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Improving Productivity in Building Construction

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***Abstract*: The productivity level of construction industry is mostly depending upon three factors they are labour characteristics, management systems and external issues. Different researchers have determined different factors that influence construction productivity. Understanding the level of productivity, it is important to develop innovative practices to improve construction productivity.**

Productivity has for many years been an issue for the construction site. This paper reviews current productivity measurement literature, particularly that pertaining on the construction site, and offers recommendations/suggestions, for improvement of productivity at the site. It also shows that productivity can be measured by monthly planned/targeted concrete and actual consumption of concrete data. Whereas targeted concrete is the input value and actual consumption of concrete is the output of the productivity. Considering single factor type of productivity i.e. concrete we have calculated the productivity for shell and core type of contract. It also show few reasons, why productivity at construction site is reduced due to improper shuttering, reinforcement activity.

***Keywords*: Productivity, construction and reinforcement activity.**

1. Introduction

A. Construction productivity

The construction industry frequently constitutes about ten per cent of the Gross Domestic Product, with the figure likely to be higher in developing than developed countries. Although most developing countries tend to adopt the manufacturing industry as the sector for stimulating employment and creating job opportunities, they still place importance on the construction industry for supporting economic development. Unlike several other industries, the level of technology in the construction industry has remained relatively unchanged over several decades. The lower pace of technological development in construction places the industry at a disadvantage when compared with other industries where enhanced productivity is achieved through the use of modern technology. As the construction industry is a diverse sector of the national economy which involves a wide range of scarce resources, its productivity is therefore not only concerned with many individual activities, but the industry as a whole.

B. Productivity in construction industry

At macro level, the building industry is considered to be one of the key industries in the general economy. The construction sector typically comprises 8-10 % of the Gross Domestic Profit (GDP) of a Western economy (McGeorge & Palmer, 2002). A 10 % improvement in construction performance can represent a 2.5 % increase in GDP (McGeorge & Palmer, 2002). There is, therefore, no doubt that improving productivity in the building industry will contribute positively to the general economy.

Fig. 1. Index of construction labor productivity

C. Objective and motivation

This study takes its point of departure in the productivity problem of the construction indus-try. Construction industry hosts the typical examples of project-based organizations (Chinow-sky, 2011) working in dynamic environments and short term collaboration patterns. After the projects are terminated project teams are usually dissolved (Bower, 2003) and therefore the transfer of the valuable experience gained during the project execution is limited. Basically, in every new construction project many things are reinvented again and again causing the same mistakes being repeated over and over again. The purpose of this study is to explore in what ways modularization may help this problem. By breaking down products, processes and organizations into components and modules, the thesis advocates, a handover of comprised work and experience is made possible and building processes may be made more efficient. I choose the building industry as my field, because of its repetitive nature as compared to, for example, infrastructure construction. It will be my argument that modularization can increase productivity in specific instances within the building sector and that these instances deserve

attention due to the potential they open for comparable processes to be enhanced and boosted. These instances cover different processes such as tendering, design, building in the long life cycle of building projects. Although examples de-rive mainly from Denmark, cases from different geographies and contexts are included in the studied so that more general perspective of the problem studied can be attained.

D. Building construction productivity at the project level

The challenge that the construction industry faces is the fact that construction production differs noticeably from repetitive manufacturing mainly because of the nature of the product and the role of the customer (Ballard, 2012). The special attributes of the building production are valid reasons for the companies operating within the construction industry to adapt to survive in the market. First, the discontinuities of the projects force companies to adapt by shrinking and expanding rapidly according to the project requirements. Valuable experiences and hard-earned knowledge disappear from the organizations together with the construction team's dissolution. Second, the supply chain must be organized in a flexible manner to support individual project needs. Last, the stakeholders of each project are different e.g. client, designer, and consultant. Even if the same parties work on different projects there may be different people assigned to the projects. Moreover, different parties come together under different con-tract types, thus redistributing the roles and responsibilities. So there are a number of valid reasons that make the construction industry particularly prone to obstacles, delays, interferences, and inefficient work flows. This does not, however, change the fact that the construction sector is a locomotive for other industries and, therefore, important for the economy. It does highlight the urgency of looking into how the particular challenges can be overcome or mastered by new and alternative approaches to the field. Before moving on to the context and structure of this research, I wish to present a concrete story from my own working life, which illustrates the complexity and inefficiency of the construction industry at the project level. On the day designated for slab concrete pouring, the architect sends a change order. There is a new drawing with a big cloud around the slab being produced and a 'HOLD' sign. The reason for the sign is unknown and the duration of the hold is uncertain. Most probably the current site situation and the urgency of the slab completion for the rest of the building construction are also unknown to the architect and other parties responsible for that change order. The days pass and no clarification comes. The contractor gets more and more worried as production has been interrupted. The production cannot be finalized by pouring the concrete, which causes steel-bars to rust. The formwork under the slab is not able to continue the planned weekly cycles. The scaffolding under the slab is not contributing to the production. Furthermore, the next production module is pending because the slab concrete pouring is a pre-request for them to start. The client is too busy with other issues and the architect has not been informed about the actual situation at the site. The consultant points out the other tens of square meters of the project to be built in order to prevent any claim of the contractor for a work schedule extension. Later we will find out the reason for the 'HOLD' sign is an embedded plate with undetermined dimensions. However, that does not require the interruption of the entire slab production, but only a small part of it.

2. Literature review

Shinde V. J., Hedaoo M. N., et al (2017) This paper includes systematic literature reviews on productivity in construction industry the paper gives an review on different method which are used for measurement of construction productivity, factors affecting and theories on improvement of construction productivity such as labour factor, management factors and external factors, the paper further reviews on the different innovations which are made for improvement in construction productivity. From this study it was concluded that there are many methods of increasing productivity in construction industry. There is enormous study on the methods which improve the productivity which consists of material tracking, healthy and safe working condition and effective management systems.

Sneha Jamadagni, B.V.Birajdar, et al (2015) This study highlights the factors affecting labor productivity of the Construction industry. From this study it was concluded that the clarification in technical specification factor ranked 1st among the 38 factors having R.I.I value is 79.22%. It is important factor in productivity.

Varma Santosh, M. R. Apte, et al (2014), from this study it was concluded that Appointing more subcontractors/ Agencies is recommended for splitting the work building wise.

3. Methodology

A. Research methodology

The research object is a sociotechnical phenomenon. As a starting point, the organizations work with processes to create products in a sociotechnical world constructed through language and discourse (Hatch & Cunliffe, 2006). Therefore, DRM is a relevant strategy not on-ly because it tries to provide solutions to problems onsite but also because it helps to deconstruct the current ways of working in the building industry through the multiple studies ap-plied in different stages and presented in Figure 4. In that way, the common understanding of every building project as being unique, and therefore having unique conditions and unique challenges, can be questioned reflexively. Epistemologically, in order to understand this social world constructed through generations of work practices passing from master to apprentice, we need a constructivist approach rather than a positivist perspective (Hatch & Cunliffe, 2006) Much of the observations and narratives are context dependent and, as opposed to positivist experiments in the natural sciences, different views points of the different stakeholders, such as designer and contractor, will be

elaborated through a constructivist approach. However, even though data is context dependent and the problems identified vary according to different sites, the tendencies observed and solutions suggested in this thesis have a general character. To illustrate, the same solutions suggested as a result of the descriptive II studies can be applied universally although contexts can be different.

B. Research design

Design science was adopted as a research methodology to add new knowledge to the accounting theory by combining practice and already existing theory primarily by accounting purposes and later by information technology first introduced design science research in management science.

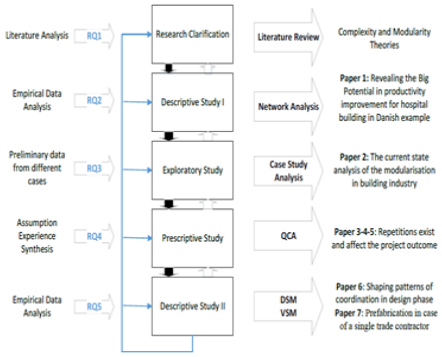

Fig. 2. Detailed representation of followed DRM

C. Data analysis methods

1) Network analysis

In order to analyze the first descriptive study network analysis is applied. Manning (2005) defines project networks, as sets of intra- and inter organizational relationships between individuals and organizations that interact within the scope of one or several projects. The complexity of the temporary organizations and the way this complexity affects project productivity is studied. Inter-organizational relationships between the hospital construction stakeholders and final design output that is in common in all cases, are investigated comparatively in order to reveal the productivity improvement possibilities.

D. Case study analysis

For exploratory study stage data analysis, cross case pattern search described by Eisenhardt (1989) and later elaborated as pattern-matching strategy by Yin (2009) are used. According to Yin (2009), pattern-matching is one of the most desirable strategies, especially if the case study is an explanatory one. With the purpose of building an understanding of modularity and its applications in construction two multiple case study analysis with 7 and 11 different case studies respectively have been made

E. Qualitative comparative analysis-qca

In order to explore repetitions across so-called unique construction projects, QCA was used in the prescriptive study. QCA allowed me to draw combinations of different factors of practices (conditions) leading to a dependent outcome. The research process was highly iterative. During this iterative process, the literature is revisited and additional empirical material was gathered to solve occurring contradictions.

F. Value stream mapping

In order to operationalize modularity, a map visualizing the flow of resource usage, including time, labor, and inventory, through implementation is used as a method. VSM, described as the blueprints for lean transformations, is applied in the final descriptive II case (Rother & Shook, 1998).

4. Results and discussion

Table 1
Planned and executed quantity of major activity

Sl. No	Month and Year	Shuttering in Sq m		Reinforcement in T		Concrete in cum	
		Planned	Executed	Planned	Executed	Planned	Executed
1	Apr-18	4663	2402	216.62	215.28	1050	541
2	1-May	12790	1808	421.3	378.71	2518	356
3	Jun-18	20643	6373	635	602.84	2731	843.17
4	Jul-18	21980	6026	780.68	539.81	2649	726.26
6	Aug-18	27558	7963	891.92	567.32	3070	887.1
7	Sep-18	31054	6707	1029.2	595.24	3400	734.4
8	Oct-18	26915	5238	1120	607.53	3139	611

Table 2
Monthly planned progress of project

Sl.No	Month and Year	Planned Total Monthly Turnover in Lakh	Planned Concrete (Cum)	Turnover for concrete in Lakh
1	Apr-18	194.25	1050	65.1
2	1-May	465.83	2518	156.11
3	Jun-18	505.24	2731	169.32
4	Jul-18	490.07	2649	164.23
6	Aug-18	567.9	3070	190.34
7	Sep-18	629	3400	210.8
8	Oct-18	580.72	3139	194.61

Table 3
Monthly actual progress of project

Sl.No	Month and Year	Actual total monthly turnover in Lakh	Executed Concrete (Cum)	Actual Turnover for concrete in Lakh
1	Apr-18	100.09	541	33.54
2	1-May	65.88	356.1	22.08
3	Jun-18	155.99	843.17	52.58
4	Jul-18	134.36	726.26	45.03
6	Aug-18	164.11	887.1	55
7	Sep-18	13.86	734.4	45.53
8	Oct-18	113.04	611	33.54

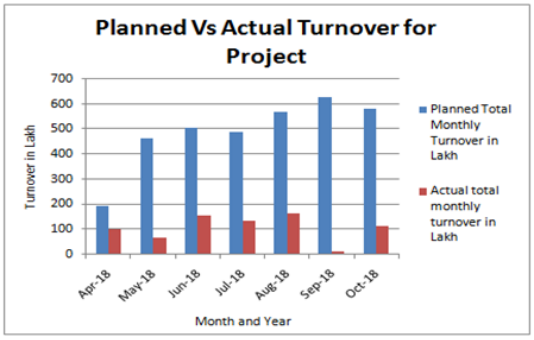

Fig. 3. Planned vs. Actual turnover for project

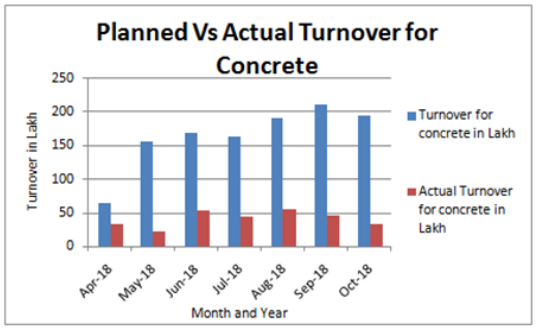

Fig. 4. Planned vs. Actual turnover for concrete

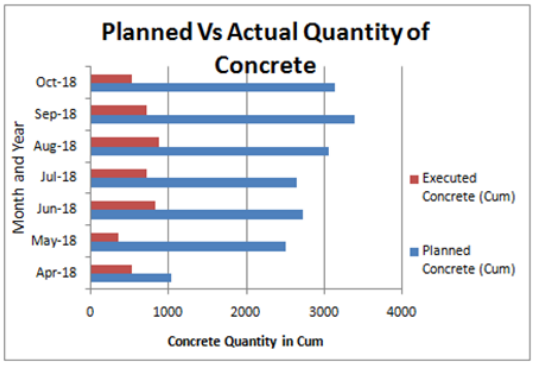

Fig. 5. Planned vs. Actual quantity of concrete

Table 4
Difference between planned quantity of concrete and actual quantity of concrete for project construction

Month and Year	Planned Concrete (Cum)	Planned cumulative	Executed concrete (Cum)	Executed Cumulative	Productivity in %
Apr-18	1050	1050	541	541	51.52%
1-May	2518	3568	356.1	897.1	29.64%
Jun-18	2731	6299	843.17	1740.27	32.22%
Jul-18	2649	8948	726.26	2466.53	34.22%
Aug-18	3070	12018	887.1	3353.63	35.11%
Sep-18	3400	15418	734.4	4088.03	33.89%
Oct-18	3139	18557	611	4699.03	32.48%

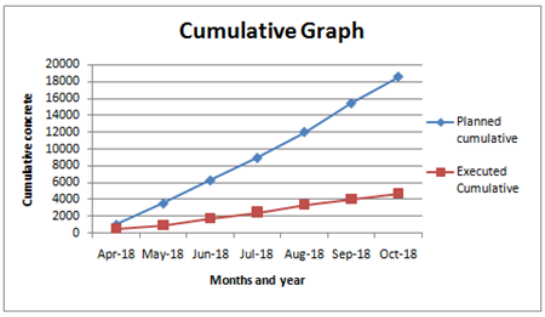

Fig. 6. Cumulative graph

Fig. 7. Productivity

5. Conclusion

- As project is already delayed by 3 months of its time schedule with productivity of 32 .48% the management has to first maintain its progress as per planned and to keep the project on schedule management has to increase the Percentage of productivity.
- Major factor affecting labor productivity are low payment, poor construction methods, use of technology/level of mechanization, delay in material delivery
- For large companies, equipment factor is highly affecting labor productivity. While in small and medium companies owner/consultant factor need special attention.
- Some construction labors are engaged in some other profession like farms, factory, domestic servant etc. and hence they do not give full importance to construction work and tend to work informally.
- Key for productivity improvement is not to complete as many tasks as possible or to maximize workload but focus on maintaining a predictable workflow.
- The theoretical model of this study proposed fifteen independent groups affecting the variation of labor productivity in the construction projects namely labor factors, supervision factors, external factors, owner/ consultant factors, execution plan factors, designer, working time factors, equipment factors, financial factors, quality factors, project factors, organization factors, leadership and coordination factors, and health and safety factors.

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