. Based on the documentation from the dialogue phase, the City of Stockholm drafted new tender documentation comprising:

1) Application rules
2) Application form
3) Assignment contract
4) Assignment description
5) Assignment specification
6) List of materials – the division between BLC and direct transports
7) Environmental requirements for equipment and machinery

8) Memorandum of production terms for the developer and the contractors in the work area
9) Current price list with fictitious quantities for logistics services for 200 apartments
10) Other documents including details regarding the facility, etc.

3.83 Evaluation criteria

The following description is from the tender process rules:

"Allocation will be based on the economically most advantageous bid in terms of price and functionality. Functionality comprises the following subareas which will be graded:

1. Management
2. Physical infrastructure
3. IT support
4. Environment
5. Innovation and development
6. Implementation

For each subarea, an overall evaluation will be made of how well the tenderer fulfils the requirements described below related to how the service will be carried out in line with the description of the assignment and other documents in the request for tender documentation. Points will be assigned as explained below for each of the subareas. Maximum points are assigned to a described functionality that is deemed to fulfil the stipulated objectives in a very good way. A maximum of 150 points can be assigned in total for all subareas.
The verbal presentation will be used for clarification of the bid submitted by the tenderer."

3.84 Winning bid

Two bids were submitted, one from Ragn-Sells and one from Servistik AB in constellation with Wiklunds Åkeri AB. Each company presented their bid. The winning bid was the Servistik and Wiklunds Åkeri constellation.

4. Implementation

4.1 Start-up meeting

A start-up meeting was held on 23-24 October 2012 in Linköping after the contract was signed. The assignment and the targets for the project were reviewed at the meeting. The function teams for the project that were formed still exist. Several challenges during the implementation phase were foreseen, which became clear at the start-up meeting. Among others, four organisations had to collaborate on the project – the City of Stockholm, Servistik, Wiklunds and Prolog Bygglogistik. Initially, Servistik was of the impression that they would manage the implementation process themselves, which the City felt Prolog should. This was quickly settled.

Figure 6: Start-up meeting in October 2012 in Linköping, Servistik

At the start-up meeting, target descriptions for each function team were drafted as described below. This was to make it possible to follow up and establish a common objective. Several workshops were held in 2012 and 2013 where the parties met. A visit was made to Wiklunds Åkeri to see their warehouse and operations, and to Servistik in Sätra to look at their warehouse operations. A final workshop was held at Kolmården in March 2013 ahead of the start-up of the entire facility.

4.2 Function team project

The function team project was a critical part in succeeding with the implementation procedure. The City set a clear structure for how the work was to be divided and how to divide responsibility for various processes.

Figure 7: Function teams and organisation for implementation

4.3 Technology

Many challenges were predicted in terms of the technical aspect of the project. Servistik and Wiklunds have ties with several technical companies that work with their organisation in

order to resolve issues, together with the City, such as gate solutions and IT structure for the transport booking system, radio LAN traffic, entrance ID06, and more.

4.31 Mobile gates

The biggest challenge was the mobile, fully automatic gate system steered by the transport booking system using a radio LAN solution. The objective was to avoid a solution involving a surveillance company, which was used in many other projects. It was clear that a large gate solution investment would save money in the long term. A principle solution for the gates was prepared in December 2012. The first gates were delivered in January 2013. The challenge was to link the gates to the transport booking system. This meant that a separate computer module had to be built that linked to the transport booking system in order to generate time slot codes. Initially, swing gates were used, but as of gate no. 10 and onward, folding gates are used to improve security and operation when opening and closing. Today, the gates are arranged so:

- Mobile gates put up on a thick steel plate
- Link to the network via a radio mast
- Steering against time slots, ID06, manual opening and phone connection with opening
- Camera surveillance outside and inside
- Transponder opening
- Mobile readers

Figure 8: The photo above shows a folding gate with a radio LAN mast and camera surveillance

4.32 BPI and information management

One objective for the project is that everyone working at the worksite must be informed about the project and the daily steering of the worksite area. For this reason, the project has created an information channel – Construction Site information, also called BPI. The channel is a standard TV monitor mounted in every establishment (two monitors per establishment) and linked to a contractor shed kit made up of a radio mast with switch and router. (It should be

added that it is possible to share information via the TV monitor, which generates information and how it is passed on.)

4.4 IT system

The IT system for steering the transport booking system to the gates started in October 2012. Integration was complex since this solution was not part of Servistik's initial IT solution. Another challenge was discovered regarding the vast number of customers to be managed in the system. The challenge was to manage a large number of customers per project and subproject with different needs and requirements that would affect different cost centres. The system had to be able to manage thousands of customers simultaneously. The implementation phase was extended to accommodate development of this

4.5 Site office and terminal

Building of the terminal facility and procurement of an office for BLC started in October 2012. NCC was commissioned to build the entire facility procured in competition in accordance with the Public Procurement Act as construction contractor, and taking part in the design-build contract for the office and warehouse.

Figure 9: Construction of BLC, winter 2012/2013

The facility was completed in March 2013. The location of BLC was a natural choice since all inbound transport comes via Ropsten and the connection to sea transport existed through a renovated quay facing Lilla Värtan. Space for the facility was divided as follows:

Facility	Space
Total size of the facility	6,800 m^2
Terminal, indoor warehouse	2,200 m^2
Waste management area	1,000 m^2
Site office	250 m^2
Outdoor warehouse, weather protected	250 m^2
Area for containers	500 m^2

Outdoor warehouse, machinery area and miscellaneous space	2,600 m^2

Table 5: List of BLC spaces

4.6 Communication and training

One of the project's most important tasks is to communicate and provide information about what BLC is, what it will do and why there should be a BLC in Stockholm Royal Seaport. This is to be communicated to all stakeholders in the project and those outside Stockholm Royal Seaport. A decision was made in 2012 about creating the following information material:

- BLC Q&A – the most commonly asked questions and answers about how BLC works
- General information about BLC
- Video about BLC and Stockholm Royal Seaport
- BLC fact sheet
- Website to spread information www.ndslogistik.se
- Training kit for all BLC customers

4.61 Q&A

A Q&A was developed and the first printed edition was released in April 2013. Regular updates have been made and edition 4 was printed in March 2016. The Q&A has been translated into ten languages and published on the website.

Figure 10: Q&A brochure, edition 1 and 4

4.62 General information about BLC

In 2014, the City created a general information brochure aimed at the state and municipalities, companies that want to learn about the project and other interested parties. The brochure describes the overall objective and purpose of BLC as well as the services and contents.

4.63 BLC fact sheet

Creation of the fact sheet for services began in 2013 and is still in progress. The target group is those working in the area who encounter the services offered there. This is to provide information about the services, such as what “development phase scheduling” and “crane coordination” are, or what the surveillance service includes. The fact sheet is continuously updated with new information. Contract forms for leasing alarm equipment and other equipment are linked to the fact sheets.

Of 15 fact sheets, nine are available today, namely:

Contractor shed information
Broadband service, contractor shed information
Development phase coordinator
Surveillance
Business model
Distribution of costs
Visitor’s entrance card
Rock crushing products
General BLC prices

4.64 Video about BLC and Stockholm Royal Seaport

Two information videos were produced in 2013. One was produced to describe BLC, while the other provides a more general description of Stockholm Royal Seaport. The videos have been translated into several languages. These videos are used for training purposes and in conjunction with lectures. They are available on BLC’s website and YouTube

4.65 Website

The IT function team created the BLC website. The purpose is to facilitate internal and external communication in the project. The website contains all information about the project, including videos, fact sheets, application forms, training registration, results and statistics, and more. It is continuously updated and is today linked to the property developers’ and the contractors’ websites with a login feature. The address is: www.ndslogistik.se

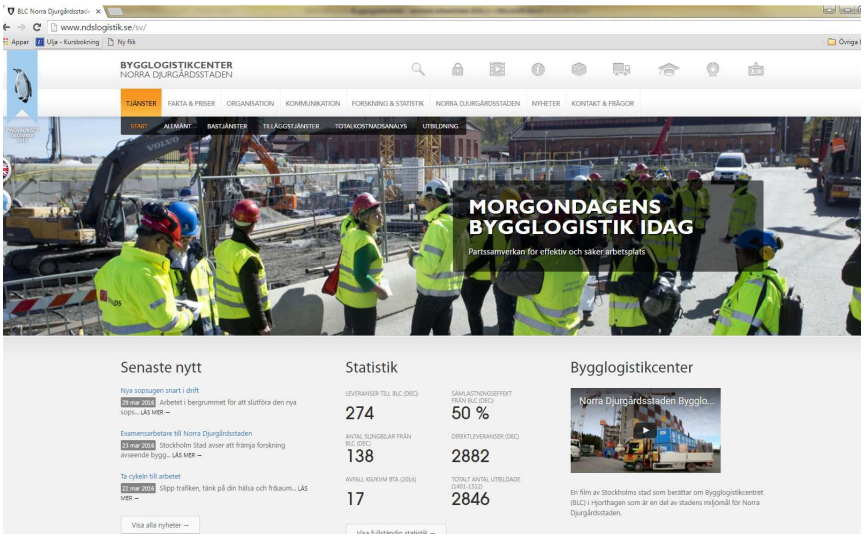

Figure 11: Website www.ndslogistik.se – home page

4.66 Training kit

Training has been the most important platform for meetings between BLC and the officials and professionals working within the area. The Communication function team decided early that the training kit was to be divided into different levels. As a result, three training levels were offered in spring 2013:

- BASIC training
- NORMAL training
- EXPERT training

4.661 BASIC training

BASIC training is for those who work no more than five days per month and who are ID06 registered at a specific work area. It is provided at BLC and booked through the website. Since training began in autumn 2013, BASIC training has been carried out in 11 languages.

4.662 NORMAL training

Normal training includes the video about Stockholm Royal Seaport, training in occupational protection and safety, and information about how BLC works. The purpose is to create an understanding of why the City has established a BLC for Stockholm Royal Seaport and what logistical challenges the construction industry faces. Many accidents and injuries are related to shortcomings in logistics. The training material has undergone two major revisions since the start. To generate interest in training, we opted to perform a survey using mentometer buttons among the participants. We asked ten questions related to logistics and material handling.

Figure 12: NORMAL training badge to be worn on helmet

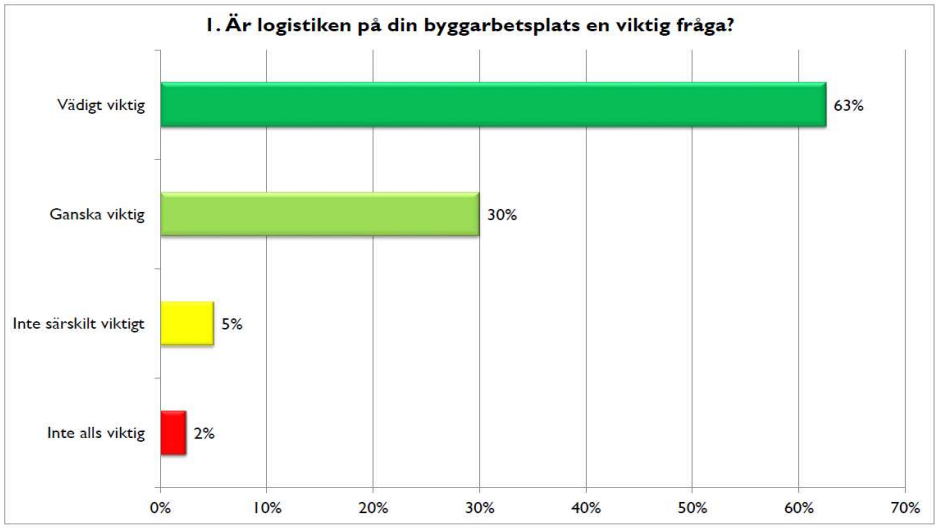

Diagram 3: Measurement of the participants' opinion of the NORMAL training – results

4.663 EXPERT training

EXPERT training is an extension of the NORMAL training programme. The EXPERT training programme is for worksite personnel who have a team leader role and/or budget responsibility. The objective is to provide insight into how BLC can contribute to production efficiency by discussing the opportunities BLC creates and the planning needed to realise the desired effects of BLC. The training covers practical aspects including booking time slots, warehouse management and deliveries, invoice issues, etc. A total cost tool has been created that is part of the EXPERT training programme. The tool is used to simulate the impact of BLC's various services on project finances and can contribute to greater production efficiency. Also refer to the section "Research and development."

Figure 13: EXPERT training badge to be worn on helmet

4.7 Research and development

One of the two overall objectives is that BLC will "promote research in construction logistics with the aim of using the construction consolidation centre to generate development in the industry." One of the function teams deals focuses on research and development. A research plan was prepared to compile information on the need for research and development and how BLC can contribute.

4.71 Research plan

A research plan was prepared with the aim of:
"The R&D plan for Stockholm Royal Seaport will stimulate innovative thinking and test new ideas and concepts that lead to better resource efficiency in society (economically, environmentally and socially). The R&D plan will:

- Constitute a manifesto for the initiatives within the area.
- Verify objectives and purposes of the project."

A number of research issues were defined that are linked to overall objectives and milestones that the project aims to achieve. Five research issues were identified.

4.711 Research issues

Research issue 1: Does BLC contribute to sustainable transports and sustainable construction?

- Sustainable and resource-efficient transports
- Reduced emissions
- Higher degree of loading/filling
- Reduced number of transports
- Reduced waste and coordinated waste transports

Research issue 2: How does BLC affect project finances (for projects built in Stockholm Royal Seaport)?

- Reduced production costs (-15%)
- Reduced preparation time for skilled workers and machinery/equipment

- Better accessibility through delivery bookings and improved planning
- Reduced scrapping of materials
- Reduced loss
- Reduced thefts
- Reduced damage (material)
- Higher quality (reduced quality error costs)
- Reduced risk of building with damaged materials
- Better planning
- Co-use of resources

Research issue 3: How does a BLC affect occupational health and safety?

- Greater accessibility
- Less risk for injuries for skilled workers (falls, etc.)
- Less risk for overexertion injuries
- Greater focus on tasks (less irritation)
- Perception of good planning and neatness => satisfaction

Research issue 4: How does a BLC affect contract and purchasing issues?

- Strategic Contractor contracts and purchasing
- Onsite call-offs and purchases
- Types of contracts between orderer and contractor
- Types of contracts between main contractor and subcontractor

Research issue 5: How does the Construction Consolidation Centre work?

- Structure and intention of the tender documentation
- What effects are created through BLC (training, APD, information, bookings, etc.)
- Types of contracts
- Business model
- Cost analysis
- Interface core services and additional services
- Regulatory framework
- Physical facility
- IT structure

Research issue 6: Does BLC contribute to behavioural changes among various stakeholders (orderer, contractor, subcontractor, suppliers)?

- Attitudes
- Personal choices
- Points of view
- Power issues
- Communication

At the beginning of summer 2013, a project to analyse cost changes and the work environment at the worksite with or without a BLC was carried out. This included a follow-up of the Abisko project within Norra 1, which does not use BLC's services.

Yet another project related to the EXPERT training programme was created to produce a tool to simulate costs of using BLC compared with not using BLC, based on the infrastructure and services offered according to the contracted prices. The total cost tool was created in collaboration with Prolog Bygglogistik AB. The tool is available to those who attend the EXPERT training programme and via the website for those with login details.

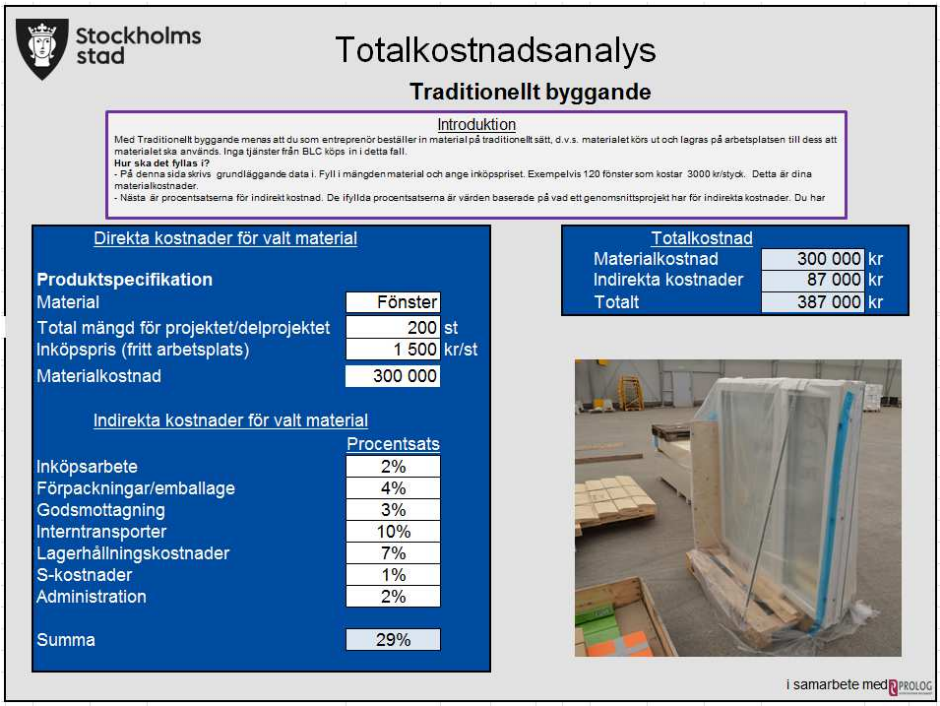

Figure 14: Picture of the total cost tool – input data

Traditional construction is described with the normally preset mark-up for purchased material. When the user stipulates that BLC is used, a set reduction is issued for each mark-up.

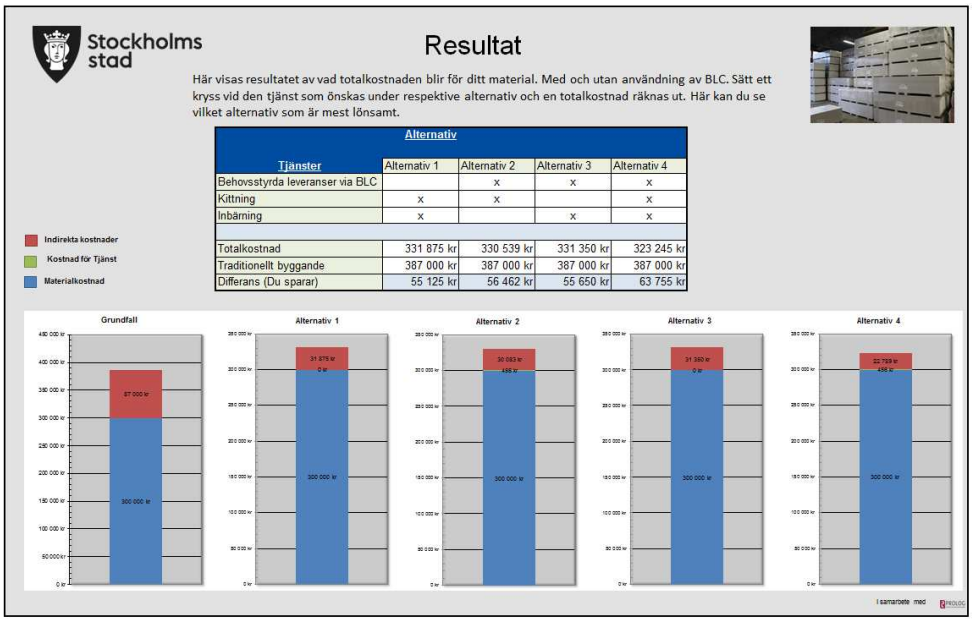

Figure 15: Results of using the total cost tool

The results show that costs can decrease or increase depending on the choices made and whether or not services are bought. It is a planning tool to be used in the project.

5. BLC today

BLC is currently driven by the operators Servistik AB and Wiklunds Åkeri AB

5.1 Parties and customers

The BLC parties are:

1. City of Stockholm
2. Operator
3. Property developers
4. Main contractor
5. Subcontractors

5.2 Organisation

5.21 City of Stockholm

The City of Stockholm Development Administration is represented by:

- Fredrik Bergman, Project Manager Implementation, City of Stockholm Development Administration

Function	% of full time	No.	Activity	Company
Project Manager Implementation	20%	1	Representative and orderer. In charge of the BLC assignment in terms of development, strategies and finances	The City
Project Engineer	30%	1	Coordinates activity	The City
Environmental Coordinator	5%	1	Environmental specifications and coordination in function teams	The City
Implementation	45%	3	Orderer support for implementation and keeping together various function teams as well as leading implementation on behalf of the City.	Prolog
Contract control	30%	3		

Table 6: Personnel functions for the City of Stockholm Development Administration

5.22 Operator

The operator is represented by:

- Ingemar Nyström, Servistik AB
- Tommy Pettersson, Wiklunds Åkeri AB

Function	% of full time	No.	Activity	Company
Site Manager	100%	1	Site management and in charge of personnel	Servistik
Traffic Pilot	100%	2	Approval and steering of transport bookings	Servistik
Customer Manager for the construction site	15%	1	Coordinate customer issues and logistics meetings	Wiklunds
Bulk material handling – crushing rock	15%	1	In charge of crushing operations and recycling of rock	Wiklunds
Development Phase Coordinator	100%	2	Development phase coordination, logistics meetings, zoning, site manager for one or more areas	Wiklunds and Servistik
Overall Development Phase Coordinator	100%	1	In charge of gates, APD plans, perimeter protection, etc.	Servistik
Warehouse Manager	100%	1	In charge of the warehouse	Servistik
Warehouse staff	100%	4	Warehouse management, incoming and outgoing goods	Servistik
Transport Coordinator	100%	1	Planning of machinery/equipment resources at the worksite, waste management resources and outbound transports with fixed-route vehicles	Wiklunds
Transport	100%	3	Fixed-route vehicle drivers	Wiklunds
Loader operator	100%	3	Operators of loaders for handling waste and crushing operations	Wiklunds

Table 7: BLC personnel functions

5.3 Management

BLC is one of many projects at Stockholm Royal Seaport. Steering of the project is structured as follows:

5.31 Steering Committee

The project has a Steering Committee. The City is the convener and chair for the Steering Committee meetings and serves as secretary. The City of Stockholm Development Administration is represented by four people, two of whom are City employees and two of whom are orderer support. The operator is represented by two people per company. The Steering Committee comprises eight members in total. Steering Committee meetings are held at intervals of eight to 12 weeks.

5.32 Function team meetings

Function team meetings are held for specific tasks such as communication, training, IT, the environment, etc., where the City and operator are represented. The City is the convener and serves as secretary. Function team meetings started during the implementation phase (see the section “Implementation”) and follow the structure of a development meeting with the aim of realising defined objectives and expectations on BLC. Function team meetings are held two to three times per year to address communication and training, IT, environment, and research and development.

5.33 BLC project meetings

BLC project meetings aim to address activities that are in progress and planned for BLC as well as monthly and quarterly financial reports. The City is the convener and chair for the Steering Committee meetings and serves as secretary. The City is represented by two people and the operator by two people from each company. BLC project meetings are held every other week.

5.34 BLC operations meetings

Operations meetings aim to address day-to-day operations issues and activities in progress. The operator is the convener and the City serves as chair and secretary. The City is represented by two to three people and the operator by three people from each company. The operator's BLC site manager, development phase coordinator, traffic pilot and communicator participate in the operations meetings. BLC project meetings are held every other week.

5.35 BLC operator management team meetings

The operator holds management team meetings with representatives from each company. These meetings aim to address personnel issues, activities in progress and finances.

5.36 Site manager meetings

Site manager meetings are held to steer the operations within each expansion phase. The City is the convener and chair for the Steering Committee meetings and serves as secretary. All contractors active in the expansion phase are represented at the meetings as well as BLC development phase coordinators. Issues concerning logistics, safety and production engineering that concern everyone within the expansion area are discussed at the meetings. Site manager meetings are held once a month.

5.37 Logistics meetings

Logistics meetings aim to address logistics planning for each contractor within the expansion area. The operator convenes and conducts the logistics meetings and is responsible for documentation. Logistics meetings are held regularly and ahead of each new phase.

5.4 The facility

Today (2016), the facility comprises:

5.41 Site office for the facility

The site office is under development. The office was expanded in 2014 since the training facility was too small. Today, it covers 70 m^2. An expansion is planned to add a new entrance, a larger changing room, larger training facilities with a conference and office room that corresponds to approximately 160 m^2. Energy consumption is approximately 10,000 kWh per year.

- Personnel area such as changing room, showers, etc.
- Office

- Meeting room
- Kitchen and dining area
- Operations space
- Training facility

5.42 Indoor warehouse

Warehouse of 2,200 m^2 indoor storage with two doors on the long side. A dehumidifier is installed to control humidity in the warehouse. Energy consumption is approximately 100,000 kWh per year.

5.43 Outdoor warehouse

A weather-protected outdoor warehouse of approximately 230 m^2 was purchased in 2015. Materials that are less sensitive to humidity and can be stored outdoors are kept here.

5.44 Waste facility

Waste facility of approximately 1,000 m^2 with an area for containers. No changes since the start in 2012.

5.5 Services 2016

The range of services contains all services included in the core services for 2012. The biggest change is the addition of surveillance of the work area. This service is included in the joining fee and refers to evening and night-time surveillance, weekdays and weekends. Another development is that the project has created a product in which household waste generated at the construction site can be taken care of using the vacuum waste collection system in the area. The following services are provided as CORE services

- Warehouse management, short-term storage and long-term storage, indoors and outdoors
- Groupage traffic and deliveries with fixed-route vehicles
- Waste management with small and large receptacles
- Clearing snow and sweeping sand
- Development phase coordination
- Crane coordination
- ID06 handling
- Gates and perimeter protection – control and operations
- Training
- Contractor shed information
- Contractor shed waste within the worksite area
- Surveillance
- Leasing of various resources
- Leasing of lighting columns for construction

Figure 16: Service organisation

5.6 Vehicles at BLC

Vehicles/machinery	Make	Environmental classification	Model year	Declared fuel consumption	Actual fuel consumption	Type of fuel	Renewable portion (%)	Emission factor (kg/CO_2 equ litre)
Fixed-route vehicle				l/10km	l/10km			
Van	DAF	Euro 5	2012	1.8	2.2	Evolution Diesel	50%	1.63
Crane truck 12 t/m	Volvo	Euro 4	2,007		3.5	Evolution Diesel	50%	1.63
Waste and goods management (loading/unloading)				l/h	l/h			
Wheel loader	Liebherr	EU phase 3	2015		4.5	Evolution Diesel	50%	1.63
Wheel loader	Volvo	EU phase 3B	2015		6	Diesel	5%	2.48
Telescope loader	Manitou	EU phase 3B	2016		3.5	Diesel	5%	2.48
Bulk material handling				l/h	l/h			
Wheel loader	Volvo	EU phase 3B	2015		7	Diesel	5%	2.48
Wheel loader	Volvo	EU phase 3B	2014		7	Diesel	5%	2.48
Excavator	Hitachi	EU phase 3	2011			Diesel	5%	2.48
Generator (crushing plant)	Caterpillar	EU phase 3B	2016			Diesel	5%	2.48

Table 8: Vehicles used by BLC

5.7 Bulk material handling within Stockholm Royal Seaport

One of the objectives with BLC was to reduce Stockholm Royal Seaport project transports by handling bulk material onsite. Bulk material handling started in spring 2013. Today, the project has handled and processed approximately 350,000 tonnes of rock in the project.

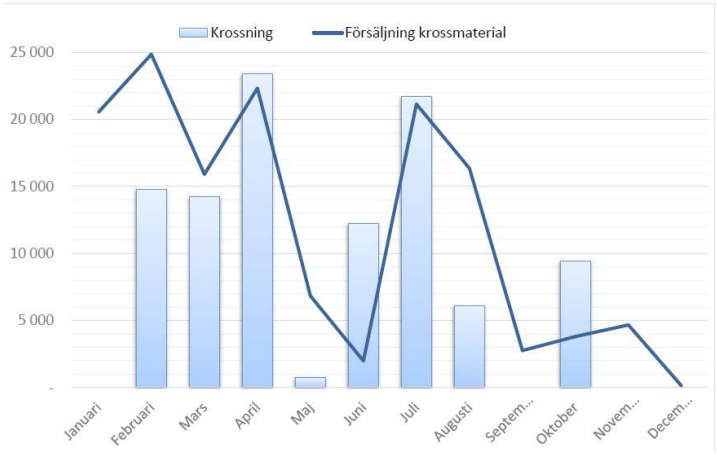

Diagram 4: Bulk material handling by BLC in 2015, diagram

Onsite bulk material handling reduces transports of rock material to and from the worksite

5.8 Technical infrastructure

The facility currently has the following technical infrastructure:

- 28 mobile drive-through gates, ten of which are swing gates and 18 folding gates, complete with time-slot controlled camera surveillance.
- 28 mobile rotary gates with ID06 readers
- 25 radio LAN masts for contractor shed information system communication
- Radio communication equipment for mobile gates
- 20 repeater kits for BIP and broadband systems
- Server unit for all systems

The gradual development of gates has been in progress since 2013 when the market could offer no complete gate systems. It has been necessary to develop the gates and this has been done together with several systems and technical equipment suppliers. Today, the gate system is so complete that the following features are possible:

1) The gates can be opened in the following ways:
    a. Connection between the transport booking system and gates with codes and verification
    b. Phone call
    c. ID06 reader
    d. Transponder opening
    e. Manual steering using the transport booking system

2) The gates can report various situations and error messages
3) Time control and statistics for incoming and outgoing

6. Research and development within BLC

6.1 Development projects

Below are the BLC-related development projects in Stockholm Royal Seaport.

Project	Development aim	Target/status
Gates	Create a gate solution designed for automated opening of gates for the transport booking system	Target: Automated gates. Complete concept and solution Status: Finished
ID camera gates	ID cameras on the gates to identify the environmental status of the vehicle and stop unauthorised incoming transport to the area. ID cameras, which are linked to an environmental status database, read the license plate number.	Target: Identify environmental status and unauthorised incoming transports Status: In progress
Total cost tool	Calculation tool for the project's total costs using various services and levels of services for BLC	Target: Training/information tool Status: Finished product
Contractor shed kit	The contractor shed kit is a radio LAN mast with transmitter and receiver used to transmit radio traffic for computer use and image transfer to all contractor sheds. The sheds are equipped with BPI screens (construction site information screens) on which BLC can broadcast information.	Target: Data transfer without fibre connection Status: Finished product
BPI	Construction site information is a software with a web-based interface. BLC steers the information on the screen and information is both local or global for the area. The information is broadcast on standard TV screens in the contractor sheds.	Target: Quick site information regarding worksite changes. Status: Development in progress
Innovation procurement using construction logistic services	Ongoing partnership project between the City, KTH and LTU. Through active involvement and mutual exchange of knowledge, the members of the development project can together enhance their insight into how procurement strategies can foster opportunities and incentives for effective utilisation of BLC.	Target: Create the prerequisites for a BLC through procurement strategies. Status: Finished.
FR EVUE – Freight Electric Vehicles in Urban Europe	Studies how local distribution using electric vehicles in urban areas can provide considerable environmental gains and demonstrates a possible phase-out of fossil fuels in the European transport system. One of the vehicles has been placed at BLC Stockholm Royal Seaport.	

Table 9: Development projects in progress

6.11 FREVUE – Freight Electric Vehicles in Urban Europe

Stockholm and the Stockholm Royal Seaport Project participate in the FR EVUE project to demonstrate and evaluate electric distribution vehicles in smart logistics solutions. This is being done in a European constellation involving many major cities, such as Amsterdam, Lisbon, London, Madrid, Milan, Oslo and Rotterdam. Studies address how local distribution using electric vehicles in urban areas can provide considerable environmental gains and demonstrates a possible phase-out of fossil fuels in the European transport system. One of the vehicles has been placed at BLC Stockholm Royal Seaport.

Amsterdam, Lisbon, London, Madrid, Milan, Oslo, Rotterdam and Stockholm participate in the FR EVUE project to demonstrate and evaluate electric distribution vehicles in smart logistics solutions. Local distribution using electric vehicles in urban areas can give considerable environmental gains and demonstrate a possible phase-out of fossil fuels in the European transport system.

Cities, private companies, sector partners, government authorities, research institutes and networks participate in FR EVUE. FR EVUE subprojects cover different types of:

- deliveries of goods (including food, waste, medicine, packages and building material)
- new logistics systems and related IT (focus on groupage traffic to reduce transports in urban centres)
- types of vehicles (from small vans to large 18-tonne trucks)
- climate (from northern to southern Europe)
- incentives and steering instruments for smarter, more environmentally adapted city logistics

The project uses some 120 electric vehicles for day-to-day city distribution. So far, experience has shown that the current generation of electric vans and trucks can offer profitable alternatives to diesel vehicles, particularly combined with modern urban logistics applications, innovative logistics software and well-designed local incentives and steering instruments. Read more at www.frevue-europe.com

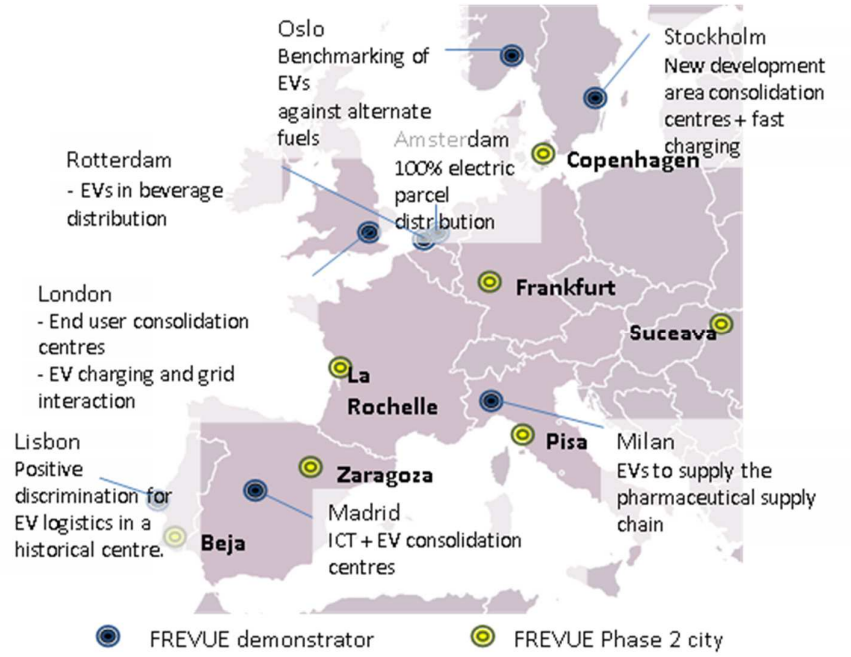

Figure 17: Overview FR EVUE project

6.12 KTH and LTU – Innovation procurement using construction logistics services

This development project aims to jointly develop, implement and evaluate suitable procurement strategies that can provide project members with opportunities and incentives to foster effective construction logistics with BLC as a base. Through active involvement and mutual exchange of knowledge, the development project members can together enhance their insight into how procurement strategies can foster opportunities and incentives for effective utilisation of BLC. It is important that the members view this as an opportunity for strategic growth in collaboration with researchers and other property developers.

The development project has three phases. First, the members will collaborate on developing and formulating guidelines for suitable procurement strategies that foster effective logistics based on BLC's services in the urban development project Stockholm Royal Seaport, with particular focus on the Brofästet phase. In phase 2, property developers implement suitable procurement strategies and in phase 3, the Brofästet project is evaluated with focus on how procurement strategies worked in actuality and their impact on the project's construction logistics.

Project targets

1) Identify various parameters that impact the project's driving forces and different project members' incentives to promote effective utilisation of BLC's services.

2) Develop guidelines for suitable procurement strategies that promote effective logistics.
3) Property developers implement suitable procurement strategies that promote effective logistics.
4) Evaluate how implemented procurement strategies work in actuality and their impact on the project members' opportunities and incentives to effectively utilise BLC's services.

Expected development project effects

1) Property developers determine targets for resource-efficient construction at Brofästet.
2) Property developers and contractors view BLC as a value-adding service organisation that can reduce costs and improve logistics within the construction project.
3) Improve procurement strategies that promote effective utilisation of BLC. Contractors work actively to fully utilise the potential of BLC.

6.2 Research projects – In progress

6.21 SBUF - – Total cost effects of third-party logistics in the construction industry

The project aims to analyse the effects of structural changes on productivity and efficiency in the construction process, and create a method for analysing total cost effects due to higher use of logistics services in the construction industry. The main result of the project will be better insight into how total costs for various construction industry stakeholders (property developers, contractors, etc.) are impacted and which conditions impact the total cost outcome due to utilisation of various third-party logistics services, such as logistics terminals.

The project will run for two years and involve both post-graduate and senior research. It is divided into three phases: 1) review of structural changes in progress, 2) create an analysis method and 3) analysis of logistics services. Alongside the funding applied for from the Development Fund of the Swedish Construction Industry (SBUF), the project is financed via the participating contractors, the City of Stockholm, Linköping University and grants from the Swedish Research Council, Formas.

Project reporting is done in the form of a licentiate theses and scientific articles, but also as popular science articles and reports as well oral reports for SBUF and interested stakeholders in the construction industry.

- Research issue 1: Which types of logistics service players and service offers are starting to appear in the construction industry?
- Research issue 2: Which construction industry stakeholders are affected by greater utilisation of logistics services and how?

To evaluate the total cost effects for the various stakeholders, a relevant and reliable analysis method is needed. Heavy demands are placed on the choice of analysis method

since new service offers affect many different aspects of the business operations of many different stakeholders. A third research issue is therefore:

- Research issue 3: How should a relevant, reliable analysis method be designed to analyse the total cost effects due to a modified and increased utilisation of logistics services in the construction industry? When a relevant, reliable analysis method has been designed, it should be applied to fulfil the overall ambition. The fourth, and final, research issue is therefore:
- Research issue 4: Which total cost effects can be exhibited for various construction industry stakeholders when different types of logistics services are utilised?

6.22 SBUF - – A construction consolidation centre's impact on efficiency and work environment in a construction project

The study aims to clarify how a local construction consolidation centre affects a construction project from a financial perspective and from a work environment perspective. The study is a comparative study carried out on a project that does not utilise a construction consolidation centre and a project that does.

The study is initially limited to two case studies with almost identical prerequisites in terms of contractor, organisation, size, structural system and geographic location. The Steering Committee will eventually add more case studies once the methodology has been further developed. If relevant case studies are localised, the Steering Committee intends to send a complementary application to SBUF.

Earlier research gives us credible standard values regarding construction costs that are relevant to the study. The most interesting aspect of this study is not the precise values that the case studies arrive at in regard to construction costs, but the changes between the case studies: does productivity increase? Do total costs decrease? Does the work environment improve? Is the planning process affected?

The results in the final report will be interesting for all construction industry players: orderers, contractors, suppliers and carriers. If BLC works as intended, all parties will improve their profitability. Stakeholders involved in BLC have expressed a great interest in knowing how BLC affects profitability.

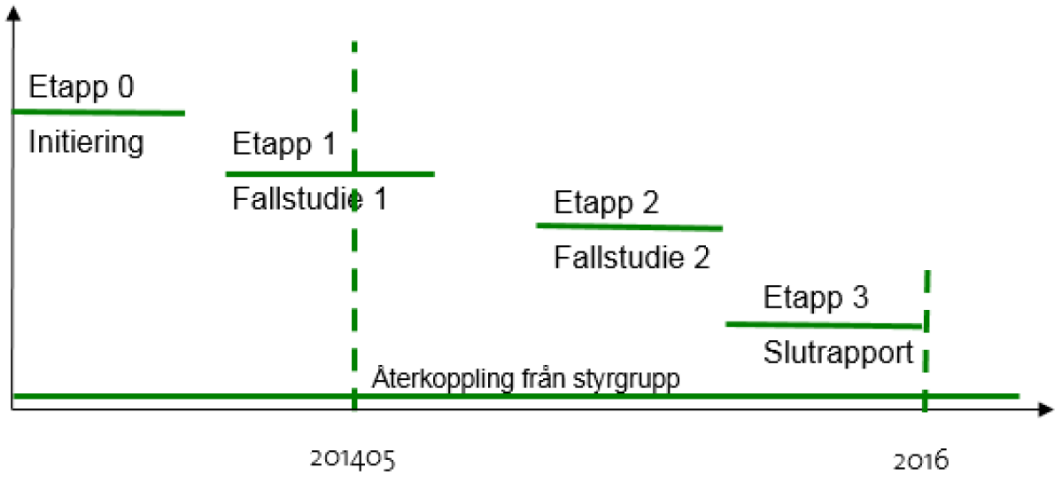

Figure 18: Image from SBUF application for Viktor Hanson project

6.23 VINNOVA - – CIVIC (Construction in Vicinities: Innovative Co-creation)

Increasing urbanisation and the subsequent high demand for infrastructure capacity in a complex environment is a challenge that cities face. The densification and creation of more attractive, sustainable and economically viable urban areas will require many new construction projects. However, transports of construction-related goods and individuals have a negative impact on the urban environment. The lack of early and accurate information, both regarding construction logistics processes and criteria from stakeholders, leads to disputes and disruptions that can harm both the construction work and the surroundings. CIVIC (Construction in Vicinities: Innovative Co-creation) will facilitate and support the planning of transports to, from and around the construction site in urban areas to minimise disruptions and energy consumption. This will be done by 1) evaluating alternatives through a multi-stakeholder dialogue, 2) using optimisation models for planning and evaluation with the help of smart data, and 3) create the development of smart decision-making process concepts for successful and effective implementation of tools.

The outcome of this 2.5-year project are: 1) identification of energy-efficient solutions for transports to, from and around the construction project in cities, 2) by analysing a broad involvement of stakeholders, increase understanding of the problems among all stakeholders (including city residents) regarding logistics and mobility, and 3) recommendations for smart decision-making concepts with a support platform for all types of urban development processes.

The project is financed through ERA-NET COFUND Smart Cities and Communities. This is a programme that focuses on smart solutions where ICT contributes to the development of energy and transport systems in cities. The focus is on how to use these solutions. It may be a question of developing integrated energy and transport systems in cities, business models, methods for planning and urban governance, or directing efforts towards quality of life, social and ecological sustainability.

Research project	Scope	Period	Responsible
Total cost effects of third-party logistics in the construction industry	SBUF and licentiate thesis. Collaboration project between NCC Construction, LiU and the City of Stockholm	2015-2017	LiU (Linköping University) Martin Rudberg
CIVIC (Construction in Vicinities: Innovative Co-creation)	Collaboration project between LSP, CTH, LiU and the City of Stockholm, Älvstranden Utveckling, Servistik and the Swedish Transport Administration	2016-2018	LINDHOLMEN SCIENCE PARK AKTIEBOLAG Maria Lindholm
A construction consolidation centre's impact on efficiency and work environment in a construction project	Collaboration project between Viktor Hanson, the City of Stockholm and Prolog Bygglogistik AB	2014-2016	Viktor Hanson AB Peter Nilsson

Table 10: Research projects in progress

6.24 Theses and reports

Between 2010 and 2016, the following BLC-related theses have been carried out.

Title	Author and year	Contents
Better logistics for construction material in Stockholm Royal Seaport. Method development for evaluation of environmental impact	Kristin Bunge, KTH Stockholm 2013	Transports were mapped by documenting delivery notes that the property developers receive as receipts for incoming deliveries. Development of tool and calculation of transport activities. The transports have then been extrapolated to refer to the total construction in Hjorthagen. Energy usage and environmental impact of the vehicles has been calculated using methods and key ratios from the Network for Transport Measures (NTM). An estimate was made of how transports can be expected to decline as a result of groupage traffic in the consolidation centre and how energy consumption and environmental emissions could thus be reduced. The project has studied emission levels of CO_2, NOx and particles.
Energy efficiency and environmental benefits of the construction consolidation centre at Stockholm Royal Seaport – A proposed method of evaluation	Anna Fröjd, KTH Stockholm 2015	The aim of this thesis has been to develop a methodology for evaluating the potential environmental impacts related to a construction consolidation centre at Stockholm Royal Seaport. The thesis has studied construction transport logistics from a life-cycle perspective to compare two different scenarios, one in which there is a construction consolidation centre (scenario 1) and one in which there is not (scenario 2). The parameters include particulate matter, energy consumption and CO_2, NOx and SO_2. Two different calculation tools were compared and the selected alternative was a tool developed by the Network for Transport Measures (NTM). An investigation of input data required to make the calculations was made and, to examine availability to this data, a number of interviews were conducted and a workshop organised with various stakeholders involved in Stockholm Royal Seaport and externally. Other matters that were discussed included the stakeholders' opinions of the construction consolidation centre, what can be improved, and how the outcome of an assessment can be improved through, for example, steering in the procurement process. Interviews and workshops were also important in order to anchor the proposed evaluation methodology with the stakeholders themselves.
A case study concerning the	Sara Hildingsson Alexander Wirdemo	Innovation has long been considered to be one of the key factors for economic growth, higher standard of living,

business model's impact on implementation of systemic innovations in the construction industry	Master of Science thesis Industrial Engineering and Management Luleå 2016	competitiveness, higher productivity and sustainable development for enterprises and industries. While innovation drives growth and competitiveness, the construction industry has long been criticised for its weak inclination toward innovation in comparison with other industries. A typical innovation in the construction industry is systemic and is said to be one of the types of innovation that lead to the best productivity gains in the construction industry. A case study was performed to address the aim of the study.
Creating motives for change through procurement A case study of two new production projects in Stockholm Royal Seaport	Bahar Baran and Ebba Storm, KTH Stockholm 2016	The report is a compilation of a case study of two new production projects with an abductive approach. The study is based on an extensive literature study, observations and interviews of participants of the two projects and can be classified as qualitative, empirical research with a hermeneutic approach to obtained empirics. The study shows that the change in the procurement process involved the developer making an addition to the tender document regarding information about BLC, its purpose and scope. It also includes recommendations on how BLC can be put to use. The addition in the tender document was forwarded to the subcontractors when these were tendered by the respective main contractors.
A public client's opportunity to to create motivations in the procurement strategy to obtain an effect project performance A case study of Stockholm Royal Seaport that focuses on two small municipal infrastructure projects	Natalie Pietrewicz and Elin Rörström Stockholm 2016	The purpose of the study is to develop knowledge about collaborative procurement strategies and how these strategies can contribute to the motivation for an effective project performance in smaller municipal infrastructure projects. The study also aims to develop an understanding about how a construction consolidation centre is applicable to an infrastructure project and how the procurement strategies can create motivation to obtain effective utilisation of a construction consolidation centre.

Table 11: Theses conducted or being conducted for BLC

6.3 Plans for future research

A collaboration between the City of Stockholm, the Development Administration, and KTH and the Centre for Building Efficiency (CBE) regarding the comprehensive theme "Purchasing and procurement". The field aims to study purchasing and procurement involving construction logistics services. The purpose is to identify any existing correlations and how the market functions for different types of procurement methods and compensation models, and which strengthen various behaviours.

7. Activity schedule

Below are parts of the activities carried out during the period 2010 to 2016:

2010

- Decision in the City Council regarding the environmental programme in Stockholm Royal Seaport and implementation of a logistics centre.

2011

- Preliminary logistics study, spring 2011
- Localisation study and continued investigation, September to December 2011

2012

- Design of the facility – space for terminal, infrastructure and site office, Q1-2 2012
- Volume estimates – calculating and zoning of the facility with regard to warehouse space and expected terminalisation, Q2-3 2012
- Tender documentation, Operator – specification is drafted, Q1 2012
- Tender documentation, Facility – drawings and technical specification, Q2 2012
- Stipulation of business model and contract model, May 2012
- Procurement phase 1 – qualification competitive dialogue procedure (KPD), Q1-2 2012
- Dialogue meetings for KPD, Q2 2012 Three operators to be chosen
- Facility procurement, open procurement, Q2 2012
- Evaluation and stipulation of qualification of operators for phase 2, Q2 2012
- Procurement phase 2, stipulation of tender documentation, procurement and contract, Q3 2012
- Contract with NCC for building the facility in September 2012
- Report and decision in the City Council regarding BLC 24 August 2012
- Implementation starts October 2012. Start-up meeting with the operator 23 October.
- Construction of the facility starts October 2012.
- Information meetings for Västra district with property developers and contractors begin in November and December 2012
- Stipulation of contract model
- Winter road maintenance starting 1 November 2012
- Sign agreement including current price list for BLC starting 1 December 2012
- Waste management starts 15 December 2012 for Västra

2013

- Implementation continues. Several meetings and function team meetings during Q1-3 2013
- Facility completed March 2013
- Traffic pilot onsite as of 1 February 2013
- Site office in operation as of March 2013
- Short-term storage in operation BLC 2 April 2013
- Training program as of March 2013
- BLC information material as of 1 December 2012
- Website version 1.0 www.ndslogistik.se as of 1 January 2013
- Opening of the facility and BLC 15 May 2013
- Gate system in operation April – the first five gates
- Development project regarding the gate system

- Development and start-up of contractor shed kit including a radio link system and contractor shed information
- First Steering Committee/Reference Team meeting with the property developers
- New site manager

2014

- Start of joint surveillance of the area
- Purchase of ten new drive-through gates (folding gates)
- Purchase of 12 new entrance gates (rotary gates)
- Upgrade of all gates via a phone call
- Replace ID06 system from Phoniro to Paxton system
- Review of redundancy computer network and UPS
- Adaptation of training programme
- New site manager
- New site manager replaced with acting site manager
- New development phase coordinator
- Development project for website and contractor shed information

2015

- Conversion of site office into large training facility
- New outdoor warehouse for weather-protected outdoor storage, 300 m^2
- R&D application (Vinnova) for effective construction logistics related to systems, contracts/procurement, construction management, environment and work environment
- Four new entrance gates, version 4.0 (final version)
- Research project regarding ID cameras Grant from the Environment and Health Administration
- Update of all information material
- Upgrade of website with an English version
- Upgrade of website for a mobile version
- Review of training programme
- Report on types of procurement methods within Stockholm Royal Seaport with a BLC
- Theses (total of three) concerning procurement and BLC
- New development phase coordinator
- Conduct first CSI survey

2016

- Upgrade website to accommodate registration for training, forms and text messages
- Purchasing of lighting columns for work area
- New site manager
- Conduct second CSI survey
- Changes in transport booking system
- New development phase coordinator
- Update information material and translations

8. Experiences and progress

8.1 Plans for future research

A collaboration between the City of Stockholm, the Development Administration, and KTH and the Centre for Building Efficiency (CBE) regarding the comprehensive theme "Purchasing and procurement". The field aims to study purchasing and procurement involving construction logistics services. The purpose is to identify existing correlations between the stakeholders, the processes and needs, how the market functions for different types of procurement methods and compensation models, and which foster various behaviours.

8.2 Business and contract model

The business model and contract model were adopted in 2012 and remain the same. The customer agreement drafted in 2012 has been developed. It has been difficult to find a balance between which costs the property developer and the contractor respectively are to carry. Initially, when Västra, a non-obligatory area for BLC, was to join, the joining fee was reduced to just over half – SEK 29 per light GFA which, in hindsight, was correct. BLC had many teething problems during the first 18 months.

An important experience is that the contract model itself worked well, from comprehensive requirements in the development contract to specific requirements in the customer contract that all sign with BLC.

It has been difficult for property developers to manage the business model of charging a gate fee in the procurement process. Property developers and contractors have found it difficult to calculate the amount of transports to the worksite and from BLC to the worksite. They also found it difficult to calculate which costs burden the project based on the current price list for logistics services. As a result, a series of seminars was launched, initiated by the City of Stockholm. The seminars are described below under "Property developer and contractor".

The amount appropriated for logistics services based on simulated volumes for 200 apartments compared with the actual costs from the first finished projects deviates substantially. The SEK 365 per m^2 light GFA that a median value indicates is currently SEK 170 per m^2 light GFA. The project in the first area had a reduced joining fee, putting the median at SEK 201 per m^2 light GFA with full joining fee.

Type of core service	Project 1	6,490	Project 2	6,292	Project 3	6,200	Project 4	10,283
Administrative services	SEK 35,804	SEK 6	SEK 24,658	SEK 4	SEK 23,548	SEK 4	SEK 20,623	SEK 2
Waste management	SEK 182,511	SEK 28	SEK 243,661	SEK 39	SEK 78,526	SEK 13	SEK 144,723	SEK 14
Development phase coordination	SEK 50,857	SEK 8	SEK 47,619	SEK 8	SEK 72,508	SEK 12	SEK 81,044	SEK 8
Gate passage	SEK 201,445	SEK 31	SEK 254,990	SEK 41	SEK 171,761	SEK 28	SEK 397,241	SEK 39
Warehouse/transports	SEK 215,320	SEK 33	SEK 307,294	SEK 49	SEK 375,738	SEK 61	SEK 157,232	SEK 15

Storage	SEK 74,796	SEK 12	SEK 127,345	SEK 20	SEK 232,050	SEK 37	SEK 245,877	SEK 24
Cleaning	SEK 16,809	SEK 3	SEK 14,201	SEK 2	SEK 12,588	SEK 2	SEK 9,261	SEK 1
Other core services	SEK 25,750	SEK 4	SEK 15,852	SEK 3	SEK 12,288	SEK 2	SEK 38,504	SEK 4
	SEK 803,292	SEK 124	**SEK 1,035,620**	SEK 165	**SEK 979,007**	SEK 158	**SEK 1,094,505**	SEK 106
Joining fee	188,195.5	29	182,468	29	179,800	29	298,192.5	29
Total	**SEK 991,488**	**153**	**1,218,088**	**194**	**1,158,807**	**187**	**1,392,698**	**135**

Table 12: List of costs for using BLC for the first project, Västra

	Estimate	Outcome Västra	Deviation
Joining fee	SEK 60	SEK 29	51.7%
Traffic pilot fee	SEK 126	SEK 35	72.4%
BLC	SEK 130	SEK 66	49.1%
Access	SEK 15	SEK 10	33.3%
Waste management	SEK 34	SEK 21	37.9%

Table 13: List of total costs for estimated values and after use of BLC for the first project, Västra.

The results show lower costs for BLC than expected. There are several reasons for this, which are commented below:

- The joining fee was reduced for the first area because it was new and untested – nor was it obligatory.
- The pilot fee was relatively low and partially due to tail-gating, meaning unauthorised passages without registering transport. While this is still common, the situation has improved. An estimate would put tail-gating at 40-50%. The fact that it was difficult to issue gate codes via text messages and problems encountered the first year in terms of opening with time slot codes affected the number of inbound passages.
- BLC costs refer to all fixed-route vehicles, warehouse and deliveries/exits, which was affected by the above-mentioned tail-gating, but also because the system was new and untested so most transports were driven directly, including those with material under 6 m^3 or EUR 6.
- Accessibility refers to development phase coordination, clearing snow and sand, security projects, etc. Relatively small deviation.
- Waste management based on 20 kg per m^2 light GFA. This cost should be higher given that no one achieved the target of 20 kg.

8.21 Ambiguous customer agreements

It was unclear what the customer, meaning the contractor and its subcontractors – and even the property developer – was actually signing. The requirements in the development agreement presented as the basis for BLC do not stipulate the terms in detail. Consequently, a number of documents and the “Q&A about BLC” were added to training and information

sessions. One example is an appendix to the joining fee agreement, which describes what is to be included in the property developer's tender documentation.

Consequently, the 2015 customer agreement was updated with Appendix 1, which explains what specifically is expected of the customers in terms of various activities. As a result of this improvement, it is clearer what applies when reviewing the contract

8.22 Development of business and contract models

The business and contract models are based on giving incentive to all involved to drive issues in their organisation. The models make it possible for both property developers and contractors to streamline worksite logistics. For property developers, their biggest challenge is tendering contractors so that they realise outcome targets. Issues that have arisen include:
- How to reduce the risk of mark-ups when tendering contractors.
- Structure of procurement method and compensation model.
- Should the property developer assume the entire cost of BLC and, if so, does this reduce the contractors' incentive?

The model itself is flexible and adjustable in instances where the individual property developer is at liberty to decide how to divide the costs. A prerequisite for managing finances, legal issues and regulations regarding BLC is that all become BLC customers.

Several conclusions can be drawn following the series of seminars held in spring 2016 on the topic "Agreements and procurement with a BLC":

1) Procurement methods and compensation models are paramount to how the BLC is used and which outcome targets are realised.
2) The contract type – construction or design-build contract – is less important in terms of how BLC is used.
3) In-depth collaboration contract as a procurement method has a greater impact on the use of more effective logistics solutions
4) Cost-plus contract with a fixed and variable share and an incentive is very important in how the property developer and contractors can streamline their production based on logistics solutions.

In brief, the property developer must be more involved in production issues to realise the outcome targets that BLC can generate. An involved property developer should create the conditions for its contractor to develop solutions to streamline the use of resources its production. This means that logistics matters cannot be addressed later in the process since they are linked to purchasing and procurement. For a project, this means that a logistics plan, which includes procurement method etc., must start during the programme phase to be developed ahead of the system documentation. At the beginning of system documentation phase, it is decided whether a contractor is to be involved and in what capacity. The logistics plan is the common denominator that demonstrates how the procurement is to be carried out with the conditions, risks and opportunities that exist in the project.

The City's estimate during autumn 2012 was that the cost for the BLC was SEK 365 per m^2 light GFA, excluding surveillance. The cost is currently around SEK 200, which is 45% lower than expected. This means that logistics services are not being fully utilised. The subsets storage and transports reveal that the costs are more than 50% lower than the expected cost simulation. In actuality, this means that there was a low ambition to use the BLC services for the Västra zoning area. The low cost need not be synonymous with low production cost for the project in question. On the contrary, a higher cost and proper utilisation of BLC should mean benefits in production

8.23 Statistics training, transport and storage

Below are examples of statistics from the BLC operations:

The diagram shows a number of training programmes divided into Basic, Normal and Expert, as well as specific security training.

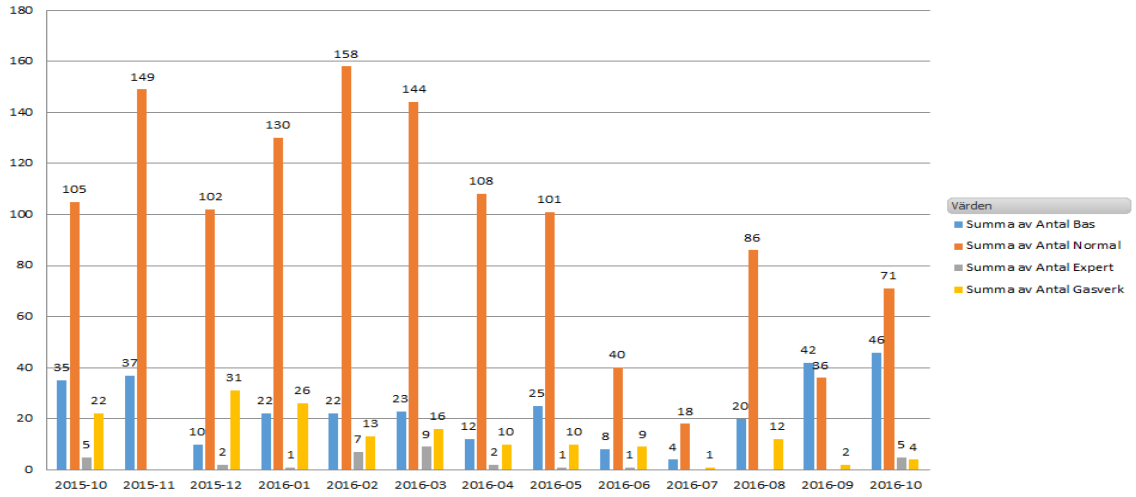

Diagram 2: Number of training sessions completed during the October 2015 to October 2016 period.

It is important to show the groupage traffic outcome. Here we see transports coming in and leaving BLC. Groupage traffic means that reductions may amount to between 40% and 60% for small-size transports to the construction area.

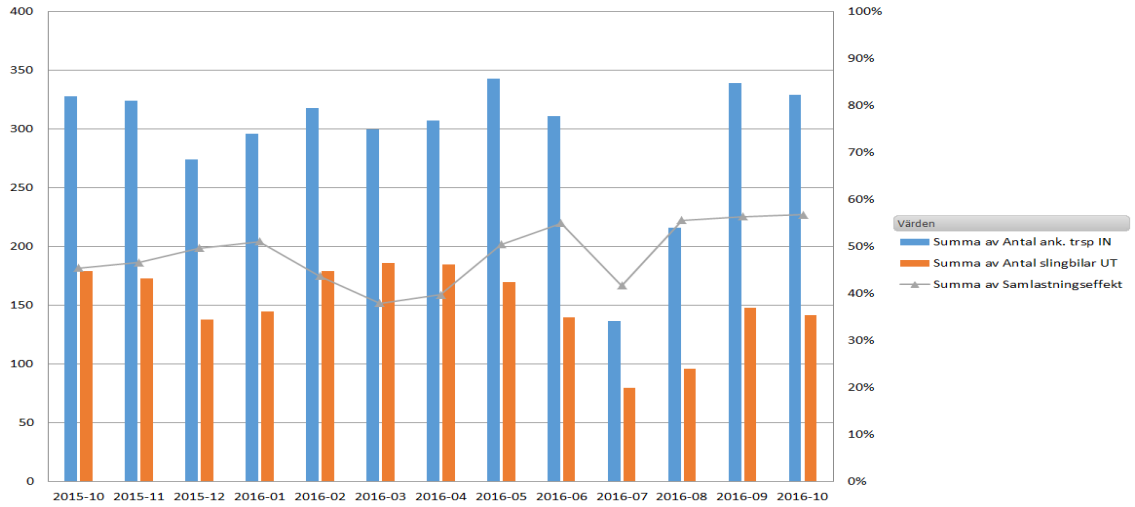

Diagram 3: Shows the number of vehicles coming in and leaving BLC.

The following diagram shows the number of outbound parcels per month and the average time materials are in the warehouse.

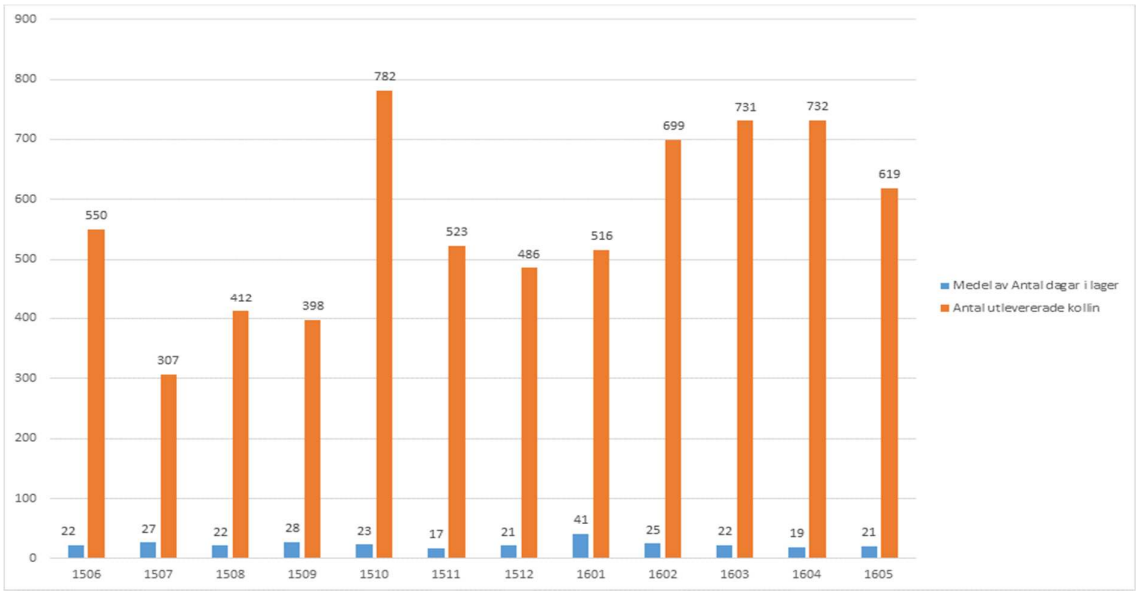

Diagram 4: Shows the storage times and volumes delivered from BLC

BLC strives to reduce the total number of transports to the worksite over time by 20-30%. During the structure phase, 80% of the transports will go directly to the worksite. During the structure completion phase and fittings phase, several transports will go via BLC for groupage traffic.

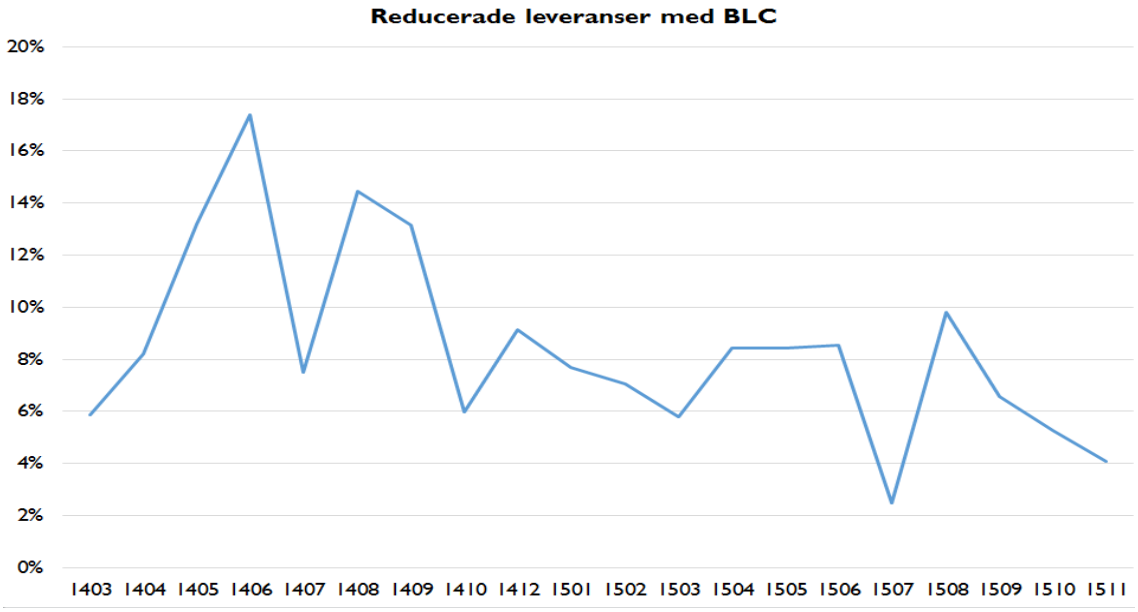

Diagram 5: Shows the reduction in the number of transports to the worksite through BLC

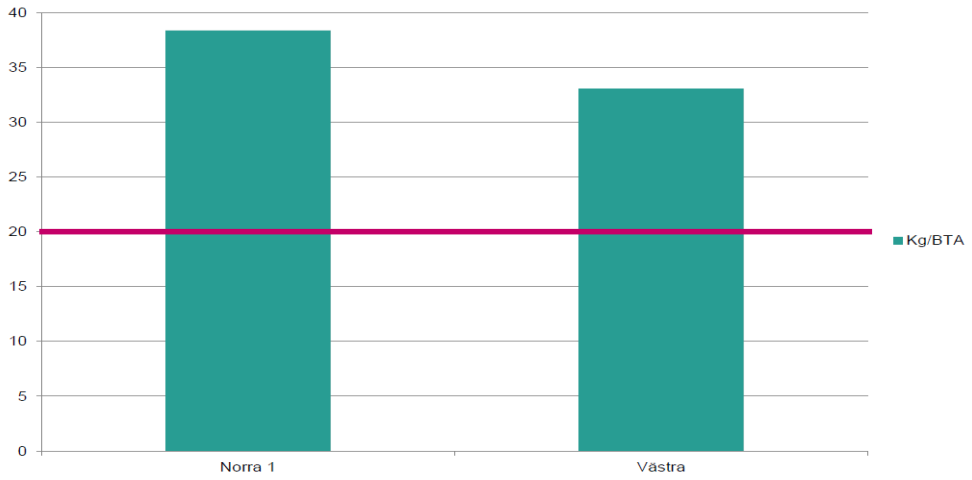

Diagram 6: Shows the volume of construction waste in kg per m^2 for district Norra 1 (no BLC) and Västra (BLC)

The distribution of costs for purchased and utilised services as well as gate passages is presented below. This is an example of how statistics can be used to see the difference in behaviour among different contractors.

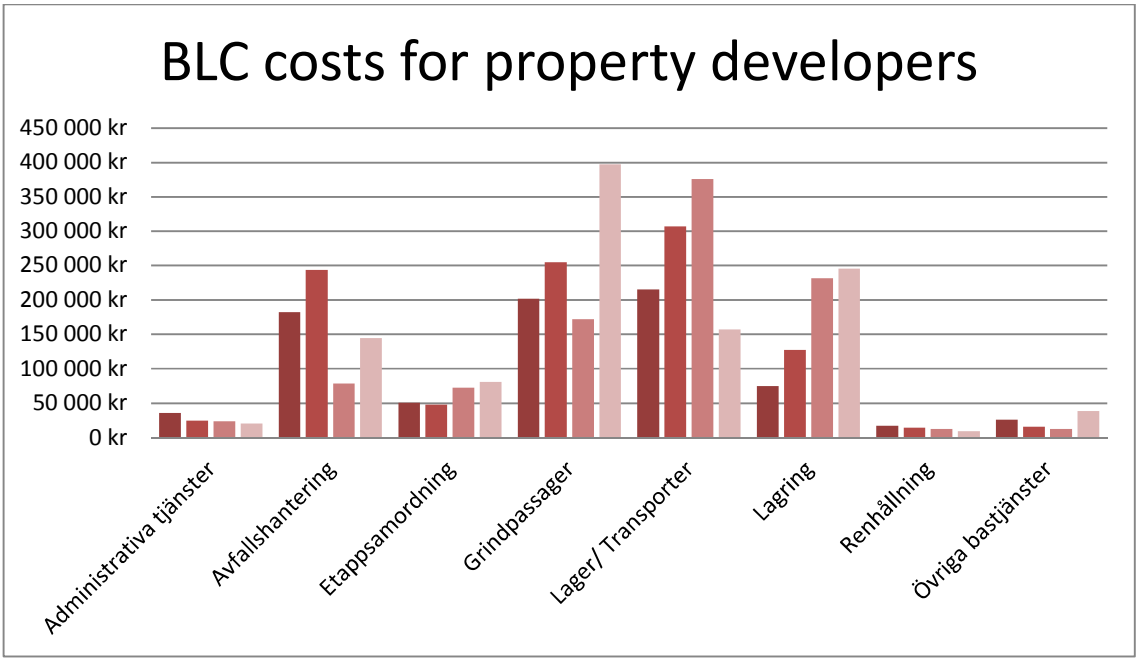

Diagram 7: Shows costs for purchased services and gate passages for some of the projects within zoning Västra. The different colours reflect different property developers.

8.3 Collaboration property developer and contractor

8.31 Residential property developer and its contractors

Over the past three years, many of the property developers' and contractors' experiences have been passed on to BLC through workshops, experience feedback and customer satisfaction index (CSI). During the first two years, 2013-2014, there was a lot of opposition to using BLC in the manner described in the contracts and supporting documentation. BLC was perceived as expensive and difficult to work with. The property developers felt that bids from contractors were more expensive since the contractors felt there was a great risk that they could not steer their transports into the worksite. The property developers had trouble communicating what could be expected and how to work with BLC.

It has evidently been difficult to communicate the message and new prerequisites down the food chain to the subcontractors. The main contractors who sign contracts with the property developers have received information about what applies, albeit somewhat sparse. This has, in turn, affected activities at BLC and the perception of how BLC functions.

When the conditions for the contractors are presented late in the process – as has been the case for most – it is difficult for the contractor to plan for BLC in a way that makes it possible to realise efficiency gains through timed transports, short-term storage and just-in-time distribution of material, no material storage at the worksite, etc.

Several theses were completed in 2016 about BLC in the area of contract and procurement issues. These will probably show how different property developers and contractors have handled BLC and which effects can be realised by changes.

A series of seminars was initiated in 2015 involving two workshops and one final seminar on contracts and procurement with BLC as the basis for the experiences encountered since BLC started. The aim was to identify which procurement methods and compensation models were best and which motivators and incentives existed in terms of working with a BLC.

The following summary was written based on the report.

“Traditional competition-oriented procurement strategies based on absolute construction or design-build contracts tendered with focus on the lowest fixed price are best for simpler projects where the degree of uncertainty and complexity is rather low. The contractors can estimate the final price with sufficient accuracy, which means that the difference between the lowest fixed price at the time of evaluating bids and the actual final cost of the finished product can be sufficiently minor. Low complexity and uncertainty also reduces the need for interaction between the orderer and the contractor. Each party can focus on optimising their own activities and processes.

This type of procurement strategy does not work for more challenging projects in which complexity, uncertainty, customisation and the degree of technical innovation is great. In Stockholm Royal Seaport, the City of Stockholm’s requirements for the environment, design, etc. are uncommonly high. Combined with the high land prices and limited space, the result is that residential development projects here become uncommonly challenging, particularly from a logistics perspective. For projects with more demanding prerequisites, traditional competition-oriented procurement strategies are not effective. Orderers should instead formulate more collaboration-oriented procurement strategies based on:

1) early involvement of the contractors in joint project planning,

2) flexible compensation models based on cost-plus contracts, and

3) collaboration models that foster trust and an exchange of knowledge.

Demanding project conditions mean there is a great need for interaction between orderer and contractors, and that the stakeholders must be able to adapt and coordinate their activities in a flexible manner – both to each other and to changes in circumstances during the course of the project.

This report discusses how and why more collaboration-oriented procurement strategies should be formulated for more demanding project conditions. It is of strategic importance for the orderers to understand how their procurement strategies affect competition and collaboration, and how they should be tailored to different project conditions to create both opportunities and motivators for the project stakeholders to develop and streamline their activities in collaboration. This report can therefore be viewed as a guideline when orderers formulate their procurement strategies in constrained and demanding urban development projects, such as Stockholm Royal Seaport.”

8.32 Development of the property developer and contractor collaboration

The development process concerning collaboration between the City, property developers and contractors is continuous. The City has initiated several activities to strengthen this

through long-term planning – such as research and development – and more directly. The following must be developed:

1) Communication of BLC between the City, property developer and contractors
2) Collaboration between company management teams in the orderer's organisation and the construction company
3) Procurement methods to realise the desired outcome of BLC
4) Statistics and compilations for continuous development
5) Training for property developer and contractors
6) Prepare comprehensive and project-specific logistics plans

8.33 The logistics plan – a key tool for property developers and contractors

In spring 2016, the City designed a logistics plan template that was introduced with the property developers in the Brofästet expansion phase for 550 apartments. The logistics plan aims to be a communication tool for the property developer when tendering a contractor and for the contractor when tendering subcontractors. The orderer uses the logistics plan as tender documentation and it is part of the contract. Together with the orderer, the contractor is to develop the logistics plan to deal with the project's prerequisites. It addresses both the logistics process, routines and practical solutions, and improving communication between contractors and subcontractors.

Level of information in the logistics plan	Concept phase/programme	System documentation	Purchasing / procurement	Construction documentation	Implementation
Level 4					Developed logistics plan and information for procurement of subcontractors and implementation. Follow up.
Level 3			Evaluation and contract conditions using the logistics plan. Material supply specifications.	Involve contractors and develop the plan together. Purchasing and event description. Targets, requirements and incentives for effective logistics.	
Level 2		Contract type and compensation model. Analysis of systems versus production.			

Level 1	Draft the plan including targets and overall prerequisites.

Figure 19: Description of how to use the logistics plan in various project phases

The potential for a successful project is far greater when using a logistics plan as contract documentation for the property developer, and even for the main contractor who is managing logistics at the worksite. Describing the prerequisites and managing these in the planning, procurement and production phase makes it easier for all involved to understand and strive toward targets to be realised in specific projects.

8.34 The City as property developer and its contractors

The City has tendered contractors that provide logistics services. The difficulty lies in persuading the contractors to use these services since they see no need to book time slot codes for inbound and outbound transport of, for example, excavated material. Transport needs are steered directly by the activity in progress, such as when excavating rock or earth. Normally, there is ample space precluding the incentive to book a “loading site”. If this were the case, a booking system is very good in cases of inner-city projects such as demolition, foundation work, and more.

Compensation for traffic pilot fees have been regulated in the Quantity Specification and through incentives in which a bonus is generated when transports are below a certain amount. If the stipulated amount is exceeded, the contractor personally covers the costs for these transports and is unable to invoice according to the Quantity Specification. The City has not utilised BLC to the same extent as contractors do for residential building. The contractors for the development project have material that can be stored outdoors, such as rock. This was stored within the area and was administered by BLC. Requirements made in the City’s tender documentation stipulate that material such as rock may not be stored at the worksite in quantities that exceed more than a couple days of production. There are situations when material such as rock must be stored at the worksite over a certain period, for example, when laying stone such as paving or other form of covering stone.

Surveillance was replaced by the construction contractor as a fixed cost estimated on the contract costs, which today is 0.15% or a minimum of SEK 30,000. This should be higher with the feedback value of 0.25% and a minimum of SEK 60,000.

8.4 Operator

Experiences in tendering an operator for logistics services as well as running operations and supplying service have accumulated over three years of operation and development. The operator’s role, to foster understanding and establish a culture and organisation, is focal in completing a development project such as BLC. Today, the operator comprises two companies with different backgrounds – one from a high-tech industry and the other a haulage firm that serves the construction industry – which is a good combination. Both

companies have experience from logistics services, but from different perspectives. Servistik is a 3PL company that primarily serves the high-tech industry. They have experience from the industrial logistics chain involving time schedules, warehousing and deliveries, while Wiklunds Åkeri has experience in transport logistics serving the construction industry with focus on material deliveries and waste management.

Getting these different company cultures to create a joint platform in the project has been troublesome. There were many challenges related to both contracts and organisations. One example was how the implementation, meaning the start-up process, was to be replaced and to what extent this activity was in the bid. Other challenges pertained to development issues, since the project is a development project and must be managed as such. The City has requested proactive solutions with short lead times, a request that has not always been accommodated.

One of many problems was the high turnover rate of employees at BLC. This applied particularly to the site manager role, but also other functions such as the development phase coordinator and traffic pilot, which had a negative impact on BLC since the site manager role is an important part of day-to-day operations.

8.5 Finances – 2012 to Q2 2016

Total costs from 2012 up until 2016 amount to SEK 70 bn. The costs are divided as shown in the table below:

	Expense	Percent
Facility	SEK 25,539,871	36.1%
Surveillance and safety	SEK 8,684,259	12.3%
Zoning specific	SEK 67,300	0.1%
Operations BLC Facility	SEK 2,760,000	3.9%
Operations BLC Orderer	SEK 2,900,000	4.1%
Development phase coordination	SEK 5,444,900	7.7%
R&D	SEK 3,138,000	4.4%
Gates, operations	SEK 2,642,011	3.7%
Gates, purchasing	SEK 8,703,741	12.3%
Gates, miscellaneous	SEK 36,800	0.1%
Implementation	SEK 7,419,225	10.5%
Communication	SEK 1,524,710	2.2%
Communication BPI	SEK 753,300	1.1%

Communication website	SEK 771,829	1.1%
Study	SEK 400,000	0.6%
	SEK 70,785,946	100%

Table 14: List of costs outcome for BLC

The cost is initially high for the facility, including equipment such as gates and implementation. Annual operating costs are around SEK 10 bn to SEK 12 bn.

9. Construction consolidation centre as a concept

Logistics issues within the City of Stockholm have been relevant in many ways for several years. It is one key to successfully driving projects in large individual infrastructure projects. The City has tested groupage traffic centres for goods deliveries to the City in the form of a logistics centre in Hammarby Sjöstad. All around Sweden, this is relevant in large projects such as the construction of hospitals and large-scale industries. However, testing the concept in an urban development area involving many stakeholders had not been done before BLC in Stockholm Royal Seaport was implemented.

What are the benefits of building a local construction consolidation centre? This will be revealed in the research about BLC that will be done, and that has been done. The facility, including equipment, is costly for the project. What then is the biggest advantage? In my opinion, and that of many others, a structured process with material supply to the workplace creates:

1) A safe workplace
2) A clean workplace
3) A resource-efficient workplace

The requirement at Stockholm Royal Seaport that everyone must join BLC and that joining is not voluntary, enhances the benefit of BLC. Economies of scale when everyone follows the same procedure are enormous. A common regulatory framework creates clarity in how a worksite should be organised for public land, and the City gains an organisation that truly addresses transport and security issues.

Much remains to be done, but this update report reveals a process that can be developed. What BLC 3.0 will look like remains to be seen. This is a starting point for developing construction logistics in the worksite and material supply to and from the worksite.