

Productivity and logistic in the construction industry

- what can the construction industry learn from stationary industry?

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Introduction

It is claimed by the construction industry itself that the productivity in the industry is low. It is also claimed that many of the actors in the industry "don't make money". Several studies have also concluded that the industry has a low productivity, and some have even claimed that there has been a negative trend in the last decade. This is opposite from what many claim has been the development in stationary industry. Why is it so, and are the some elements the construction industry can learn and adapt from the stationary industry?

In improving the productivity of stationary industry, logistics has been one of the main focus-areas. Key elements are lean and agile manufacturing, supply chain management and just-in-time production. When it comes to the construction industry, logistics as an operative function has always been an important part of the construction process. Activities such as procurement and ordering, reception, transport, and on-site storage as well as planning and project management related to these activities are important aspects of such logistics. Nevertheless, based on our case-studies, one will not find the same positive development here as in the logistics of stationary industry. It is therefore interesting to see if there are some elements, or parts of elements, that are possible to transfer to the construction industry. To do this it is important to see the logistics in context with project management, another important aspect of improvement in the construction industry.

To investigate these issues, a research project titled "Productivity and logistics in construction projects" has been established at NTNU/SINTEF with funding from Statsbygg (The Directorate of Public Construction and Property) to investigate the Norwegian construction industry. The project's long-term objective is to improve the productivity in the construction industry through focusing on the coordination along and between supply chains, if possible toward planning, managing, and executing such projects based on principles from stationary industrial manufacturing. At this stage, the project has progressed through literature studies combined with in-depth interviews with a wide spectrum of actors within construction projects.

In the research project several problem-areas have been identified, and attempts to increase the productivity linked to these, have been suggested. Example of problem-areas are the early phase of the projects, planning, changes, organisation, communication/ cooperation, project management, culture, and logistics. This papers present some of the findings, focusing on an assortment of the problem-areas identified.

Productivity in the construction industry

A general definition of productivity is value added compared to the input factors. Persson (1994) claims that the construction industry has had a minor increase in the productivity than other industries. Table 1 gives an overview of the development in

productivity from 1996 to 2001 for the Norwegian construction industry compared to the development in the oil/ship building- industry and the engineering industry (SSB, 2003).

	1996	1997	1998	1999	2000	2001
Construction industry	1,00	0,97	0,94	0,72	0,83	0,96
Oil/ship building industry	1,00	1,14	1,46	1,29	1,53	1,61
Engineering industry	1,00	1,14	1,56	1,69	4,00	1,92

Table 1: Development of productivity in different industries in Norway 1996 - 2001 (SSB, 2003)

The table shows that the oil/ship industry and the engineering industry sector have had a considerable better development in the productivity than the construction industry. This trend is supported by Krogsrud (2002). The author claims that the labor productivity has increased 25% less than in the private business sector generally since 1995. The numbers are found by calculating the relation between the number of employees and the totally capital turnover. Drevland (2002) claims that the productivity in the branch is low, and it is even decreasing. A Danish report concluded that the development of the productivity in the construction industry had stopped FRI (1991). The construction industry itself also claims that the lack of productivity in the industry is part of the problem of generating profits (Kolltveit, Sjetnan, Wolf & Langlo 2002).

Some explains these differences in the development with that each project in the branch are unique and that the coordination of the activities is not good enough. It is believed that the logistics on the construction site has a large impact on the development of the productivity. Swedish research results claim that more than fifty percent of the constructions-costs are non-value added transaction costs (Statsbygg 2003).

Persson and Solberg (1994) say that a great share of a construction workers day is spent on waiting for other activities to be finished. A German study shows that as much as 50 percent of a workers day on the building site is non-productive (Solberg and Persson, 1994). A Swedish research study (Statsbygg 2003) explains this by claiming that one third of the time spent on the construction site is spent on building, one third goes to preparations but the last third is pure dead time.

In addition to this, there are several other Norwegian and international studies and statistics that points at a negative, or at least low, development of the productivity in the construction sector. Some of them do indicate that the logistics is of special interest in improving productivity in the construction industry. A British report sees the logistics of the material and the information, as one of the major weaknesses in the industry Statsbygg (2003). This is supported by a Danish report that claims that an improvement in logistics has a potential to reduce the cost by up to 20 % (FRI 1991). This is easy to understand when it is known that eighty percent of the calls for materials are rush-calls and that 30 percent of the materials used are waste (FRI 1991). Another finding points out that materials are only bought in big quanta's without thinking of the specific building-process (Statsbygg 2003).

A Norwegian research report claims that by basic initiatives it is possible to shorten the construction time by up to 40-50% (Persson and Solberg, 1994). The findings from our case-studies within this field, are that there is no doubt that there is a potential to improve the productivity in the Norwegian construction industry, and we believe that a special attention should be aimed at the logistic functions. But focus must also be put on coordination between the actors and an overall evaluation of the function to all the actors involved. One central aspect in this work is common targets and success factors.

Problem areas in the construction sector identified by the interviewed actors

The actors we have interviewed have identified several problem-areas. In this paper we will focus on three of them:

- ◆ The problems in the interface between the builder, the advisers and the executors. This problem is often referred to as “early phase- problems” that emphasize the whole project.
- ◆ Logistics problems for building materials and other products used during the construction process.
- ◆ Problems in the construction project planning and management.

Most of the actors we have interviewed argue that the problems in a typical construction project come into being in the interface between the builder, the advisers and the executors (see figure 1). The advisers are the architect and the consulting engineers, while the executors are the building contractors and supportters.

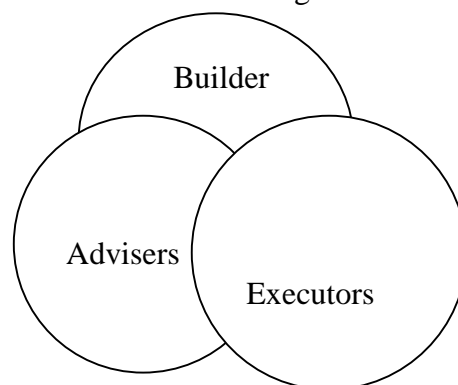


Fig 1: Problem area; the interface between the builder, the advisers and the executors

Our opinion is that these interfaces are of a special interest because much of the premises for the ensuing productivity and logistics are created here. The problems could be due to several things like communications problems between different professions and cultures and that the architects are thinking too little about the building process in their drawings. But the thing we will point out is that the actors in the three categories, most of the times do vary from project to project. This is in contrast to e.g. stationary industry where the bindings between actors in e.g. a supply chain are more often a long-term relationship. Furthermore, in the very beginning of a typical project, in the idea-phase, it is often just the builder and the architect who are participating. This can maybe also explain the fact that many of our respondents claiming that there often are a lack of technical expertise in this phase.

When it comes to logistics planning it seems to be a potential for improvements in both the planning of how to organize the construction site and of the logistic of the building itself. For the logistic of the construction site, a well-known problem is that

equipment and construction goods are delivered or placed at wrong geographical places and not on time. This could be the result of defective storage planning or that a storage plan does not exist at all together with lack of routines for the receiving of goods (e.g. logistics planning). The result of this is also that many building sites look very disorganized. The inability by the contractor to deliver materials at the right time and the right place is identified as one of the most common problems in the construction industry (Thomas, Horman, de Souza and Zavriski (2002:2).

Another impotent area is purchase routines. Today, most of the purchases are done by telephone, even though most of the interviewed actor's wish to do most of this through the Internet. This could be due to that many are not familiar with a computer. More Internet-based purchase routines are believed to be more cost-efficient than telephone-based purchase, for instance to help decrease the normally huge numbers of rush orders, which is looked upon as a problem. Those of the interviewed subjects who have carried out the change from telephone to more automated purchasing routines support this.

Planning has always been a theme when it comes to improvements of the productivity in all businesses, and the construction industry is no exception. Several actors in the industry emphasize that projects are behind schedule due to that plans are not finished in time. In addition, plans that also take care of the interfaces between the actors in the project are often missing. The interviewed actors in the Norwegian construction industry do specially mention insufficient planning regarding detail plans. Several do also want more milestones and better overview of dependencies in their projects. It is nevertheless important to realize that there is no point to "over-plan" the projects. An identified trend in the construction industry is that the actors only plan what is within their own field of expertise and disregards planning of elements/factors outside their own domain.

Insufficient planning could also be due to that the project management in construction projects could have been better. The respondents especially single out the technical project management. Many claim that the plans consist of too few subsidiary goals and that the project management should control the projects more strictly. This relates especially to the project and the project management's ability to meet the deadlines in form of the milestones. A typical problem, pointed out by many of the interviewed subjects, is that a lot of actors are utilizing the slack in the plans completely, i.e. never starts work until they really have to start to reach the deadline. This leads to that the project decreases its possibilities to catch up for unforeseen problems. Another aspect pointed out is the meeting-procedures: How often should the different meetings be held, who should participate and how should the meetings be structured? This could be the reason why some claims that many decisions are taken too late and that they often are fuzzy.

What can the construction industry learn from stationary industry?

At the forefront of logistics, the stationary manufacturing industry has pushed the border forward. Practically all the theoretical and applied developments within the field of logistics have occurred here. Key concepts include lean and agile manufacturing, supply chain management and just-in-time-thinking. Despite the fact that construction projects involve a large number of actors, complex chains of material supply, and unpredictable and hard to plan processes, few of the

developments in the stationary manufacturing industry have been linked or transferred to the construction industry. However, not all concepts and principles are applicable to the construction industry. E.g. lean manufacturing principles and the transfer to the construction industry is discussed by Thomas, Horman, de Souza and Zavriski (2002:1 and 2002:2).

In the construction industry it is normal that the different businesses/actors maximizes only their own profit and do not look at the whole (as supported by the carried out interviews). This is different from stationary industry where e.g. the target could be to optimize the whole supply chain, which is looked upon as one of the factors that have led to an increase in the productivity for all the actors in the chain. As a result of this the different supply chains are competing against each other instead of the situation in the construction industry where single actors, even within the same project, are competing against each other.

Our opinion is that ordinary industrial production has developed several approaches that seem to be adaptable for construction projects. Specific could this be composition and control of supply chains and involvement of suppliers in the development and planning of the product and the production. As an example; stationary industry has come far in developing and utilizing methodologies for mapping and analyzing value chains, modeling of processes and techniques for improvements of their processes. Even though one in the construction industry have special external conditions and contracts, our opinion that it should be possible for the construction industry to use these tools, directly or modified.

Learning from the development that has taken place in the manufacturing sphere toward “Design for Manufacturing”, construction projects would probably benefit immensely from focusing more on “Design for Construction”. Other possible areas are VMI (vendor managed inventory) and ERP (Enterprises resource planning).

Supply-chains in a typical construction project

“Supply Chain – a set of three or more companies directly linked by one or more of the upstream and downstream flows of products, services finances and information from a source to a customer” (Mentzer, 2001).

Logistics impact productivity, and in construction projects, logistics can be analyzed at (at least) four levels;

1. The construction site will during the execution phase of the project function as one large production system where an extremely complex array of activities must be carried out, in a setting of compressed space and time.
2. The leading into the construction site is a number of supply chains that ultimately deliver the materials and products that go into the building.
3. Each actor performing construction activities in the execution phase usually juggles several projects in parallel and must plan the logistics of these.
4. The finished building will be a site where inhabitants perform tasks, in some kind of logistics, which should also be considered when designing the building.

On the other hand it is also necessary to look at the logistics of the whole projects: the progress from a need or an idea to a finished and “smooth working” building. Typical

of this logistic are the transfers of information, thoughts and decision basis. This is closely connected to what is known as the core-processes in a typical construction project:

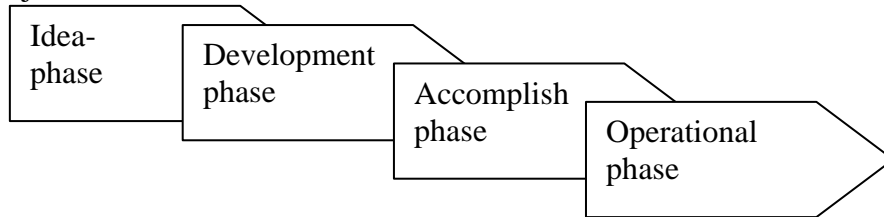


Fig 2: Typical phases in a construction project.

Based on this thinking it is possible to map two basic different supply-chains for a typical construction project: “the supply-chain of materials” and “the supply-chain of actors” (see figure 3 and figure 4).

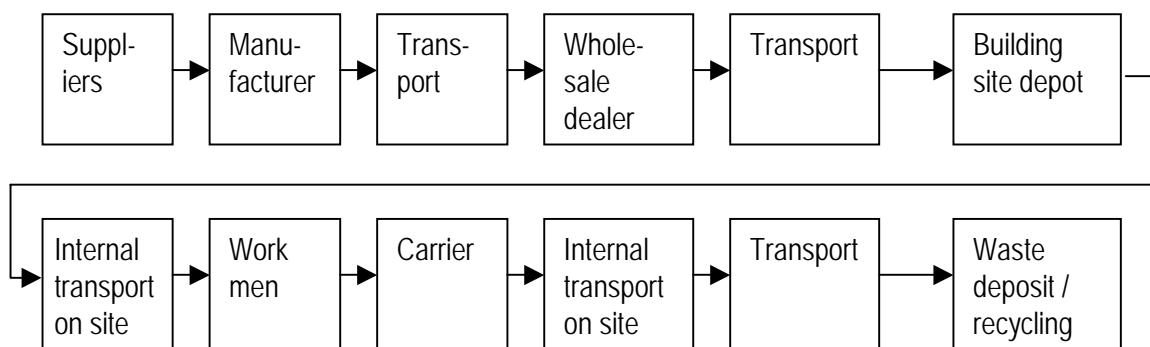


Fig 3: Supply chain of materials – material flow

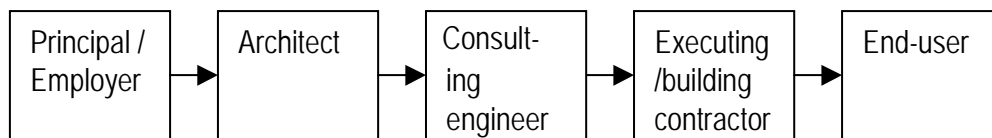


Fig. 4: Supply chain of actors – from idea to executing to end-users

It is important to make the industry aware of these different tasks to ensure that each is understood and allow the planning of them partly on their own terms and partly in integration with each other is extremely important to improve the logistics of such projects.

Whereas industrial supply chains in manufacturing industries often have a long-term horizon, the practice of competitive bidding in the construction industry ensures that every new project means a new constellation of partners. The long-lasting supply chains of the manufacturing sphere means the members of the chains optimize their operations with each other to deliver the best possible product at least costs to the end customer. For the members, the incentives structure direct them toward viewing the supply chain as one integrated chain competing with other supply chains and success is ensured by making ones own supply chain the best one. For actors in the construction industry, every project is a one-off happening where the incentive structure motivates them to make the most profit out of each project. This discontinuity is detrimental to construction project productivity and can probably only be changed by altering the practices of how “construction chains” are composed.

A possibility for the construction industry could be to aim at more lasting relations between the actors in both the value chain of materials and in the value chain of actors.

Attempts to increase the productivity in the construction industry

From review of literature, knowledge about supply chain management in the traditional manufacturing sector, and discussions with construction project personnel, we have arrived at some intermediate findings regarding improvement measures for the construction industry. The list of such potential improvements has grown quite long, but in this paper we have decided to focus on three core areas:

- ◆ Design for Construction/Design for Logistics, an adaptation of the Design for X (manufacturing, logistics, recycling, etc.) that has been successful in manufacturing industries.
- ◆ Supply chain optimization for building materials and other products used during the construction process.
- ◆ Construction project planning and management.

These three core areas and some improvements are presented below in a short-list form.

Design for Construction/Design for Logistics

- Increase architects and early-phase participants knowledge and competence regarding logistics on the construction-site and buildability of different solutions to ensure higher productivity in the construction phase.
- Improving the logistics on the construction site implies to plan for more parallel access-points, good flow of material and people.
- Buildability implies that chosen solutions don't require complicated processes, impossible or difficult orders of activities. In addition, required materiel must be in place on time.
- The use of process-analyses of how the building is going to be used after it has been constructed should be carried out (this has been carried out in e.g. the new hospital in Trondheim (Henriksen, 2003)). These analyses are carried out before the architects and others start their participation.
- Use of Concurrent Engineering, where contractor and others are required to participate early in the project in order to contribute with their knowledge and understanding of the construction phase already during design and the early stages of a project. The involvement of representatives of manufacturers / wholesalers etc of various materials, solutions etc at an early stage are also important. This can be utilized by having them influence the choice of solutions in terms of cheaper and/or more logistics-friendly products.

Supply chain optimization

- The use of e-purchasing from the construction site with delivery the next day. This can e.g. involve delivery of already ordered materiel (but stored at vendor/manufacturer/wholesaler), or rush-deliveries of standard materials. This reduces the need for storage space (and facilities) at the site and eases the on-site logistics.
- Categorization of material, products by an ABC-categorization. A is for next-day delivery, B is for two-three days delivery and C is for much later. What's

experienced is that this encourages the use of standard material/products etc. The categorization should be carried out early in the project, as this is important input both to architects and others.

- Vendor-Management-Inventory solutions should be implemented where the vendor/wholesaler/supplier contains a certain amount/level of material/standard-goods on the construction-site and the project does not pay until actually using any of the material.
- Wholesalers/Suppliers have the responsibility of delivering, unpacking, and removing waste on-site at the correct geographical location and on time. This enables time to the commissioning engineers/installers to carry out their work and decreases “idle” time.

Construction project planning and management

- In planning, the dependencies between activities must receive increased focus. Planners must increase their knowledge regarding logistics to the construction site (e.g. cooperation along the supply-chain) and construction logistics (e.g. on-site logistics, possibilities and dependencies).
- The possibility of using stricter plans regarding actors and reducing available individual slack should be analysed and carried out. This might impact the current practise seen in the construction industry today where activities are started at the latest possible date the slack allows. Precision should be prioritised and not slack.
- More milestones and stricter follow-up of these milestones are asked for by all actors and should therefore be an important focus-area for the planners.
- Wholesalers and suppliers should be asked for more detailed information regarding their time-estimates for deliveries and activities.
- Vulnerability and risk analyses should be carried out. Also taking advantage of risks (rather than avoiding risks) should be evaluated. Risks can also be looked upon as possibilities. However, this is usually not the case in the conservative risk-reducing mentality of the construction industry (Arge 2001, Kolltveit et al 2002).
- After the plans have been laid, it is of vital importance to communicate the plans to all involved parties. This area sometimes is underprioritised in today’s projects. Focus on start-up meetings and how to communicate the plans are important.
- Follow-up meetings and communication meetings should be held with a broader participation than today and more frequent with more focused meeting agendas and stricter management and implementation of decisions from these meetings.

Summary

Early involvement of more actors in a construction project seems to be important. By doing this it is possible to utilize knowledge and experience from many disciplines that later will be impacted by early-laid plans and decisions. The use of Design for construction where logistics both to and on the construction site are taken into consideration, and where input from e.g. end-users and wholesalers/suppliers are considered by architects and others involved in the early phase, are believed to impact greatly on the productivity of a construction project. Planning is another important area, making sure the on-site logistics (both in regard of persons and materiel), risks, dependencies between activities are considered. More use of milestones and stricter

control of available slack seem also to be success factors. The latter should be supported by closer follow-up and improved meeting processes. The use of e-purchasing and other tools for ordering and handling orders to the construction site together with close cooperation with suppliers and wholesalers is also identified as important. Further, long-term supply-chain thinking and more long-term cooperation between actors in the construction industry are believed to give valuable contributions to the productivity of the industry. The same is also true for modifying and implementing principles and methods used and developed in the land-based industries.

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