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## A review of performance measurement for successful concurrent construction

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### Abstract

Concurrent engineering and performance measurement are both manufacturing industry concepts that have coexisted and complemented each other for the manufacturing industry success. Construction industry has integrated manufacturing philosophies but still waits for the success manufacturing industry enjoyed. With the help from the literature, the paper looks into the status of performance measurements in construction. The literature review generated more questions than answers. It reflected that the existing construction industry structure needs overhauling. Finally, the paper presents six questions with the help of literature evaluation for future research to start a focused debate on measuring the success of concurrent construction.

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*Keywords:* Performance measurement, Concurrent engineering

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### 1. Introduction

Due to the size of the construction industry, productivity trends in this industry have notable effects on national productivity and on the economy as a whole (Allmon et al., 2000). Construction industry adopted philosophies from the manufacturing industry like concurrent and lean manufacturing for productivity improvements. Manufacturing industry have testified many success stories from Concurrent Engineering (CE) application. Fine et al. (2005)

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reported 30-60 % reduction in time-to-market, 15-50 % reductions in life costs and a 55-95 % reduction in engineering change request with CE applications in automotive industry. Performance measurement is also a manufacturing industry concept, it was initially introduced and successfully implemented in the manufacturing industry (T. Haponava et al., 2012). Performance measurement plays an important role in ensuring the project success and its subsequent usefulness to the sponsoring organization (Pillai et al., 2002).

Construction industry is notoriously fragmented with a typical project involving up to six or more different professional disciplines (Anumba et al., 2000). Fragmented nature of the construction industry lead to slightly different evolution of performance measurements in the construction industry to the manufacturing industry. The paper reviews the status and the evolution of the performance measurements in the construction industry in a theoretical framework to investigate how we can measure the success of concurrent engineering projects. It also indicates and discusses six areas for the focus of future research to simulate the success from the manufacturing industry for the construction industry.

## 2. Research Method and Limitations

The paper is inspired by the experiences gained by the author working in concurrent projects for construction and offshore industry for the last 5 years. The author was involved in the production of (Building Information Modelling) BIM models and the follow up of execution activities with design information between contractors, sub-contractors and suppliers. As Easterby-Smith et al. (2008) described the influence of experience as acting as a sensitizer and filter for the researcher. The study is restricted to the performance measurement systems that author experienced in the Norwegian industry and aimed the research for the improvement of the existing systems.

The paper is a first step to a larger study aimed at improving the performance of the Norwegian construction industry. The literature part of the study followed the steps specified by Blumberg et al. (2011), 1) building of an information pool, 2) application of a filter to reduce pool size, 3) a rough assessment of sources to further reduce pool size, 4) an analysis of the literature in the pool and 5) the refinement of filters or stop search. The performance measurement literature was searched with the help of Web of Science, Google Scholar and Scopus. The literature was then divided into two pools a pool of efficiency measurements and a pool focused on measuring the effectiveness.

The secondary literature pool with the keywords of `Performance Measurements in Construction` `Concurrent Engineering` `Concurrent Construction` & `Performance measurement in Concurrent Construction` was skimmed to 350 publications in an Endnote library. The performance literature was then filtered to the influential and most cited authors with the help of (Taticchi et al., 2010) where they used (A. Neely, 2005) citation/co-citation analysis in there web based search using ISI web of Knowledge database on `performance measurement`. The publications with more relevance to the existing construction industry structure and methodologies already in practice by the Norwegian construction industry were then selected for closer examination by the author's experience.

To limit the first leg of the study concurrent readiness models (BEACON model, CERAMConstruct Model) and uncertainty evaluation techniques (fuzzy models, evidence theory, system simulation method, Information theory method, Grey theory, Artificial Intelligence, Dynamic evaluation method, Interactive multi objective evaluation method, Rough sets method, AHP models and DEA etc.) were marked out of scope.

## 3. Theoretical Framework

Against the traditional sequential engineering, concurrent introduced the concept of simultaneous or parallel engineering to the construction industry to reduce project time. Evbuomwan et al. (1998) in the context of construction defined Concurrent Engineering (CE) as an `attempt to optimize the design of project and its construction process to achieve reduced lead times, and improved quality and cost by integration of design, fabrication, construction and erection activities and by maximizing concurrency and collaboration in working practices`. Due to an increased global pressure to construct a building or a facility as early as possible, parallel processing in CE is becoming a necessity (Kamara et al., 1997). The earliest definition of CE came forward by Winner et al. (1988) and concurrent practices in the construction industry started to surface during late 1990's (Evbuomwan et al., 1998; Kamara et al., 1997).

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