Findings from Expert Interviews (Chapter 5)

No.	Question	Assumption/ Initial Comment	Interviewee
	Key Question		
0	How can productivity and safety issues in construction be resolved by integrating temporary construction items (TCIs) in the logistics and site management process?		
	Not relevant		**TCI Provider 1**
	Not relevant		**TCI Provider 2**
	Productivity and safety goes hand in hand, and either cannot be lacked because if safety is left out the workers on construction site cannot do their job efficiently when they feel unsafe and must tread carefully and thus a decrease in productivity. Here in the SDU SUND construction site we use temporary construction items such as barriers which are placed around excavation pits to ensure the safety of the workers. As well as the crane tower to lift all the heavy materials down to the pit for the workers.		**Client 1**
1	**Problem Space**		
1	What products do you provide for construction sites? How's the future demand regarding these products expected?		
	- Storage yards/ material stocking locations, Construction site fences, Setting up of access scaffolds, stairs, stair towers and ramps, temporary facades, cranes - Setting up of water and power supply on site		**TCI Provider 1**
	- Formwork and Scaffolding - PERI standard forms make approximately 95% of all used forms at PERI - PERI is trying to get more actively involved in the beginning of a construction project to already place their expertise --> Formwork decision already have a impact in the design phase but most focus is on construction phase - Future demand is expected to stay high as concrete is still the most frequently used construction material and prefabricated elements are mainly used in buildings as stadiums, carparks etc. - PERI also holds some shares at startups that try to disrupt the building industry with their solutions (e.g. 3D-House Printing from COBOD)		**TCI Provider 2**
	Not relevant		**Client 1**
2	How do you supply construction sites with your product and what services do you provide with your products? Do you use any technology to facilitate this process?		
	- Ajos takes responsibility for the establishment and operation of construction sites as a construction site contractor. This includes the heavy tasks such as the setting up and operation of machines and equipment, monitoring, logistics and the dialogue with the authorities as well as the co-ordination with the other parties at the site and service tasks such as cleaning, canteen operation, janitorial functions and security guard services, etc. --> If you ensure cranes, hoists, site huts and modules, or other equipment, at your construction site, then your subcontractors can do those tasks they have been hired for. **Services**: - Logistics management, Subcontractor co-ordination, Waste management and sorting, Setting up of gates, booms and central islands, Establishment and management of storage yards/ material stocking locations, Construction site fences, Setting up of access scaffolds, Setting up of stairs, stair towers and ramps, Setting up of temporary facades - smartBYG - the Ajos Web-based logistics program - makes it easy to manage the logistics at your construction site, so you avoid traffic bottleneck - For larger and more complicated construction sites, Ajos offers digital simulations of the construction site arrangements using Virtual Design and Construction (VDC) technology, which we have access to via MT Højgaard. Tell us all about your plans - and receive a detailed picture of what your optimum construction site could look like. By using VDC, we can optimise the logistics, placement of equipment, site hut clusters, access routes and the like. The simulation ensures that your construction site is established as efficiently as possible - and that you avoid expensive errors, BEFORE you start the construction work. When construction starts, drones can assist in creating overview pictures and performing digital progress reporting.		**TCI Provider 1**
	Services: **- Buy or Rent products from PERI, Logistics planning, Engineering, Maintenance and digital services with BIM Competence centre** **- Buy: If contractors buy the formwork and scaffolding elements from PERI, it is their responsibility to plan and managed their use for the construction industry** **- Rent: PERI is taking an active part in the construction process and digitally plans quantities, task sequence, logistics etc. of their products based on the given project information (e.g. from a 2D/3D model)** **Digital Services:** **- Laser & Drone scanning of existing buildings for generating models based on photos and point-clouds** **- Data processing with different software applications and formats (IFC, rvt, etc.)** **- PERI CAD --> 3D modelling of formwork, scaffolding solutions based on building model --> Automatic generation of material quantity lists** **- Product Libraries of PERI standard solutions as plugin in modelling software** **- Visualization and simulations (How-to-Animations --> Easy access to product-specific animations supports safe and efficient execution)** **- Integrated and lean workflows --> Linking of designs and animations directly in PERI CAD** **- Cloud-based Design coordination & collision checking between PERI model and building models** **- Linking important documents at specific building parts** **- Checklists for safety and maintenance work (Minimized risk of accidents, Guarantee of planned quality, Sustainable documentation of responsibilities)** **- Issue/ Defect Management** **- QR and RFID codes for the exact identification of different elements with link to the use plan of the elements based on the 3D-model and schedule information** **--> Optimized construction site employment and management of TCIs** **- Augmented and Mixed Reality**	- General Workflow: 1. Receiving Project Data 2. Transforming Data into usable 3D-Model (IFC, DWG, NWG) 3. PERI CAD planning of formwork and scaffolding solutions based on 3D-model 4. Model processing 5. BIM 360 management process	**TCI Provider 2**
	Not relevant		**Client 1**

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3	How are temporary construction items considered in a construction site regarding budgeting, management and monitoring?		
	The assignment can be described in the BSB Construction Case description and job description that is on any project. It leans up to contract schedule that you build on. In relation to safety, work must be planned so that it complies with applicable rules and legislation.		**TCI Provider 1**
	1. Budgeting/ Planning: If supplier is not integrated into site planning & logistics, contractor used a Lump-sum value in % estimated based on gross value of the building to generate an approximate amount of TCIs --> If supplier is integrated, all digital solutions can be applied to support the construction process 2. Management: TCIs are ordered to serve the entire project. This surplus on elements causes storage & logistics issues and results in high costs for the use of TCIs as their usage is not optimized 3. Monitoring: Not yet done from contractors, but supplier could enable QR or RFID codes to monitor the use of their products		**TCI Provider 2**
	TCIs on site: Formwork and its components, supporting props, electric cables, lighting, water supply and drainage, site facilities, cranes, driving/walking path fences and signage, orange posts around excavation, steel plates, lifting platforms, concrete barriers **Planning**: First planned as a percentage of the total costs in the official offer, developed from the owner and accepted by the contractor --> Based on design, the total amount is estimated for the whole construction site --> Contractor is then ordering on a "just-in-time" approach the TCIs which are needed for the upcoming tasks on site (Already a quite lean approach, but still only based on a rough estimation and the experience of the contractor) --> Is not scheduled in detail. Only estimation for whole project but no information is there how much (quantities) is needed for each phase or even construction activity **Budgeting**: Initial from owner in the official offer but during construction, invoices are sent from the contractor based on the progress --> Costs are estimated and then invoiced by the contractor. Little transparency, which was also leading to missing fences for the construction roads in the site budget (Walking roads have not been planned properly and now much more fences are needed) --> If TCIs can be quantified in a simple way for each construction activity, a better estimation can be done for TCIs --> Rough planning will lead to changes that lead to cost overruns Budgets of construction items are organized monthly for the whole length of project and is managed when entrepreneur asks for invoices by requiring for documentations about items and quantities if suspicion arises. **Monitoring**: The construction activities/ items are monitoring by conducting inspections on the construction site. **Use of Formwork**: For supporting Elements in the lower levels as Foundation, Basement Walls Information is planned when it will start and end (Not detailed how long to it will take to install, poo concrete and dismantle it) --> But not specific on TCIs (ask Morten again if it is included as part of the schedule activity) --> Can be used though to passively plan them!		**Client 1**
4	How is the construction site layout and logistic planned and managed? What information/data is considered in this process?		
	Not relevant		**TCI Provider 1**
	Not relevant		**TCI Provider 2**
	The site layout and logistic is planned in accordance to the process schedule. It is planned in such a way that it is most convenience to execute tasks regarding the safety of the workers on construction site. The entrepreneur's suggestions on how he would execute the tasks are also taken into considerations. As for the management, it is done by inspections at construction site as well.		**Client 1**
5	What items create the most difficulties regarding site & logistics management on site? Where is the most potential to make improvements?	Items, such as formwork and supporting structures are used repeatedly during construction. These items produce waste and block construction progress because they are not properly considered in construction management.	
	- Interim installations such as electricity, light, water, heat, closing the facades for weathering, ramps and level jumps in floors, cranes and construction site lifts. Logistics management of materials in relation to how many contractors are set to work on the individual floors according to schedule. If there are several subcontractors gathered in the same room, it is to be regarded as common areas with the requirements to these places		**TCI Provider 1**
	- Specialized formwork - Formwork in general has a great improvement potential as it is often moved around and reused on site - To much material on site which is not used		**TCI Provider 2**
	There has been some difficulties regarding excessive amount of water from groundwater as well as bad weather. High voltage power lines which have also been causing some troubles because it has been taken into considerations at a timely manner. Also, the uploaded information/drawings how to implement the tasks on site is very crucial as well. Obtaining information on existing cables/wires on early stage so it can be integrated into schedule. --> Because TCIs are not planned in detail, there is no transparency and real information about when and where which types of TCIs are needed on site. Having the updated information based on the construction progress, the would enable "just-in-time" delivery and lean management of the items for each phase from delivery, storage and utilization over dismantling and reuse to returning the elements to the supplier.		**Client 1**

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2	**Solution Space**		
6	What data or information would be needed to improve the management of these items? How can this information be obtained? (e.g. BIM, sensors, supplier information, site progress etc.)	--> Formwork as a service	
	- If TCIs were already embedded in the tendering process, planning interim installations and their location over time could be optimized. - One can simulate the construction site and logistics via BIM		**TCI Provider 1**
	- Specific info about products (number, weight, area, dimensions, static capabilities, supporting elements, How-to-Animations etc.) - Info about 4D/ 5D planning to link to TCIs - **Status management:** (Ordered, delivered, stored, in use (erected, ready for concreting, Dismantling), storing, ready for pick up --> Planning and then sensors to monitor --> Goal is to obtain information as easy and quick as possible		**TCI Provider 2**
	Updated information about TCIs and take them into account in order to be able to determine whether they are a hindrance to the tasks that need to be executed on the construction field. If they directly support a task, they the information should enable a lean management, so the items are stored where they are used later on. The planned amount will also give the management a reference to check the actual installations. --> Information about TCIs would benefit both the contractor and owner representative for CM by increasing transparency, but it directly affects the contractors work. The information can either be distributed with the Exicute application, collectively with the current construction activities		**Client 1**
7	Is it possible to automatically generate the number of standard formwork based on geometry of building parts? Does your company have such a solution?	By linking the TCIs to their related construction activity, it must be possible to derive amount and type of TCIs.	
	not answered		**TCI Provider 1**
	- Normally Engineers are planning the formwork and scaffolding design for every construction project using PERI CAD - PERI Quicksolve is a simple application that generates formwork solutions by using a quick sketch and some parameters of wall elements - PERI automatic planning is based on rulesets and assembly and use manuals of their standard products --> Rules: How much formwork top-up, Push/Pull props, connecting elements --> Visual scripting was used in PERI for defining the rule-based algorithm to automatically generate formwork solutions for given geometries --> C++ file was generated which could be imported into CAD system to include TCI information - Supporting elements can be defined via average values (Panels, connections, anchor, Push/Pull props, concreting platform **--> Define ruleset based on assembly and use manual of a standard product at PERI (Mostly used is Maximo formwork)**		**TCI Provider 2**
	Could be possible with a algorithm that takes in information from the building model and the available forms		**Client 1**
8	In your opinion, how will the proposed setup improve productivity and safety on site? How would you as a supplier/ construction management benefit from it?	The proposed process improvement of site & logistics management regarding TCIs is proposed. The main idea is to link quantities of temporary construction items to the building activities of a BIM plan and with that receive updated information about when and where specific TCIs are used in the construction process.	
	not answered		**TCI Provider 1**
	- Productivity and Safety are also aspects that are most important for PERI - In general, having a plan and real-time information about the utilization of TCIs always improves productivity and safety on site - Solution data graph can also be equipped with ISO standards and safety regulations - Extension to use IoT-Sensors and supplier information is very useful to complement the proposed solution, but works also without		**TCI Provider 2**
	- The proposed setup might have a positive impact on the productivity and safety because the entrepreneur can always see when he/she needs to have the TCIs ready for the upcoming tasks. It might also save both entrepreneur and construction site management team time as it is already planned for them. One would always now what types and quantities are right now on site and will be needed later - An automatic and updated utilization plan lessens a lot of burdens from both parties --> You know how much the quantities are and it is transparent to the parties --> Safe time for estimation and have a better estimation. - In Safety meetings it is discussed what needs to be done . If the utilization plan of TCIs will notify the construction professionals about the safety risk factor of each construction activity, based on the TCIs, activities which need special attention due to higher risk factor can be addressed in the safety meeting and its weekly look-ahead plan and or the daily meeting of the contractor. --> Notification for construction workers if a TCI need special attention due to a higher risk factor --> Manual or simulation with proper installation of the item - Safe space and costs when you don't need TCIs because now you would still pay the monthly rent --> **Rent out and Re-Rent** --> Removed two containers because they didn't need it anymore --> Fences e.g. is paid by meters per month, so there would be a high incentive to rent it out again if it is not needed - Depends on the cost-benefit if to rent it out and re-rent it or to just keep it!		**Client 1**
9	Who would benefit from the proposed solution?		
	not answered		**TCI Provider 1**
	not answered		**TCI Provider 2**
	Would help both parties (construction manager from owner and contractor) as updated information about how much of each item is used when and how long (to help contractor with their planning but also to check the budget if all budgeted items are used (Now everything is planned manually) - **Owner**: Costs (checking), Costs (renting costs), and more - **Contractor**: Reliability of planning, make money, Efficiency of construction process if improved --> Delay is mitigated (no fines) - **Supplier**: Supplier can have a more dynamic rent system where TCIs can be moved around different construction sites more dynamically as updated and transparent information about the utilization of TCIs is available for all relevant stakeholder		**Client 1**
3	**Other comments**		
	It was actually never the case before to plan in this detail on each activity --> It is more an estimation of the whole project It would also take the task easier for **the construction manager** from the client side if he know what type of material/ items are need in a specific month and the quantity --> Knows how much money to pay for the contractor		**Client 1**