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Case study regarding the logistics of construction sites in Iasi, Romania

Tudor-Cristian Petrescu
PhD student, Faculty of Civil Engineering and Building Services, "Gheorghe Asachi" Technical University of Iasi

Summary

Broadly, the logistic organization of construction sites means splitting-up tasks in a few categories: material procurement, production, inventory and transportation. This perspective may be in line with the construction site organization of a construction company. The paper proposes a framework for evaluating these types of tasks, in order to later establish the most efficient type of internal organization for a construction company. Furthermore, a case study has been done regarding GF+4F blocks of flats, built before 1989 in Iasi, Romania, with the aim of illustrating construction site logistics when prefabricated materials are used.

Keywords: logistics, materials, production, inventory, transport, construction site, block of flats.

1. INTRODUCTION

Creating a link between the theoretical and practical aspects of construction site logistics represents a key aspect of this paper. In other words, this paper aims to „translate" certain theoretical aspects into the „reality" of the construction site. The problem to be anylized is the measurement or quantification of construction site – related tasks [1].

2. RESEARCH METHODOLOGY

Some tasks can be measured quantitatively (objectively), whilst others can be measured qualitatively (subjectively). After explaining these tasks, a complete picture of the construction site may be drawn, which may be subsequently used in order to optimize logistic processes, which a construction company employs in order to deliver a project. It is important to understand that the task definitions have been conceived to be used as a questionnaire, thus having direct applicability on the construction site.

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3. EVALUATION CHARACTERISTICS

3.1. Material Sourcing

3.1.1. Sourcing

Materials can be obtained from local sources, or as imports. It also depends on the natural resources available for a country. Imports are also used, particularly if certain, otherwise unobtainable types of materials are required (but it is desireable that imports are kept to a minimum, in order to use locally-available resources). Sources of materials vary in the quality and quantity of the raw products, which can influence any construction project, particularly in performance aspects.

Overall, the Sourcing category can be measured quantitatively (ex.: extracted tons/year, quality degree, revenue from raw materials, pricing).

3.1.2. Quality Certification

It is provided by the manufacturer, following laboratory tests. The contractor may also have the obligation that, for different materials, it should also take samples and send them for analysis at a certified laboratory; the results must be the same as the ones declared by the producer. Furthermore, all construction materials are nowadays EU-certified, with ISO standards.

Overall, the Quality Certification category can be measured quantitatively (ex.: compressive resistance kN/sqm, resistance to no. of freeze/thaw cycles, thermal resistance R).

3.1.3. Extent of Prefabrication

Bricks are a product which is, by nature, prefabricated. By contrast, concrete in itself is a product that is prefabricated when it is actually poured in prefabrication moulds and prefab elements are obtained.

Overall, the Extent of Prefabrication category can be measured qualitatively (ex.: low/medium/high prefabrication).

3.2. Mechanization/Machinery

3.2.1. Sourcing

Necessary mechanical equipment for the construction site can be owned, leased or rented. Generally, large firms will have their own machinery for construction works, whilst smaller firms usually lease or rent necessary equipment for the duration of the works. A distinction may be made between the so-called "small mechanization" (ex.: hammer drills, welding torch), which almost all construction

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firms possess and "large mechanization" (ex.: haulers, excavators, cranes), which a firm may or may not have.

Overall, the Sourcing category can be measured quantitatively (ex.: no. of vehicles, expenses).

3.2.2. Extent of Mechanization

It can be easily computed with the help of specialized computer software (ex.: Primavera). Data about the construction software is fed into the software, which then provides all manner of data. Generally, the "large mechanization" has a relatively small period of usage in the total execution time of a building.

Overall, the Extent of Mechanization category can be measured quantitatively (ex.: percentage of use of machinery, no. of hours/days in use, various data graphs).

3.2.3. Vehicle Park

As previously mentioned, internal vehicle parks may exist, ranging from relatively simple ones to quite complex ones. Vehicles can be rented/leased/bought from third parties.

Overall, the Vehicle Park category can be measured quantitatively (ex.: size, number of vehicles, vehicle categories).

3.3. Labor

3.3.1. Size

Labor is usually organized into teams. Numbers may vary considerably, according to project size and complexity. Teams are headed by foremen, who answer to engineers. Teams may also be distinguished by their specializations: carpenters, welders, etc.

Overall, the Size category can be measured quantitatively (ex.: no. of workers).

3.3.2. Degree of Qualification

Usually represents a certificate that the said worker has obtained a qualification (minimum level) in a certain trade. Practical skills can also be obtained on the construction site. Even so, there are differences among workers qualified in the same trade, with experience, skill and talent influencing the final results.

Overall, the Degree of Qualification category can be measured qualitatively (ex.: low/medium/high qualification, qualification degree, qualification classes).

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3.3.3. Extent of Specialties

There exist workers qualified in one trade, but there is a minority of workers who are multi-qualified. This comes both as a plus and a minus, because it is hard to specialize in several trades at the same time, even though there is some potential for cost savings on the construction site.

Overall, the Extent of Specialties category can be measured quantitatively (ex.: number of multi-qualified workers, total no. of qualified workers on a construction site).

3.4. Production

3.4.1. Production Type

Production may generally take place either on-site or in the factory. Of course, these situations correspond to the respective building systems - on-site building vs. prefabrication.

Overall, the Production Type category can be measured quantitatively (ex.: money as business volume - expenses/profits/budgets, cubic meters of concrete/masonry/prefab units).

3.4.2. Production Mode

The production mode can be in-house, for big companies; for small companies, generally subcontracting and externalization are used.

Overall, the Production Mode category can be measured quantitatively (ex.: bills of quantities, payouts).

3.5. Inventory

3.5.1. Inventory Size

Inventories are generally made up of resources - construction materials, machinery, raw materials, etc. Usually the construction company keeps track of the inventory, and the construction site is allotted resources on an as-need basis; inventories can be quite dynamic in their nature.

Overall, the Inventory Size category can be measured quantitatively (ex.: bills of quantities, resource usage reports).

3.5.2. Inventory Location

Locations of inventories are usually the construction site and the factory; intermediary inventories may also exist. These are especially important in the case of prefabricated elements, as a factory constantly produces prefabs and these may

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need to be stored temporarily until works on the construction site begin. Also, just-in-time delivery is quite important, as it obviates the need for intermediary inventories and can avoid extra costs. It is desirable not to have intermediary inventories.

Overall, the Inventory Location category can be measured quantitatively (ex.: geographic location, no. of locations in a region).

3.6. Transportation

3.6.1. Transportation Type

Two major types of transport are nowadays used in the construction industry, namely road transport and rail transport. The choice of transport is linked to available infrastructure and costs.

Overall, the Transportation Type category can be measured quantitatively (ex.: costs, expenses, no. of vehicles of each type).

3.6.2. Degree of Customization

Usually, in the case of on-site construction, relatively little customization exists. However, there are special vehicles created for prefabricated materials, which are customized, especially for long prefabs and "stack" transportation of prefab elements.

Overall, the Degree of Customization category can be measured qualitatively (ex.: low/medium/high customization, special vehicle types) [2, 3].

4. CASE STUDY

The case study has been made taking into account Standard Project no. 770-771-v2 P+4, prefabricated building, Iasi, units built between 1978-1989 (3-4 months/sector), 17 apartments/sector.

4.1. Sourcing

Prefabricated panels were brought from a construction factory (IMC - Factory of Construction Materials) in Iasi, with a total capacity of 60.000 cubic meters/year.

4.1.2. Quality Certification

The building was constructed under the norms and building codes (Romanian STAS) valid for the years of the construction project. They were inspired by the DIN-type German standards.

4.1.3. Extent of Prefabrication

Very high degree of prefabrication. Whole sub-structures, including installations (bathrooms, kitchens) were entirely prefabricated.

4.2. Mechanization/Machinery

4.2.1. Sourcing

Drills, grinders, circular saws, welding torches were part of the small mechanization. The big mechanization was completely for internal use. There existed one tower crane for assembling prefabricated panels. Trailers for supply of prefabrication, which were "platform-type" for plates and "shelf-type" for wall panels, were also used.

4.2.2. Extent of Mechanization

Obviously, mechanization was used more intensively than in the case of in-situ buildings. Out of about 3-4 months of the total duration of construction for a sector, the tower crane was present for about 1 ½ months in the construction site. Trailers were used about 2 times/day, with 2 trailers used in total, one of each (previously mentioned) type. An excavator was used only in the beginning, for the digging of the foundation pit.

4.2.3. Vehicle Parks

For the project: one tower crane, one trailer of "platform-type", one trailer of "shelf-type". All vehicles use were internal.

4.3. Workforce

4.3.1. Size

The workforce was about 170 laborers in total, from all the trades - masons, carpenters, welders, plumbers, etc.

4.3.2. Degree of Qualification

About 20-25 people were unqualified. The rest had certification.

4.3.3. Extent of Specialties

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Thus, about 150 laborers were qualified, which corresponds to a high degree of qualification.

4.4. Production

4.4.1. Production Type

Factory production only. In the construction site, only assembly and finishing operations were performed. The profit was 5% of the whole value of the building, which went to the State.

4.4.2. Production Mode

Everything was made in-house. Work was paid according to the executed "quantities" of works/tasks, through activity records and bills of quantities, according to national regulations. All works and tasks were rigorously regulated by Law.

4.5. Inventory

4.5.1. Inventory Size

Everything came from the factory to the construction site. There was no intermediate inventory. The construction site had an inventory. Usually no more than 300-400 prefabricated elements were stored in-situ (the equivalent of another sector), when 7-8 sectors made up the entire building site.

4.5.2. Inventory Location

Iasi

4.6. Transport

4.6.1. Transportation Type

The local road infrastructure was used.

4.6.2. Degree of customization

Medium degree of customization. Special trailers were needed for the transport of prefabricated elements, but all the other machinery was quite common [4, 5].

5. CONCLUSIONS AND SUBSEQUENT DEVELOPMENTS

It can be deducted that construction projects based on the use of prefabs are capable of delivering increased efficiency on the construction site, compared to „classic" projects. Unfortunately, prefab building is only possible with the strong support of a dedicated industry, which ceased to exist in Romania after 1989.

Furthermore, prefab structures are excellent at solving a pressing issue of the society – housing (or the lack of it). In a relatively short period of time, whole neighbourhoods can become available on the market. Finally, although advantageous from both an economical and a technological point of view, these types of dwelling usually have bland aesthetics, require a qualified workforce in order to be built and they proved to be less resilient to earthquakes than masonry or concrete frames' structures.

As far as future research directions go, the exploration of construction site logistics may be continued with other comparative studies, such as: in-situ vs. Prefab construction, Western vs. Eastern Europe building systems. These studies can be made from various perspectives and may employ different criteria, thus leaving to the author(s) what they would like to select as comparison terms [6].

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