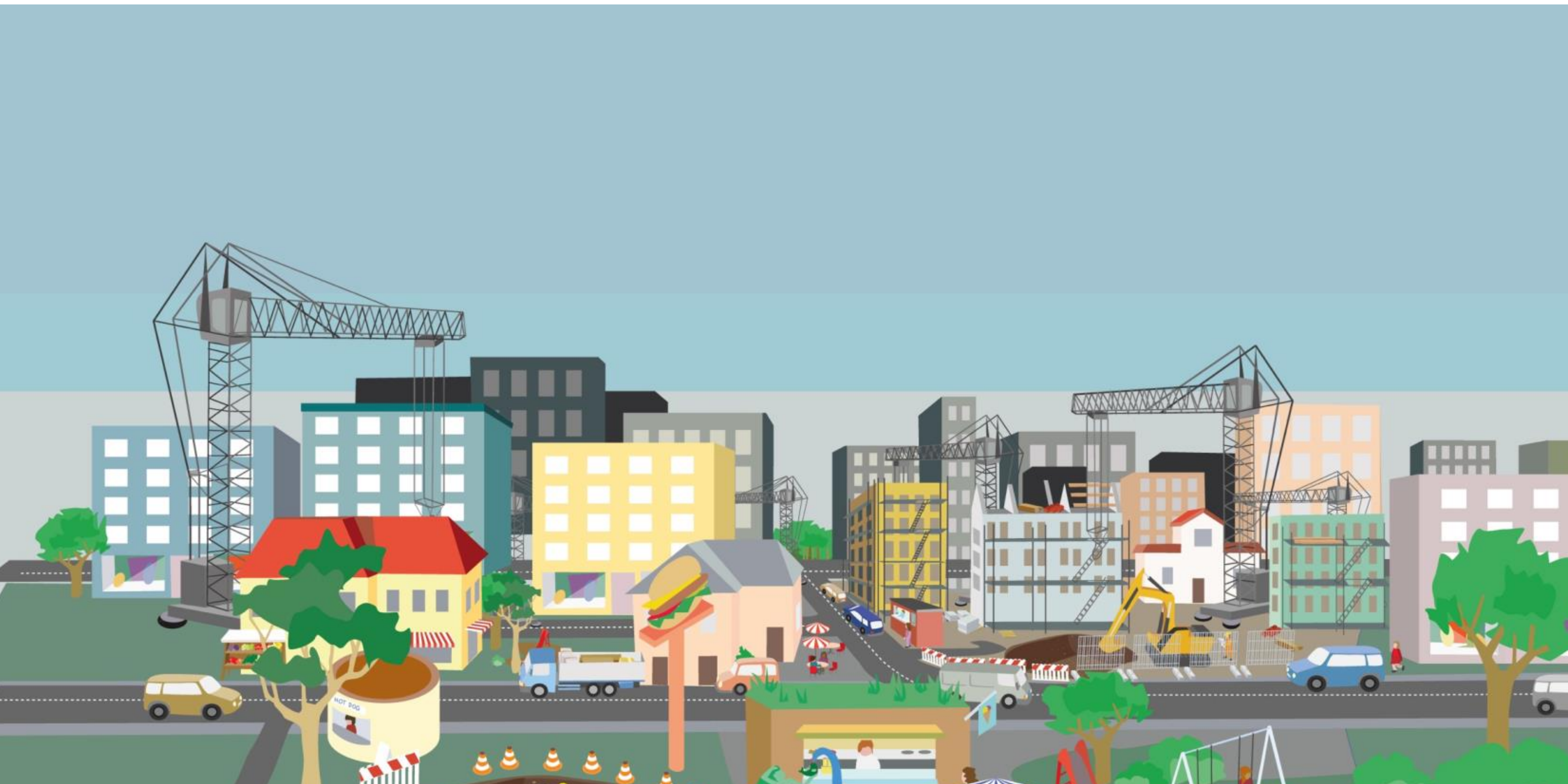
WP1: Construction logistics scenarios and stakeholder involvement

Deliverable 1.1: Scenarios of construction logistics

October 2020



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MIMIC Deliverable 1.1

Scenarios of construction logistics

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Executive summary

Construction logistics scenarios is an illusive term, that need to be defined to be useful. This deliverable defines construction logistics scenarios as part of both the construction process planning and the construction logistics planning. It is defined on three hierarchical levels; strategic, tactical and operational and these three levels are related to the project phases of the construction project.

- On the strategic level, in the strategic planning phases of the project, we need to identify the scope and goals of logistics in a construction project. The scope is related to geographical boundaries and the goal to the stakeholders involved.
- On the tactical level, in the planning phase of the project, we identify several scenarios of construction logistics. These scenarios are to include contextual and logistics considerations.
- On the operational level, in the implementation phase of the project, we identify and implement a specific construction logistics setup.

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1. Introduction

The purpose of MIMIC is to demonstrate how SMART Governance concepts can be used as an aid in the construction and city planning processes to facilitate and support logistics to, from and on urban construction sites to improve mobility and reduce congestion within cities and thereby reduce the negative impact of construction sites on the surrounding community. The MIMIC project integrates construction logistics, construction management, city logistics, sustainability, and optimization of flows research, with the goal of developing the SMART Governance Concept 2.0. This concept provides the implementation partners (Cities and companies in the construction process and supply chain) with a structure of tools organized into a supportive platform for construction logistics issues in the urban development decision and procurement processes (D4.2 and D4.3).

Today there is a lack of planning and coordination among private and public actors in construction projects and logistics is seen as a operational issue, to be handled as the actual construction production commence. This gives rise to problems that the SMART Governance concept would like to contribute to solving. The problems have been highlighted by several researchers and are summarized according to the CIVIC project (2018) as follows:

1) An inefficient supply chain. Incoming transports are not coordinated due to a lack of data and supply chain planning, and an unnecessary high number of transport movements are sent to the site. Furthermore, contractors experience low delivery performance and thereby lack materials and resources when needed, which hinders the progress of the project and generates express transports, thus further increasing the number of transports close to the construction site.
2) Inefficient logistics on site. Lack of control at the construction site and inferior planning will lead to materials losses and extra costs, as well as hazards for workers at site. Furthermore, even more transports will be generated to replace the lost materials, as will trucks with low fill rates due to small shipments.
3) Lack of coordination between construction project and society, by which we mean all parties related to the construction project (see image). The surrounding society impacts the construction site in the form of the residents and shop owners close to the construction site and share, for example, streets and parking with the construction activities. The stakeholders will also affect the construction site through shared utilities such as water, electricity and heating. The emergency services also have demands regarding the construction site as they require access to the site and the surrounding activities. When this is not adequately coordinated, there will be clashes that affect the productivity at site and citizens due to congestion, lack of space, safety issues and delays. For example, the lack of planning regarding how personnel are to travel to the site creates competition regarding parking spaces and generates unnecessary traffic that could have been avoided by coordinating public transport.

These problems causes negative effects such as congestion around construction sites since vehicles are often unable to be unloaded and loaded immediately upon arrival. Instead, they should wait for further instructions before being directed to the right location on site. One way to handle above problems in construction projects today are so called construction logistics setups (CLS). A CLS offers new or improved ways of how the logistics is organized for one or several construction projects meaning that all actors in the project have to be part and coordinate their flows to, on and from site (Janné and Fredriksson, 2019). Developing a CLS it is important to be able to create logistics scenarios to evaluate the impact of different logistics services on the logistics performance in a project. Thus, an important part of the SMART Governance Concept is scenario evaluation.

The goal with the Smart Governance Concept is to enable an early planning of construction logistics in the construction project so that a construction logistics setup can be selected that improves the logistics performance of the project. Construction work has some distinctive characteristics that influence the logistics (Janné and Fredriksson, 2019) and thereby the Smart Governance Concept.

1. Each construction site requires a new logistics setup since the location is unique and temporary.
2. Construction sites are material intensive and are supplied on an irregular basis depending on the construction phase (first concrete, last furniture).
3. Activities should be performed in sequence and if one activity is delayed, all the following activities will also be delayed. Therefore, construction materials should be delivered to the contractors at a construction site at the right time and in precisely coordinated numbers.

The Smart Governance Concept help to increase the knowledge of construction logistics (D1.3), collecting stakeholder needs and criteria of construction logistics scenarios (D1.1, D1.2 and D1.4), and to evaluate the impact of construction logistics scenarios different stakeholders (D2.2, D2.3, D3.1, D3.2 and D3.3).The problem that this deliverable (D1.1) is responding to is the lack of a common definition of what is a logistics scenario. Therefore, the goal of this deliverable is to define what logistics scenarios are and how these can be included in the Smart Governance Concept 2.0 (D 4.3).

The deliverable is organized as follows. First a general overview is given on what is a scenario and how is this related to different planning levels. Next, different types of scenarios (goal/scope, scenario and setup) are elaborated up on. Last, conclusions are drawn presenting the definition and hierarchies of scenario to be used in the SMART Governance Concept 2.0.

2. Construction logistics planning

A scenario is a description of actions or possible events in the future. In the Smart Governance Concept, logistics scenarios provide alternatives to be evaluated in decision making processes. Thus, scenarios are used for planning purposes.

Construction logistics is about the interface between two processes. The construction process and the supply chain process (Thunberg and Fredriksson, 2018), illustrated in Figure 1 below. In section 2.1 the planning of the supply process is described and in section 2.2. the planning of the construction process.

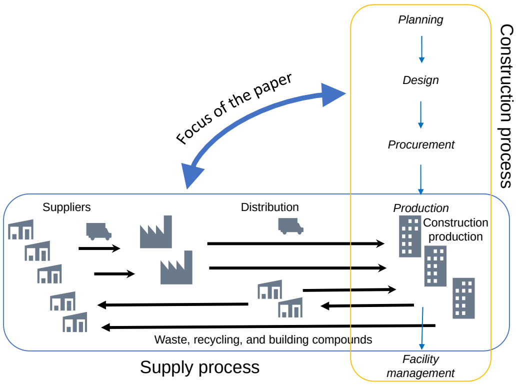

Figure 1: The interface between the construction process and supply process (Thunberg and Fredriksson, 2018)

2.1 Planning of the supply process

Planning in construction supply processes, i.e. construction logistics, can be perceived as hierarchical, with processes at different planning levels: strategic, tactical and operative (Thunberg and Fredriksson, 2018). These planning levels each have a different horizon, planning object and frequency (Jonsson and Mattsson, 2009). Strategic planning has a long-term horizon and sets the boundaries for the mid-term horizon tactical planning, which again sets the boundaries for the short-term horizon operative planning.

The planning object is defined as what is planned (Jonsson and Mattsson, 2009), and the frequency refers to how often the plan is updated (Jonsson and Mattsson, 2009). The time horizons affect the object, i.e. the more short term planning the more detailed the planning will be, and thereby the more detailed the object will be. Thus, planning at a strategic level means that we have planning objects at an abstract level, such as goals and scope of the construction logistics setup. At the tactical planning level we can focus on planning objects such as different possible logistics setups (CLSs), that can fulfill the goals set at the strategic level, hereafter called scenarios. Finally, when planning at the operational level a scenario from the tactical level has been selected to be implemented, hereafter called setup.

According to Fredriksson et al. (forthcoming), a CLS concerns how the logistics are specifically organized for one or several construction projects. It is a bundle of agreed upon services, specifically combined to manage and coordinate material and resource flows to, on and from one or several construction sites. Based on how it is structured and managed, the construction logistics setup will affect the performance levels of the construction site.

The relations between the planning levels and the goals, scenario and setup in construction logistics is summarized in Figure 2.

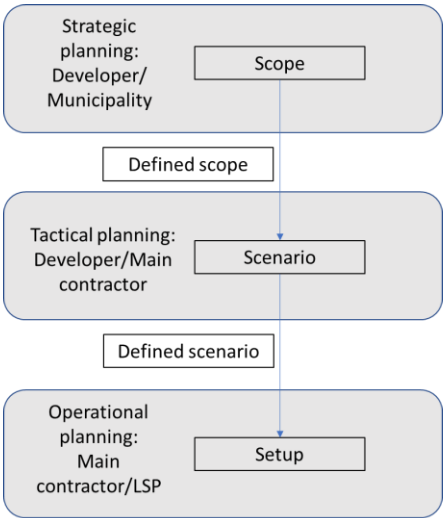

Figure 2: Relationship between scope, scenario and setup in the Smart Governance Concept

2.2 Planning in the construction process

The hierarchical planning levels of construction logistics can be linked to the planning phases of the construction process, as it is presented in Figure 3. This is an important issue in order to make this way of how to make construction logistics an issue not only seen as operational within the construction industry.

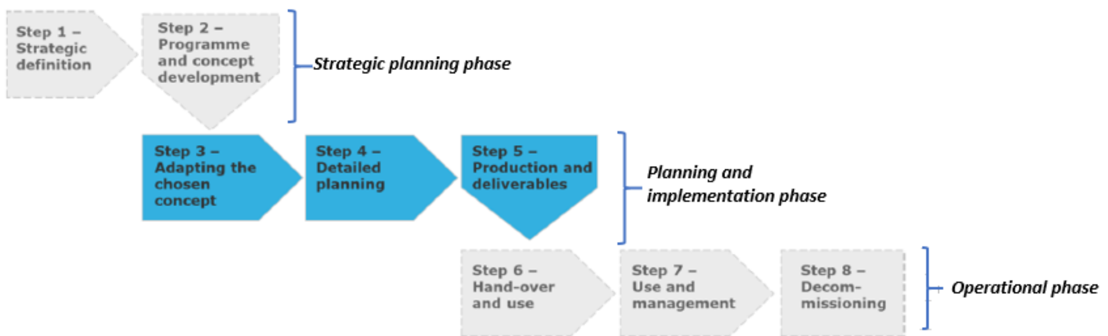

Figure 3: The hierarchical planning levels of construction logistics linked to the project phases of a construction project (adopted from DNV.GL, 2018)

The building process seen in an expanded life cycle perspective ranges from early phase planning (definition, program and concept development), design phase, production/ construction phase, to operation, management, and finally end-of-life/decommissioning (Eikeland, 1998; Moum, Hauge & Thomsen, 2017, see figure 4). All projects are unique and several different forms of procurement, and contracting strategies, forms of remuneration, and organizational models are practiced during the building process, both at national and international levels. Individual projects represent various combinations of possible sets of implementation models, and differ largely. The sub-processes in a construction project are not necessarily sequential as shown in figure 4, and may be described as circular, sequential with repetitive sub-phases, and in other ways. Still, the main phases a construction project undergo, are by and large the same in the different building process models.

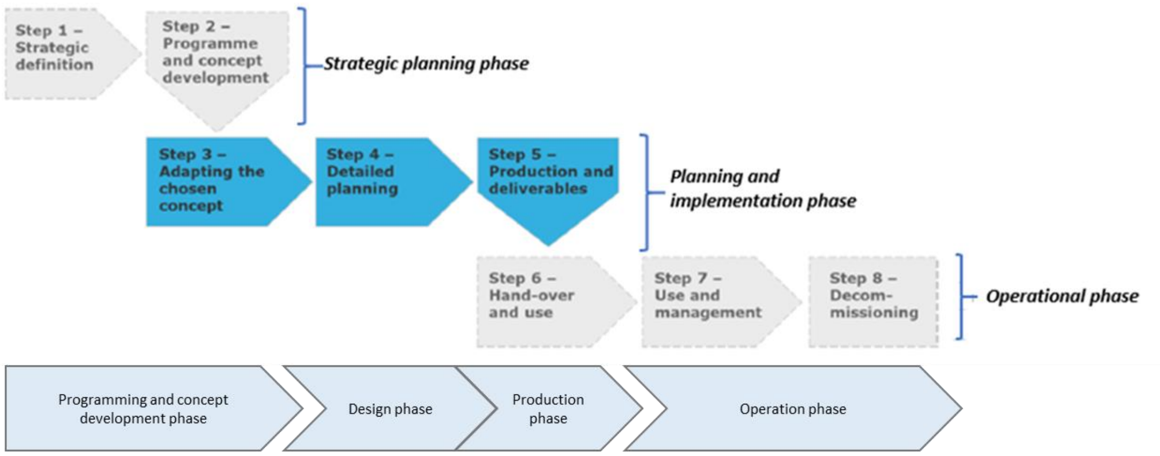

Figure 4 Linear demonstration of the building process imposed on the hierarchical planning levels of construction logistics in figure 2 (SINTEF/Flyen 2020, based on DNV.GL, 2018)

Many models for the building process have been developed, with more or less concurrent descriptions (Mejlænder-Larsen et al., 2016). The phases of a building process are independent of contractual contexts. Choices made in the programming and design phases are highly influential on environmental aspects, such as material choices and construction methods, the source of materials (transportation distances), and so forth. Also, conceptual choices and decisions in the early stages of construction projects are important factors in the construction logistics setup for a whole project. Thus, the hierarchical planning levels of construction logistics should be incorporated from the beginning of a new project.

3. A hierarchical view on construction logistics scenario

3.1 Goals and scope of a CLS

To achieve ambitions of efficient construction logistics involves, establishing all-embracing visions and guiding principles of construction logistics that relate to all types of stakeholders affected by the transports to, from and around the construction sites in the city/area.

According to Fredriksson et al. (forthcoming) each construction project can be divided into three zones with different scope, see Figure 5 below. These three zones are related to the geographical boundaries of Table 1. Zone 1 is the construction site itself and the traffic that takes place in the form of material being unloaded, loaded and moved at the workplace, in Table 1 called the building level. Zone 2 is the area in the vicinity of the construction site, i.e. a few hundred meters around the fence, which includes e.g. resident tenants or local businesses in the area, in Table 1 called the neighborhood level. Zone 3 covers rest of the city where transports need to pass in order to arrive at the construction site, which affects third parties, ie the residents of the municipality, in Table 1 called the city level.

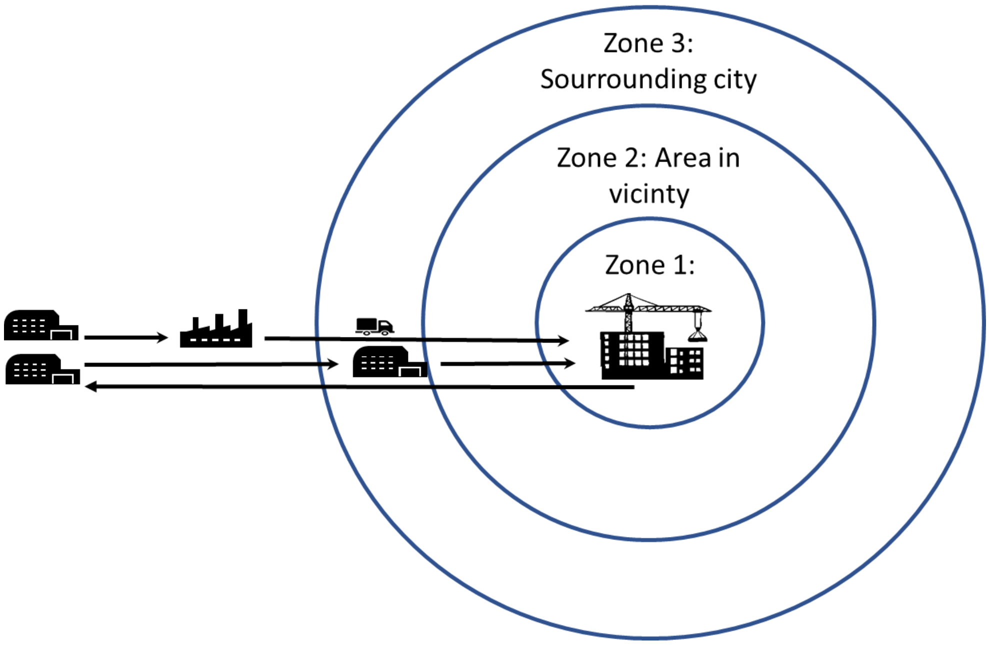

Figure 5: The three zones of construction logistics (Fredriksson et al., forthcoming)

By linking the hierarchical planning levels of construction logistics to the phases of the building process, as shown in figure 3, the construction logistics aspects and -solutions lift the discussion of the building process from one project and one building process at a time, to several simultaneously ongoing building processes. This latter is the common case in urban environments presently, where there is always several ongoing projects competing over the urban space. Thus, the challenges and opportunities linked to congruent and coinciding projects, such as local planning and construction logistics solutions is highlighted. Furthermore, it's worth noticing that all the construction sites in a given city have overlapping zones, see Figure 6. This is of high importance as construction transports must share the traffic infrastructure with other road users (Dablanc, 2007). However, the additional transports coming with construction create a conflict situation regarding city infrastructure (Behrends et al., 2008), which is more or less dimesioned for regular traffic excluding projects such as construction.

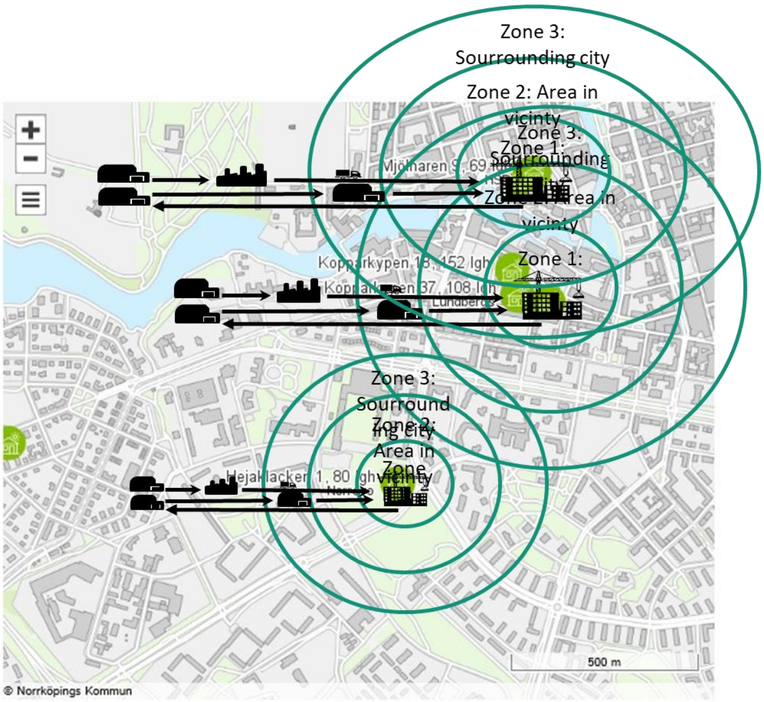

Figure 6: A city with multiple construction sites and their overlapping zones (source LIU)

It is also important to involve the relevant stakeholders from the construction industry in the different project phases/stages and geographical boundaries impacted (see table 1). Based on the zones, three main types of actors can also be identified: main contractor, developer and municipalities. This is important as different stakeholders can relate differently to the different planning objects; strategic (goals/scope), tactical (different scenarios of CLS/project contexts) and operational (the specific CLS implemented). Furthermore, this will also allow for a combination of the different processes view on planning. The construction logistics has a top-down view of planning where the ones involved in the processes are to be included, versus the construction industry who has a more bottom-up point of view on planning where it is involve several stakeholders to get buy-in and acceptance, rather than focus on efficiently planning the process.

Table 1: Matrix combining project phases, geographical boundaries and actors (source SINTEF)

Project phases	Geographical boundary	Stakeholders (R - Responsible; E - Executes; C - to be consulted; I - to be informed; D - Decides)								
		Architect/Landscape architect	Building owner (Public)	Building owner (Private)	Contractor	Consultants /subcontractor	Citizens/ neighbourhood	Manufacturers/ suppliers	Logistic service provider (LSP)	Construction merchants/Retail
Strategic long term planning	***Building level***									
	Neighbourhood level									
	City level									
Tactical, mid-term planning and implementation	***Building level***									
	Neighbourhood level									
	City level									
Operational phase	***Building level***									
	Neighbourhood level									
	City level									

The first zone, building level, is from a logistics planning point of view the main contractors responsibility as how the logistics at the site/building level is managed is impacting the efficiency and effectiveness of the construction production in the single project. The logistics planning in the second zone is, the neighborhood level is mainly the interest of the building owners/developers as these in most cases care how the construction logistics impact the vicinity of the site. These usually own several buildings close by and will be the ones that handle citizens/neighbor complaints as well as lack of logistics management in this zone will decrease the value of these buildings. Logistics planning in the third zone, i.e. the city level, is mainly the interest of the municipality as it, as earlier mentioned, affects third parties such as school children or other types of travelers. Based on the zones and the different actors caring for the zones, we can identify different scope regarding the scenarios. A scope is what geographical boundary the construction logistics should have impact on. Thus, we can have logistics scenarios covering different scopes.

The scope will also affect the goal with the CLS, such as productivity or effciency, sustainability, safety and inconvenience. Fredriksson et al. (forthcoming) have shown that the municipality mainly has a goal of decreasing the impact on third parties. This means that the municipalities when evaluating construction logistics wish to decrease environmental impact and increase traffic safety. Furthermore, the developers would like to decrease disturbances on third parties close to the site and at the same time have an efficient site. They thereby have the goal to control traffic close by, appear as they are doing something to decrease disturbances to tenants and to decrease the construction time. Finally, the main contractor would like to have a safe and efficient site, to a low cost.

3.2 Scenario

In the world of construction logistics a scenario needs to cover two things, contextual scenario and logistic scenario see Figure 7.

Contextual scenario address challenges and needs of the construction project in order to achieve the project goals and ambitions. One good example of a specific contextual scenario is the emission free construction site defined in the Norwegian construction industry (Bellona 2019, Fufa et el 2019, Venås et al 2020). The emission free scenario arises from a need of reducing emissions from construction sites, and is closely related to the defined scope and goals of the construction project itself. There might be specific contextual challenges related to the location of the site, construction method, weather conditions etc. In addition, solving the challenges of implementing electrical machinery at site will further lead to the need of specific logistic scenarios. These scenarios must handle the contextual needs and challenges of the project itself. For example, how to handle transport on-site and storage of materials. On the site it is a question of how to handle material and resources on the ground as well as the vertical level.

Logistic scenario, based on the contextual issues, covers how to organize the logistics, i.e. what logistics service elements are relevant to handle the logistics within the defined scope and to reach the goals or ambitions.

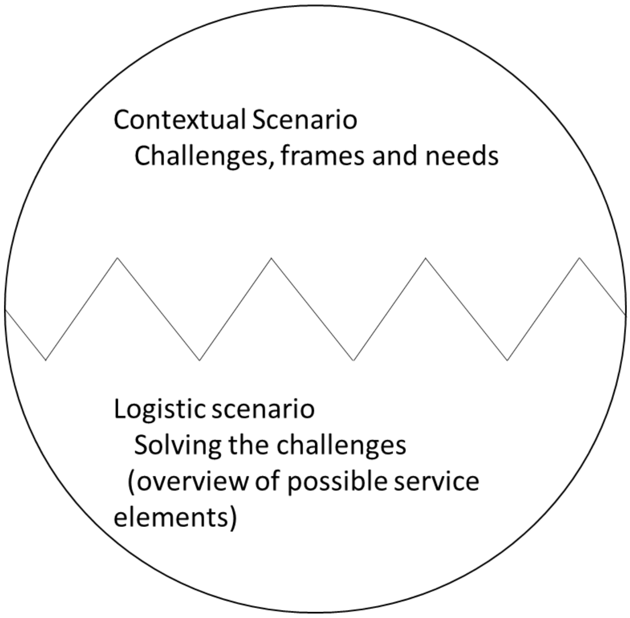

Figure 7: The relationship between contextual scenario and logistics scenario. The combination becomes a construction logistics scenario.

The construction logistics scenario aim to describe the possible service elements needed to solve the logistical challenges. These services have to be within the physical systems boundaries of the construction logistics system (see Figure 8). Construction logistics focus both on coordinating the fragmented sourcing of materials and resources to and from the construction site and on coordinating materials and resources at the site itself (Fredriksson et al., forthcoming). By this it covers the transport activities to and from site as well as activities on site. The activities to site mainly relate to transport of materials, resources and personnel. The activities from site refer to both waste management, return flows and a circular flow for reuse. The activities on site focus on both horizontal and vertical flows of materials and resource to enable efficient use and waste handling by the craftsmen but also reuse in a circular flow.

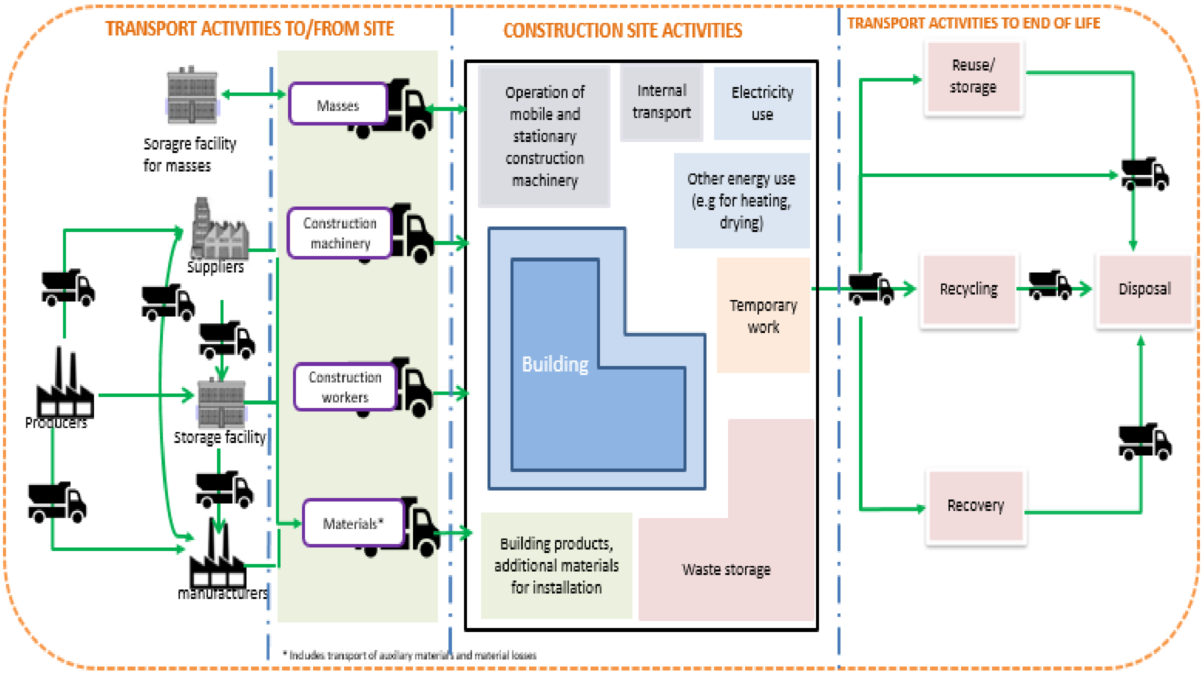

Figure 8 System boundaries for construction logistics physical activities (adopted from Wiik et al 2018 and Fufa et al 2019a)

3.3 Setup

A construction logistics setup is made up of different service elements. These service elements can either be implemented as stand alone services or they can be combined into modules. The most common modules are planning, inbound logistics, warehousing, on-site logistics and waste management.

See Table 2 for services identified by Fredriksson et al. (forthcoming). Fredriksson et al. (forthcoming) have identified that a minimum service to include is a booking system, i.e. the module planning.

Tangible	Intangible
Boundary fencing	
Surveillance and security cameras	Logistics organization and coordination
Site establishment	Standardized labelling
On-site materials handling (inventory, carrying and cleaning)	Education
Checkpoint with parking	Follow up and adherence to rules
Machine resources	
Waste management	
Traffic piloting	
Road maintenance	
Site layout plans	
Booking and planning systems	
Terminal with short-term storage, cross-docking, kitting, and transport from terminal to site	
VMI on site	
Smart container	

Table 2: Construction logistics service elements.

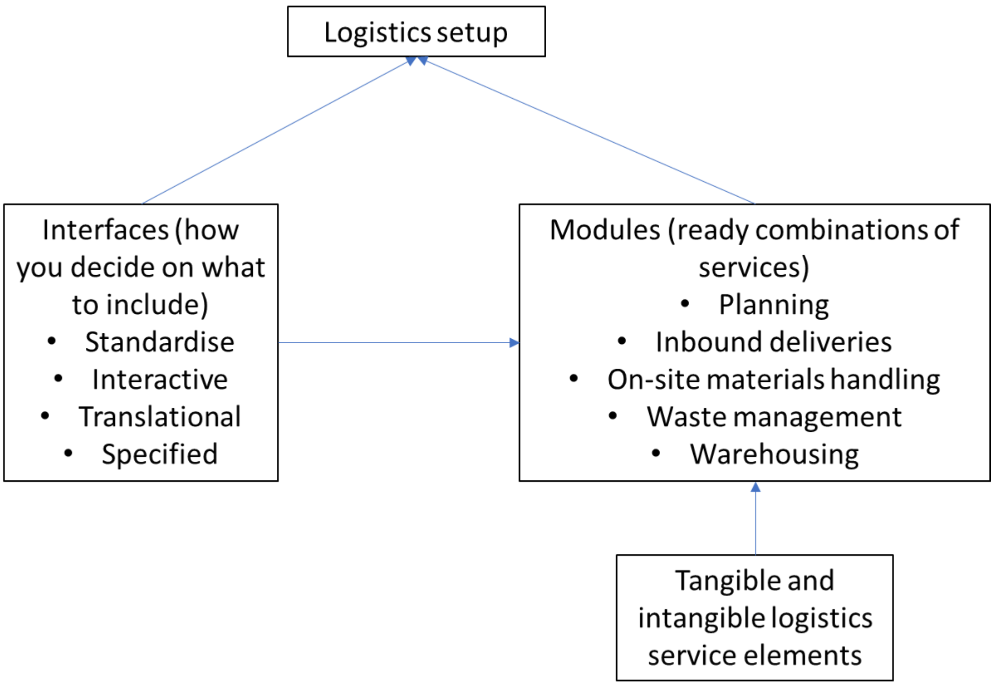

Figure 9: The parts of a logistics setup

Figure 9 also includes interfaces. Interfaces show the interaction between the actors, that is how the interorganisational connections are organised (Hulthén et al., forthcoming). This is based on a framework by Araujou et al. (1999) that identifies four types of relational (customer-supplier) interfaces based on how customers and suppliers relate their resources to each other.

- The *standardized interface* occurs when neither the supplier nor the customer needs to be aware of each other's contexts. In this situation what is exchanged, or provided, between the parties can be managed by a standardized interaction. This is when a logistics service provider offers a standard set of services to be implemented in the construction project.
- The *specified interface* appears when the customer wants a customized solution and therefore specifies in detail how the setup should be the designed and realized.
- The *translational interface* occurs when the customer instead specifies a functionality of the logistics services rather than the specific services itself. This means that the supplier has more freedom to decide what resources are appropriate to use and how they should be utilized as long as the setup fulfills the customer's needs and its own logic regarding resource use. In this interface the supplier needs to translate the functional demands from the customer into a setup that is in line with the expectations of the customer.
- The fourth type of interface is called *the interactive interface* and illustrates the case when the supplier and customer jointly, in interaction, develop the specifications of the setup together so that both the context of the supplier and the context of the customer could be taken into consideration when deciding on which resources to be used and how.

Janné et al. (2019) have studied the construction logistics setups in five hospital projects. These are here used to show examples of the spread of what a logistics setup can be but also to show the interplay between the contextual scenario and the logistics scenario in Table 2. The setups are further described in Appendix 1.

Table 3 below shows the interplay between the contextual scenario and the logistics scenario seen in five construction logistics setups used in hospital projects studied by Janné et al. (2019)

Solution design category	Case findings
Contextual considerations	
(1) Goal	Operations as usual (A, B, C, E, F), Third-party disturbances (A, C, E, F), Smooth logistics process (D), Not disturb service units within hospital (E)
(2) Organizational complexity	Multiple organizations affected/participating (A-F), High level of mandate (A, F), Low level of mandate (C, D), Hierarchical belonging (A, C, F), Organizing and coordination (A, B, F), Difficulty in implementing (C), Different initiators (A-F), Conflicting goals in tendering (E)
(3) Structural complexity	Centrality of site location (A-F), Combination of new-builds and renovations (A, B, C, D, F), On-going hospital operations (A-F), Adjacent construction projects (A, E)

Construction logistics elements	
(4) Infrastructure	Checkpoint (A, C, F), Terminal (B, D, E), Vehicle waiting area (A, C), Boundary fencing (A, C, D), Safety and security (A), Site establishment (A, E), On-site materials handling (B, C, D, E), Machinery (B), Waste management (B, C)
(5) Land use management	Dedicated/common unloading zones (A, C), Integrated logistics plans (A, B, F), Site-layout plans (A, B, C, F), Gradual site enlargement (E, F)
(6) Traffic management	Traffic control (E), Traffic routing (A, B, C, D, F), Milk-round deliveries (B), Eco-logistics
(7) Regulatory measures	Time access restrictions (A, B, C, F), Load access restrictions (B), JIT deliveries (D, E), Land use restrictions (A, C, E), Strict booking rules (C), Follow-up of adherence to rules (A, B, C, F)
(8) Technology shift	Mandatory planning systems (A, B, C, D, F), Standardised labelling (B)
(9) Stakeholder involvement	Relationship management within project (A, F) and to external stakeholders (F), Common goals (A), Education (B, C), Follow-up of logistics improvements (C), Coordination between project and logistics (D)
(10) Business models	Organization (A-F), Own budget (A), Logistics manager (D, F), Initiation (A, B, C, D, F), Resources (A-F), Activities (A, B, C, D, F), Pricing (A, C, D), and Value creation (B, C, D, E)

Table 3: Categorizing construction logistics solutions (Janné et al., 2019)

3.4 Scenario evaluation and setup assesment

In the Smart Governance concept an important part is scenario evaluation and setup assessment. It is separated between the two terms in this project. Scenario evaluation implies how the combination of a logistics scenario will perform in the project context. Thus, scenario evaluation is done during tactical planning (middle left part of the figure 10) with the purpose of selecting the setup that fulfills the goals identified on the strategic level in the best way (upper left part of the figure 10). However, setup assessment means how the actual implemented services performs in the project and to be done at the operational level. Though, important to remember here is that the setup assessment framework provides the scenario evaluation tools with data. The assessment framework, used as scenario evaluation tools, are developed in WP2 External cost calculation (ECC) and Life Cycle Assessment (LCA) are the methods used in this study as part of the Construction Logistics assessment framework (Brusselaers,et al 2020 forthcoming).

The goals defined on strategic level (upper left part of figure 10) relate to different scope and therefore we can also view performance differently. Though, to get an overview of the total impact of a setup the External Cost Calculation and the LCA should be combined. This will enable to see how the setup perform seen from the view of different actors.

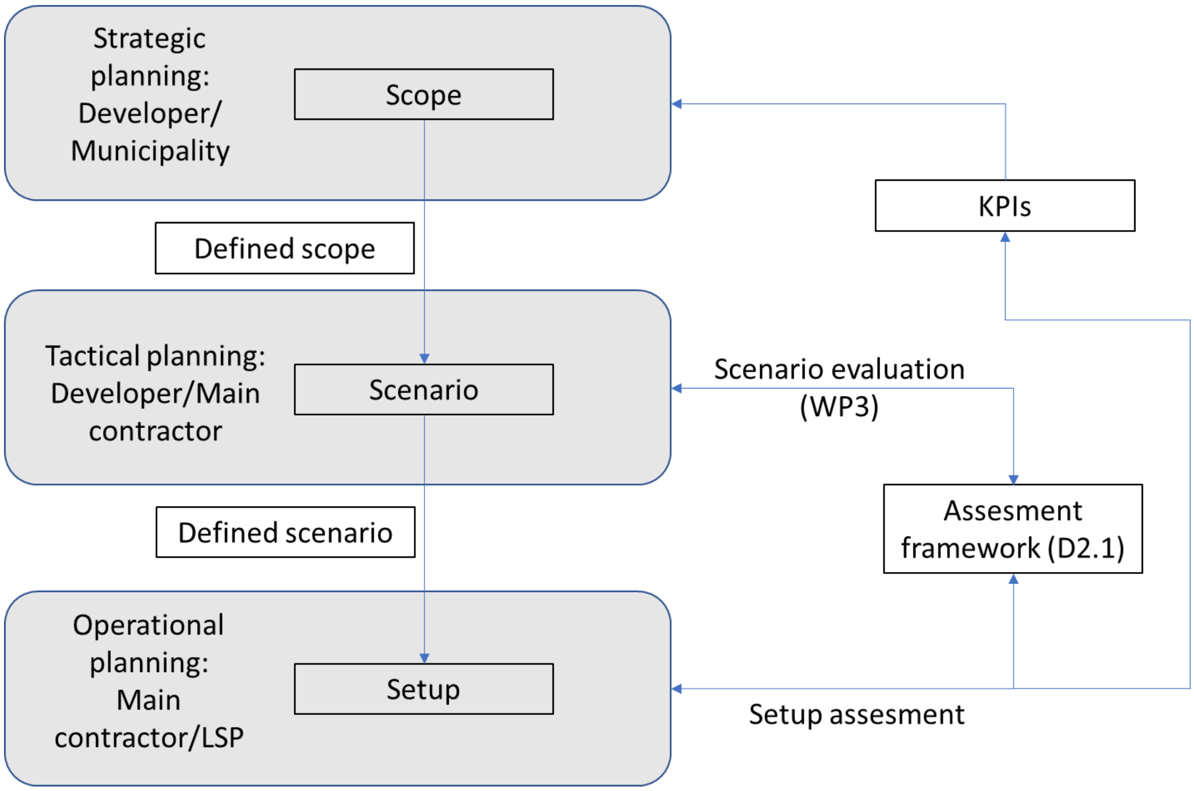

Figure 10: The relationship between the assesment framework D2.1 and the construction logistics scenario and setups defined in this deliverable D1.1.

4. Conclusions

The goal of this deliverable was to define what logistics scenarios are and how these can be included in the Smart Governance Concept 2.0. The deliverable started with defining a hierarchy within logistics scenarios, following the planning hierarchy of logistics planning and the project phases of construction projects. These suggest to work on three levels; strategic, tactical and operational. On the strategic level we work with goals and scope of construction logistics. Here we define the main stakeholders of the construction logistics system as well as how the construction logistics can have different scope in relation to the transports of the city. The goals and scope are limiting the contextual and logistics scenario at the tactical level. Here we work with several different possible combinations of logistics service depending on the contextual and logistical needs of the main stakeholders. From these scenarios are on the operational level one of them selected and implemented as the final CLS in the project. There are important feedback and evaluation loops from the operational and tactical level to higher planning levels with the help of the assessment framework presented in Deliverable 2.1.

5. Acknowledgements

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Appendix 1 Examples of Construction logistics setups from Janné et al. (2019)

Case A is a 7 year long combined renovation and new-build project in a medium-sized city in southern Sweden. The regional council employed a construction management (CM) company to manage the site and the material and resource deliveries. The goal of the logistics solution is primarily to reduce impact on third-parties and to ensure that the hospital operates as normal. As the hospital is located in the busy city centre, the CM company opted for a checkpoint solution with a planning system for all delivery bookings and waiting area for lorries outside of the city. The CM company is managing the site as well as all delivery activities and by having their own budget, they are in a position where they can focus on managing relationships and ensuring that all stakeholders strive towards a common goal, but they also have mandate to enforce rules and regulations towards contractors, suppliers, and transport providers in the project. However, as their mandate is only for the project, there has been issues in coordinating regional and local council road and construction works adjacent to the hospital project with what happens on site.

Case B is a 5 year long combined renovation and new-build project in a medium-sized city in northern Sweden. The regional council employed a consultancy company to set up and manage the construction logistics solution with the main goal of not disturbing ambulances and ongoing operation of the hospital. This company joined forces with one of the dominating logistics software companies in construction transport administration and one of the largest haulers in Sweden. The consultancy company have set the rules of the solution; however, use is not mandatory. This has made it difficult to enforce the utilization of the CLS. There is a recommendation of booking deliveries 24 hrs. in advance of arrival. The haulers terminal in the city of the hospital is acting as a CLC and all goods are taken via this. Thereafter, goods are delivered based on call-offs to the site via milk runs and carried up into the building. Full truck loads are going straight to site. The solution is seen as positive by many of the actors on site, however still only about 10% of the materials are taken via the terminal.

Case C is a 12 year long project in a medium-sized city in mid Sweden including both new buildings and renovation. The regional council identified a need to control construction logistics with the main goal to avoid disturbances of ambulances. The regional council contracted a construction logistics service provider whom to start with was to report to and get orders from the main contractor of the project. However, this left the construction logistics service provider with little power and it was difficult to implement the solution. The solution has strict rules of booking deliveries in advance. Booked deliveries are routed via a checkpoint at a large parking space on the outskirts of the hospital area and the goods are carried in during night. This CLS has developed over time and during later years focus have shifted towards measuring logistics improvements and the construction logistics service provider have been given more autonomy in relation to the main contractors.

Case D is 5 year long project to build and renovate the psychiatric ward, the infection clinic, and the medical laboratory of the hospital in a medium-sized city in mid Sweden. All three wards and clinics are operational during construction, with the current medical laboratory scheduled for demolishing once the new laboratory is completed. The main contractors site manager demanded a CLS to ensure that material deliveries are running smoothly and in accordance with plans. The CLS is organizationally located under the main contractor and consists of a terminal, with additional services such as kitting, on-site materials handling, and a machine resource pool. Deliveries are carried out after call-offs, based on takt production. The main contractor has a dedicated logistics manager in the project, acting as the contact point between the construction project and the logistics provider.

Case E is a 4 year long project to build a new trauma and cancer hospital in the existing university hospital campus in Helsinki, Finland. The hospital district selected a general contractor with construction management at risk –delivery method including quality, time and budget targets. The goal of the CLS is to enable existing service operations on campus (including ambulance route), keep the vivid road next to the site open, and not disturb the existing service and maintenance tunnel under the new building. The company is responsible for logistic services, which on site are provided by a logistics company. A terminal is utilized to enable JIT deliveries as there is no space for inventories on site. There were challenges to find cheap space for the terminal. In general, prefabricated products and takt production control are used as much as possible. The city is renovating an adjacent road at the same time which makes logistics even more challenging.

Case F is 9 year long renovation and new-build project in the central parts of Copenhagen with the aim of creating a modern all-round hospital. The regional council tendered for a joint building site management solution. The winning bid by a CM company includes managing the site and logistics of the whole project, whereas the logistics of the individual contractors are managed by the contractors themselves. The goal of the CLS is to reduce impact on third-parties and to ensure that the hospital operates as normal. The CLS is a virtual checkpoint solution with a planning system where all deliveries are booked. It also includes establishment, joint site layout plans, and follow-up of rules and regulations.