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Buildings' Site Management and Supervision: Cost Analysis of Labor Positions

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Abstract

Make a building project happen often means "thinking outside the box" and resolve the problems' loops. For the selection of building's project contractor is significant the ratio among quality and cost, which should be 60 % versus 40 %. Before composing tender bids, the cost estimates precede, which can vary in species depending on a building type, available budget, time, and other conditionalities during building construction. In this manuscript, were analyzed a few of the most interesting cost estimates of building stock and was enclosed a practical specimen of a fragmental cost estimate. It was shown a veritable real-estate (residential-commercial) in a building process with the supervisor's maneuvers and building's site management. At last, this manuscript serves as a runway and end view on building processes and building practice, and some of the burning issues in building practice are exactly labor positions.

Keywords

building's project contractor, tender bids, cost estimates, building's site management, labor positions.

I. INTRODUCTION

Buildings' site supervision is supreme craftwork that contributes to quality buildings' uplift, maintenance of their resilience, and safety. On the terrain, it transforms into scheduling all types of labor activities, in-depth screening, and retrofit of labor positions, subcontractors' crew composition changes, green accounting as well as the wrestle with uncertainties [1]. There has been a variety of papers addressing the buildings' site supervision as a cumbersome issue of buildings' site philosophy.

One study's findings [2] pointed out what has an impact on buildings' supervision, as is buildings' site layout, top management support; project participants commitment; project conceptualization, etc. Any deficiency in specified artisans (painters, tile workers, plumbers] on buildings' sites can play a significant drawback in the quality of newborn buildings, which is ascertained in [3, 4, 5]. The scrutiny of existing building supervision mechanisms was processed in [6]. For example, it was discovered that 50 % of poor construction supervision related to buildings' collapses in Nigeria could be assigned to the design faults, 40 % to the construction faults, and 10 % to the product faults [7]. Different techniques for the assessments of project costs and project cost variances were proposed in [8,9,10,11,12]. In this manuscript, were analyzed a few of the most interesting cost estimates of building stock and was enclosed a practical specimen of a fragmental cost estimate. The building under the supervision process was residential-commercial with the building's site management live. The cost estimate of cost-significant labor positions and the cost analysis of labor positions were directly analyzed and discussed on the example of bid for the plaster

Suspended ceilings in the monitored building. The aim of this manuscript is to end view on building processes and building practice as well as the interpretation of cost analysis of labor positions.

II. BUILDING SITE MANAGEMENT

A vacant lot is referred to as a new building site, and construction works range from remodeling, restoration, renovation, and adjustive reuse of existing facilities. Building sites serve as temporary material warehouses and dumps, guaranteeing the material supply and delivery on a regular basis [13].

Building sites must be deployed with multi-facets: accommodation for site clerks, administrators, other operatives of the site; work activity areas such as an area with scaffold for artisans; temporary access roads with parking plots which enable site access and control of site work activities. Building sites deliberately should be clean-cut in order to provide an unobstructed flow of available finished products and raw materials. The on-site mechanization should also provide as little obstruction as possible, i.e., if the rail-mounted tower cranes better works than the horizontal jib crane, then the first should be engaged [14]. Building sites are data-driven tools, but the data are usually inconsistent, incomplete, and unstructured.

Overhead costs of the building site encompass organization costs of the feasibility of the site works as well as the administering and management of the building site. These costs can be classified on: personal, material, and other costs. Personal costs are gross earnings of the building site's staff members (head of the building site, site's construction

engineer, technicians, other foremen, warehouse clerk, support staff). Material costs of the building site refer to the following: travel costs and per diems; transportation of workers; surveys of materials and expertise; food costs; protective footwear and other resources; reserve funds; office materials and accessories; professional literature; terrain costs; excavation costs etc. Singular building sites compute calculative factors, gross and net (calculative) factors, factor for manual work, factor for machine work, factor for a combined work.

2016. McKinsey's report emphasizes that the average project time overruns were approximately 20 % relative to the completion date of the works, but the average project cost overruns were approximately 80 %. The roots of the productivity gap in the building industry are hardwired due to the lesser hourly wage for a global construction sector than for a global economy sector [15].

There are construction works that are done on and off the building site. Wooden plankings for a simple formwork are modeled by a power saw at the building site, while a more complex formwork is delivered by transport. On the bare building site is not stipulated the section for armature production, yet the armature is delivered by auto-trucks as a semi-finished product. Fig.1. is given the backyard façade of the building blocks-the appearance of the building's site.

Fig.1. Backyard façade of the building blocks-the appearance of the building's site - (Author's source).

III. TOTAL CONSTRUCTION COSTS - DIRECT AND INDIRECT CONSTRUCTION COSTS

Total construction costs are appraised to 41.6 % globally, and the largest stake goes to the land costs. One division of the total construction costs is on: capital costs, management, maintenance, and usage costs, and removal (demolition) costs. The other much more prominent division of the total construction costs in the literature is direct construction costs and indirect construction costs.

Direct construction costs encompass the costs of materials, the costs of the labor force, and the costs of mechanization (machinery).

Indirect construction costs are all the other general costs which encompass: legal and contractual duties of the construction company; funds of the construction company for monetary stockpiles; costs of the preparatory and final works on the building site (excavations, concrete plants, service workshops, terrain laboratories, water supply, gravel and sand supply, warehouses and landfills); fixed asset costs; overhead costs of the building site; overhead costs of the construction company; earnings of the contractors and other agents as well as the profit of the construction company.

IV. COST ANALYSIS OF LABOR POSITIONS

The costs incurred during the feasibility of certain specified building works are called unit costs. They impose the prices for certain species of works per unit of measure (ft, SF (square foot), m, m^2, m^3, piece, kg...). There are several work activities defining material (unit) costs: the transport of material to the building site, manner of its storage, material preparation costs, the assembly of material, the rate of quality for a material unit. The Cost Estimate Norm for a Bill of Quantity of Construction Works is the baseline document for the cost control of building works.

According to some western countries, the design cost accounts for less than 1 % of the life cycle of construction cost [16]. The total construction cost has a lot of fluctuations and variances, especially during the construction phase. Total construction cost variances manifest as: duration disruptions, construction project abandonment, reputation damage, joint ventures of stakeholders, time lags, provisions on different currencies, late deliveries of goods, etc. [17]. An appraisal of overall construction costs can be done by forming and using different cost models. Before making up any cost analysis of a labor position or any cost model for construction, there are several principles to be guided for: knowledge of the type and technology of construction works, formation of an adequate organizational skeleton, perceiving of the time impact, consideration of the impact of the contractual relationship, division of the construction works on fragments (elements), standardization of the cost estimate [18].

The most customary (construction) cost model is the model of unit pricing and quantities for construction works. In the early phases of building's uplift, because of the insufficient number of input data, the cost model of unit pricing and quantities for construction works is often not so doable. Then some other simplified cost models can be implemented based on the total area or capacity of the building's parts. More complex projects often implement cost model combinations.

Generally, the construction cost models can be referred to as rough cost estimate based on the capacity or size of a

building (area, volume,...); fragmental cost estimate; cost model (estimate) by building phases; cost model based on Bill of Quantity and Estimate of Works; cost model by resource consumption; model of cost-significant labor positions; probabilistic simulations and risk analysis; expert systems for construction cost estimate [14]. In the sequel, will be analyzed in detail, the most interesting cost estimates of the building stock.

A. Rough Cost Estimate – is both functional, performance-related, and size-related cost estimate in construction engineering. For the scope of construction works, apart from the area or volume of a building, authoritative units can be steel weight for metal construction, density, perimeter, length for the pipeline settings, etc. This kind of cost estimate is very simplistic and coarse. The surface of the building's basis is applicable to the majority of standard buildings for a rough cost estimate. The volume of the building is the authoritative unit for a rough cost estimate of extremely high, large-sized buildings: factories, halls, stadiums, music auditoriums, public spaces, etc. Such cost modeling is used in the earliest stages of the building project, and its accuracy is approximately 25-30 % for the most standard building types [14].

B. Fragmental cost estimate – is cost appraisal of (processed) building elements (fragments) or building parts. The payment of costs is done in a sequence of interim situations, which reflect the actual current condition of a processed building element. That means the payment to the contractor or subcontractor can be based on fixed installments or based on the progress of work. That is why situations are interim because they can be changed until the final decision or agreement. Any modifications on a building element or building part must be valorized adequately and reflect on the payment to the contractor or subcontractor.
It is known that mechanical or electrical work of the building constitutes 30-50 % of the total value of the building. The fragmental cost estimate is much detailed than the rough cost estimate. Since in the fragmental cost estimate, the building elements are overriding, the list of elements can be from 4 to 40. The building elements in the fragmental cost estimate are elected based on the ultimate function in the building rather than on the material they are made of. For example, one division of the building on elements can be the following: groundworks, foundations, structural frame, and interiors, whereby each of these elements can comprise several sub-elements. The other division of the building on elements can be the under-ground structural part, above-ground structural part, interior processings, installations, interior furnishing, and external works such as façade works and amendments as building elements can be identified building parts, systems in the building or cost-specific and technologically related groups of works or activities [19]. Divisions on building elements can also cover specialty works, roof construction, interior columns, interior partitions, etc.

C. Cost estimate by cost-significant labor positions

The quantity of construction work (its complexity and size) is a significant determinant for a cost estimate of that type of construction work. Masonry works by masonry style, sort of adhesive paste between the bricks (cement mortar, limestone mortar, plaster mortar), type of the used brick, profoundly differ from facade works (laying down galvanized metal substructure, screws, putting up panels) in the costs (cost estimates). From the Bill of Quantities and Estimate of Works, there are cost-significant and non-cost-significant labor positions. With the so-called WBS technique" (work breakdown structure), the building can be classified on certain species of construction works that are performed as wholes or certain labor positions. The construction cost model, by cost-significant labor positions, originated from Vilfredo Pareto, emphasizes that a very little number of cost-significant labor positions from BQEW determines the very big part of total costs of construction.

There are two target questions that must be answered in order to use this type of cost estimate for the construction. The first target question is what are the specific, cost-significant labor positions for that type of construction (masonry, stone, wooden, concrete, low-energy, passive, etc.) The second target question is what percentage of the total cost these cost-significant labor positions determine.

Hereby, the certified equation Eq. (1) for the cost-significant labor position (specific species of construction works) is the following [14]:

$$C = C_0 \cdot \left(0{,}15 \cdot \frac{B}{B_0} + 0{,}35 \cdot \frac{RIII}{RIII_0} + 0{,}29 \cdot \frac{ACC}{ACC_0} + 0{,}21\right) \quad \text{..... (1) [14]}$$

C - corrected or adjusted price of certain construction works at the time of computation, formed on a monthly basis and noted in a bulletin;

C_0 - the initial (appraised) price of certain construction works on the day of the contract conclusion;

B - the arithmetic mean of (daily) prices on a monthly basis, for the engaged mechanization (tower crane, dredge...) at the time of computation;

B_0 - price per hour of mechanization's engagement, valid on the day of contract conclusion;

RIII - the arithmetic mean of gross hourly rates, on a monthly basis, for the laborers of the third category of training, on the day of computation;

$RIII_0$ – gross hourly rate for the laborers of the third category of training, valid on the day of contract conclusion;

ACC – the arithmetic mean of wholesale prices per unit of measure, for used material, on the day of computation;

ACC_0 – price per unit of measure, for used material, on the day of contract conclusion;

0,21- dimensionless calculative factor.

The above-mentioned equation computes the differences in the price of construction works, taking into consideration the Price of performed works aggrandized by the costs of resources throughout the building process. The costs of resources are the costs of materials, mechanization (machinery), and labor force, which are collected monthly and newly over again create a price of construction works. On that manner, the calculation system of differences in prices is created, and after each month, one index price is archived as input data in the project documentation and reports.

The cost estimate by cost-significant labor positions as a cost model is applicable for the narrowly specified type of building and is not recommendable for buildings with a huge number of different labor positions (industrial, sports buildings, stadiums, etc.). Additionally, there are many building types on which this cost estimate is not applicable and where must be included other engineering factors which modify the structure of total costs [14].

All construction cost models are at first outline proposals and cost checks. The fragmental cost estimate on buildings was established in the 1950s, while the further appendices were specialized by the Building Cost Information Service (BCIS) [20]. In the UK, for example, during the past decade, their cost estimate method, modified from the bare lump sum founded on Bill of Quantities to the lump sum schedule and specification method.

V. SINGLE PROJECT'S PORTFOLIO – COSTS OF PLASTER SUSPENDED CEILINGS

The supervised building consisted of two building blocks, one eight-story and the other six-story. Two building blocks were two constituent building parts in the same plane of the building. The building was conceived as of mixed purposes, partly residential, partly office building. In the cross-section of both building blocks were situated from 10-12 apartments on the first six floors, while the top floors of the higher building block (7. and 8.) comprised fewer apartments. Each building block had two connected elevator boxes and a staircase beside. The ground floor was anticipated for the office area, and the building blocks also had three underground floors designed for garages and basements as pantries. Underground has also settled a power substation with the cables and switch gears. Around the building blocks were projected access ramps and trails as well as the lawn parties.

The hierarchy of duty delegation on the project was the top-bottom. The top management (top managers) were the owners of the contractor's company, which was at the same time the main contractor (main contract side). The other main contractor of the project (the other contract side), which was also the investor, was a municipal, local agency for construction works competently for public construction works. The top management of the contractor's company engaged only one subcontractor's firm. The subcontractor's firm had its own labor crew.

In the following drafts, on the next page, are depicted the trans-sections of the building. Fig.2 is depicted the backside of the building blocks towards the backyard of the building. Fig.3 is attached the architectonic floor plan of both building blocks (with a staircase and elevator boxes). Fig.4 is given a roof of a higher building block with the cross-sections.

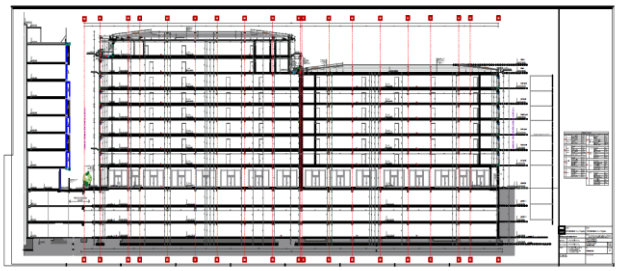

Fig.2. The backside of the building (building blocks)- (Author's source).

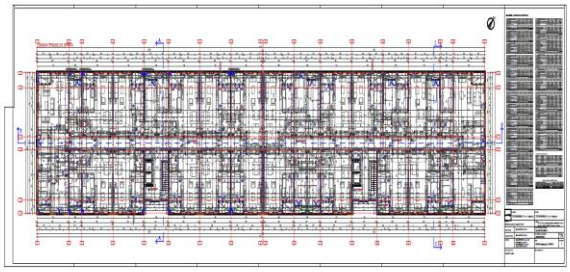

Fig.3. The architectonic floor plan of both building blocks (with a staircase and elevator boxes) – (Author's source).

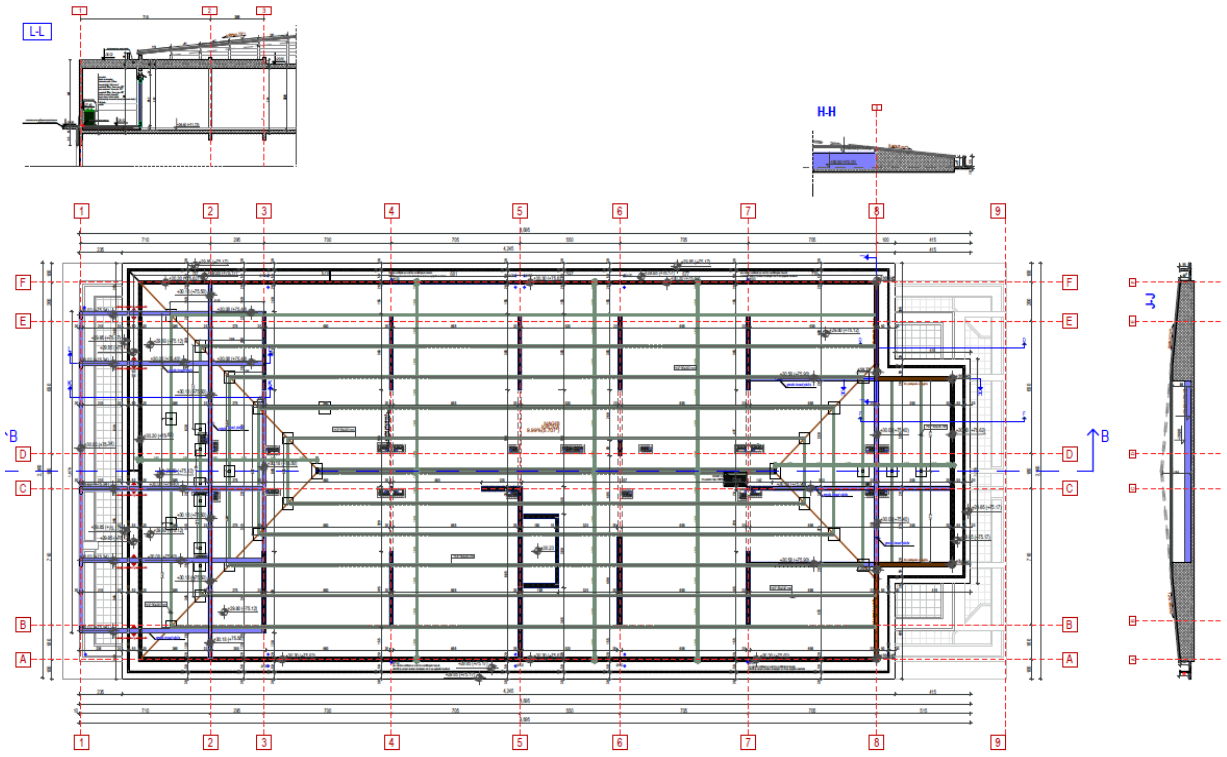

Fig.4. Higher building block's roof with the cross-sections - (Author's source).

For each construction project is characteristic a costs' flow. This construction project was done based on the Bill of Quantities and Estimate of Works. The labor positions were clearly signified by the type of construction works, the number of construction works, and measure units.

On Table 1 was given some sort of bill of quantities in abbreviated form, specifically and merely related to the plaster works-suspended plaster ceilings. The enclosed bid price is at the same time contractual and contracted price of finally finished products (suspended plaster ceilings). In Table 1, the plaster works are distinguished by: a) feasibility mode (cascading, linear); b) spot of feasibility (wet knots, bedrooms, living rooms, and corridors of the apartments); c) measure unit of calculation of works (m^2 or m^1) and d) by the number of works in relation to the available area. Suspended plaster ceilings had an additional role, served as concealers for LED lighting, partly in the living rooms and bedrooms. Conjunctions on two dabbed gypsum boards were bandaged with fugen filler in 2 hands.

Furthermore, this bid price from Table 1 reminiscents on the fragmental cost estimate. The fragmental cost estimate is cost appraisal by building elements, which can be defined as building fragments or building parts. The fragmental cost estimate (from Table 1) is, in this case, the cost estimate of internal processing, which is actually a ceiling finishing, and one element of ceiling finishing is the setting of suspended plaster ceilings. The other ceiling finishing works are bandaging, smoothing, and painting.

Looking back into Eq.(1), [14], the mentioned equation for the cost estimate by cost-significant labor positions can not be implemented on the type of work in Table 1- plaster works. Simply these plaster works are not so time-consuming and do not require all needing resources, which are cited in Eq.(1) [14]. For example, when it comes to the used mechanization during plaster works (suspended plaster ceilings), the used mechanization is so minor that it can be neglected. All gypsum boards are in advance cutted and shaped. Also, the plaster works from Table 1 (suspended plaster ceilings) are one-term works, do not require a monthly periodical calculation of price. As for the laborers of these suspended plaster ceilings, there do not have to be exposed necessarily specifications about their training or specialty, so the specialty label of laborers does not apply to this case of construction works.

Table 1. The fragmental cost estimate- cost estimate for the suspended plaster ceilings, which is adapted as a final singular cost – (Author's source).

SUSPENDED PLASTER CEILINGS FOR LINEA'' CONSTRUCTION			
Construction of a flat, monolithic, suspended ceiling on a metal substructure, from KNAUF gypsum moisture-resistant boards, 12.5 mm thick, bandaged with fugen filler in 2 hands. The ceilings are done in all wet knots (bathrooms, toilets, and laundries). Computation by m².	Comprised area (m² or m^1) 907 m²	Unit price (€ /m² or €/m^1) 11.40	Calculated price (€) 10 339.80
Construction of a flat, monolithic, suspended ceiling, on a metal substructure, from KNAUF gypsum ordinary boards, 12.5 mm thick, bandaged with fugen filler in 2 hands. The ceilings are done in the corridors of the apartments and partly in the living rooms and bedrooms. Computation by m².	885 m²	10.60	9 381
Construction of L-shaped cascade on a metal substructure, made from KNAUF gypsum ordinary boards, 12.5 mm thick, bandaged with fugen filler in 2 hands. One edge is treated with a metal EX rail. The cascades are done partly in the living rooms and bedrooms. Computation by m^1.	2177 m^1	10.60	23 076.20
Construction of plaster concealers for LED lighting, on a metal substructure, on the ceiling, from KNAUF gypsum ordinary boards, 12.5 mm thick, bandaged with fugen filler in 2 hands. The edge of the plaster concealer is straight with the finishing U profile. Plaster concealers are done partly in the living rooms and bedrooms. Computation by m^1.	2010 m^1	11.35	22 813.50
In total:			65 610.50 €

V. CONCLUSIONS

The (construction) cost estimate is the technical process of forecasting the costs of the construction. There is a so-called economic tenet for buildings, WLC – (whole life costing) which encompasses the LCA (life-cycle assessment) of a building and a lot of other value assessments of a building. The aim of this paper is to reassess the existing (construction) cost estimates, appearing in the construction practice, to better influence the service life span of the buildings, quality of the built buildings, quality of the labor positions, running costs of the construction.

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