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WHAT ACTUALLY DRIVE CONSTRUCTION PROJECT PERFORMANCE FROM OPERATIONS MANAGEMENT PERSPECTIVE

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ABSTRACT

Construction industry is always an interesting discussion topic. Some have it approached from its planning and scheduling view accommodating risk analysis. Other interesting topics related to construction industry are its business model, organization and operations. The author argues that construction is a function of them all. An emphasized study on a specific topic above would be less relevant given the fact that construction industry is highly fragmented. From literature review, factors such project integration, communications, knowledge and understanding, human resources, safety, financial, and cost management drive more significant impact on project scheduling performance

Keywords: *project scheduling, risk management, construction management, performance, operations*

1. PRELIMINARY

Construction as an industry is very complex and fragmented. It is a combination of engineering, economy, commercial and (in many cases) politics. Construction in many cases [1], is associated with gentrification in which not easily separated from the style of policy handling of the government in power. Power and capital along with people who run the system have explicit grounding in construction projects.

As a commercial function, construction is inseparable with strategic and operation variables. Strategic variables accommodate derivative variables such marketing strategy and finance strategy. Most pitfall related to finance strategy of new investors for investment eligibility decisions is when looking at published prospective reports on certain construction industry of a certain region. A paper [2], offering a little insight of how not to tie to a single variable during a decision-making process related to financial strategy. It implicitly suggests a fragmented sensitivity analysis for such investment with highly fragmented factors. Similar to those strategic variables is operations. This is the perspective view that this paper will elaborate further.

This paper is commonly structured with opening on presentation of contemporary operation management. Following the opening, this paper presents an elaborated tentative summary with suggested methods addressing to the contemporary issues. A closing discussion will then conclude this paper.

2. HAS PROJECT SCHEDULING ADDRESSED THE DELAYS ENOUGH?

Project scheduling has been among an intensive discussion topic in project management. There have been interesting studies on project scheduling. Significant developments in this specific subject such the use of genetic algorithm for both and constraint and non-constraint resources have been an interesting topic published in many papers over the years. However, it is still sometime in the news (Figure 1) and some publications referred in [3] reporting such overbudget projects that had been way too far dragged from their initial completion dates. Those projects listed in figure 1 were unlikely not to engage extensive services of operations management.

The objective of this paper is to set out a basic framework that is practically representative to construction industry. The author argues that construction is a function of various subjects. Those subjects are such macro economy (such loan policy, interest rate, etc.); micro economy (real spending ability level of people, loan policy for public, etc.); system and policies (roadmap of national projects, permit procedures complexity, imported materials/machines, etc.); current political standings; other industries performance, etc. Those subjects are inseparable at a various degree of dependency. What happens today is that practitioners of project management and professional users of project planning would rather go deeper on a specific sub subject (such as scheduling) as the major indicator by holding significant assumptions relatively constant to distinguish a success from failures.

Risk analysis as a way to counter uncertainties has been incorporated into project planning activities. However, risk analysis is often manifested as a single number to represent various fragmented uncertainties during planning stage within a single or even multi project environments. As per the dated publication of a paper [3], there were less discussions for simultaneous scheduling in multi-projects management while literatures and even professional organizations do not always consider sufficiently resource-constraint in project scheduling.

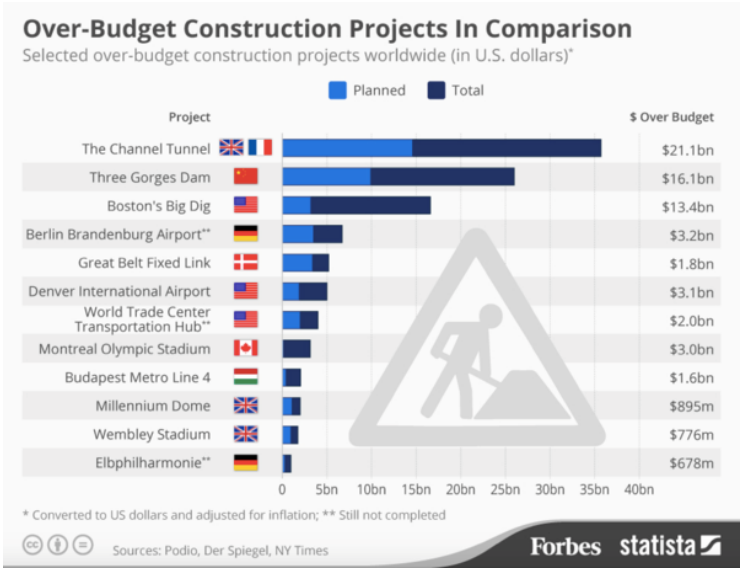

Figure 1. Infographic showing major projects worldwide with overbudget issues. [4]

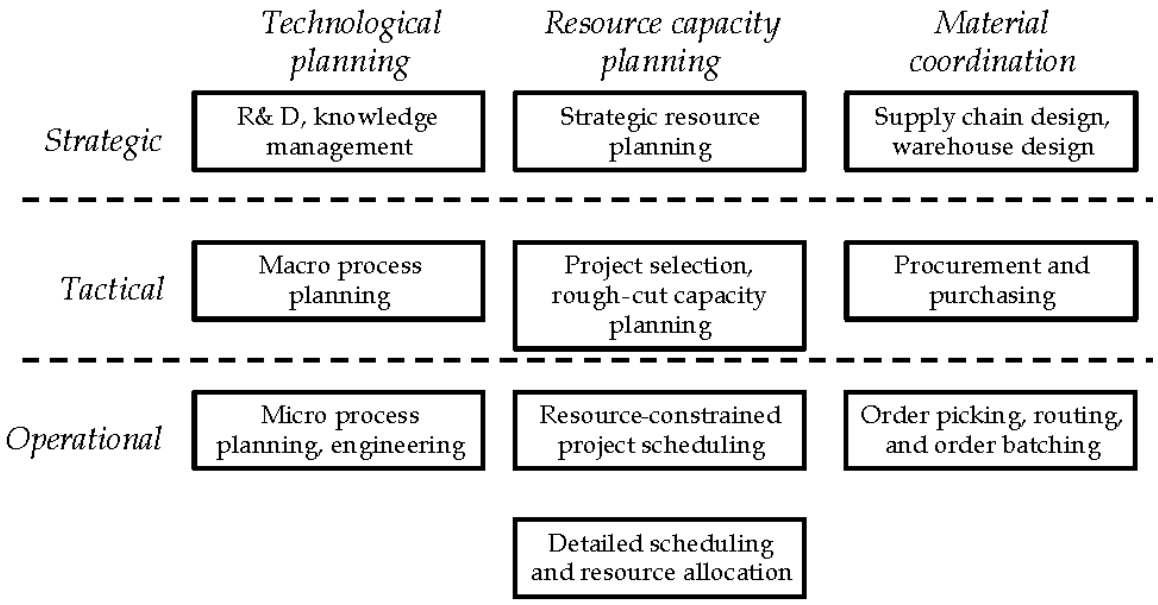

Figure 2. Hierarchical framework. [3]

3. ACTUAL CONSTITUTING FACTORS IN HIERARCHICAL FRAMEWORK

Project risk, as referred in PMBOK Guide [5], a Guide to the Project Management Body of Knowledge –a set of terminology and guidelines published by PMI (Project Management Institute)- is defined as

> *an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality. A risk may have one or more causes and, if it occurs, it may have one or more impacts. A cause may be a given or potential requirement, assumption, constraint, or condition that creates the possibility of negative or positive outcomes*.

PMBOK [5] also suggests four measures to avoid and/or eliminate the risks' damages.

Three strategies, which typically deal with threats or risks that may have negative impacts on project objectives if they occur, are: avoid, transfer, and mitigate. The fourth strategy, accept, can be used for negative risks or threats as well as positive risks or opportunities. Each of these risk response strategies have varied and unique influence on the risk condition. These strategies should be chosen to match the risk's probability and impact on the project's overall objectives.

Discussing construction as an industry means taking the whole packages related to it. Construction in general can have a very strong association with social and economic situations of a region. Let us take a look at - for a quick example- the annual volume of transported goods flowing into a specific region classified as construction materials. To some extents, it can implicitly provide some information about construction activities. The deeper the trace for that information, the more detail information obtained which will then be useful for specific analysis in operations.

In figure 2, a hierarchical framework for project planning and control classifies three hierarchical levels along with each functional plannings. The hierarchical framework above is well explained through variability and dependency determinants. Variability describes uncertainty at the tactical stage. This also tells that the tactical stage may exploit high freedom of flexibility. The uncertainty

described in variability measure usually becomes gradually less by the progressing activities. Dependency measures the limit of a particular project to external impacts.

Supplementary to figure 2, the author offers a bigger picture (figure 3) of economic environments that both explicitly and implicitly affects functional plannings. Operations strategy, along with finance and marketing, supports business strategy. What is particular in this explanation in regard with hierarchical framework at figure 2 is that operations strategy is actually positioned within tactical level that deals with internal factors whereas business strategy and its marketing and finance strategies are at strategic level that have a lot of external interactions.

Figure 3 could be immediately associated with external factors. In this case it will likely influence the strategic level at the hierarchical framework. That is true at some extent to when we draw figure 3 as a single uncertainty coefficient and rather assuming it as constant through the whole project completion period. The practice is pretty much similar to assuming IRR as a major indicator, even if the IRR analysis is done through multiple IRR for each sub criteria. We know that sensitivity analysis in most IRR analysis holds fix other parameters while observing a particular parameter [2].

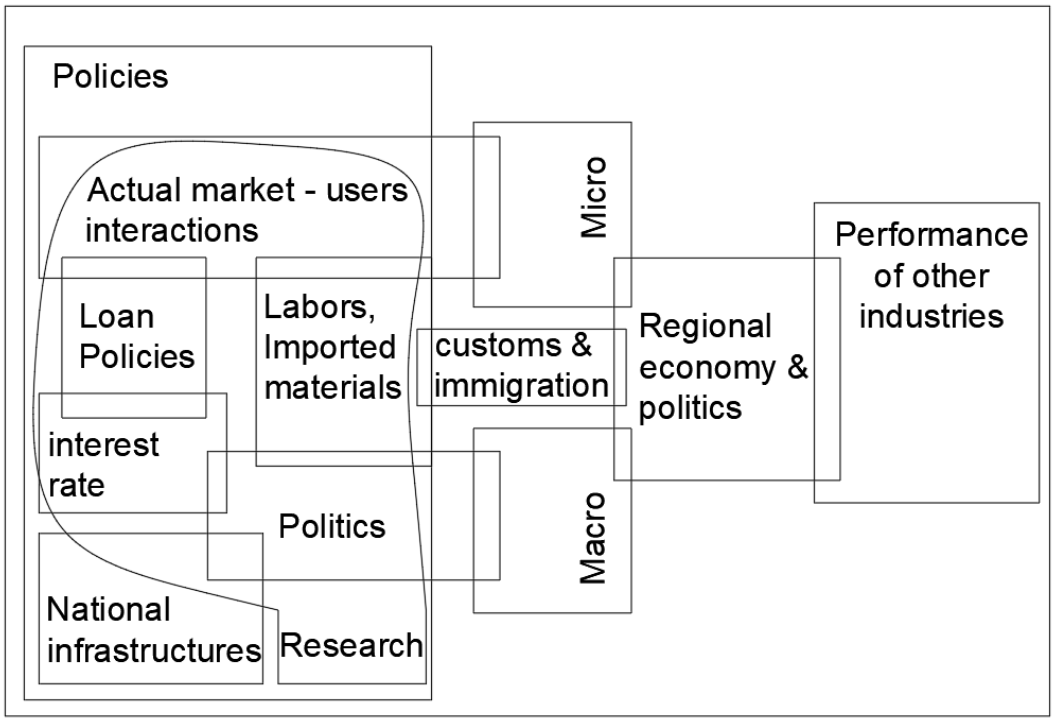

Figure 3. Relations of constituting factors for project planning within economic environments.

Ideally, figure 3 is instigated in all levels at different portion of influence. Situations in figure 3 could be imposed diversely to every entity involved in a particular project. For example, when a related schedule for outsourced labor supply is made, a certain risk factor causing delay on labor supply could be how far the labor supply available, transportation to the site and local regulation on basic income. They could be all taken from a coefficient described in the earlier tactical or even strategical stage. It means the coefficient is assumed constant. What if there is a potential delay of labor supply caused by road closure due to there is a group of

people protesting for lowering price demands. Second example, what if the road closure is caused by a sudden occurrence, such a group of people expressing dissatisfaction by the outcome of a government court institution for a certain case related to an insurance company failure to respond to a claim demand (usual business issues to a group of persons)? Remonstration in most cases is expected especially when political instability exists. People in the area are aware of the environment, how to measure it as a direct risk? Though expected, there is no fixed schedule on when a remonstration event becomes uncontrolled mob that could immediately stop a usual operation schedule. The mob, if it was related to political instability was induced indirectly by factors considered to be within strategic state. Yet if the environment is happening normally, no major political issues cold generate people unrest at any moment, measuring the risk factor within strategic state could be irrelevant. Suggesting the risk caused by the second example to be included in tactical level where its partial inclusion in timeline base is calculated periodically looks fit better. The difference between two examples above is where the uncertainty lies. It turns out that uncertainty happens at the higher hierarchy. There are risks that create similar effects but different in how much and when to consider them.

While everyone is busy in the middle of progressing work, the fact that construction is a fragmented business is rather no longer among the critical considerations. Again, taking an example from a labor supply contract, when the labor supply is carried out by an outsourced company, the most tangible measure to enforce the schedule is by the agreement with all penalty placed for not restraining the agreement. The outsourced labor company will likely to have different operation strategy than that of the main contractor and every other entity in that particular project. The commitment to follow the agreement will likely be abandoned whenever a much better situation arise for that particular outsourced company, one that even still better after covering the penalties. For the project, receiving penalty insurance sometime does not correspond the time lost caused by turbulence from labor supply disruption. The tradeoff; An increased penalty during agreement process would induce higher project cost.

There are for sure examples in similar situations, in terms of how and when a potential problem-causing factor from figure 3 happens. The message to this point is that imposing a factor in a certain hierarchical level without knowing the context of that factor could reduce the accuracy of uncertainty estimation within scheduling especially in fragmented nature of construction industry

4. REAL SITUATIONS AT CONSTRUCTION SITES

There seem from above situation almost no way out for project planning if such situation above has to be considered in a way that accommodates every single uncertainty related to the project. The project planning period would be absurdly time consuming that way. Yet, we know such situation occurs over time. That explains why the bigger the project the more the chance for escalating delays and eventually goes overbudget.

A paper [6] in 2004 elaborates an idea of more socially informed society paradigm as an effort for better operations management at site. The paper describes rather chaotic situation of working construction sites after a series of observations and at those sites. Failures to follow theoretical project management rules that exemplified by people at those working construction sites. Those failures actually are more like disorganized working system in the sense of overlapping and obscure limit of descriptions of jobs causing potential interruptions and distractions to each

other. This situation would probably be overlooked by those never attended meetings at a construction site.

Another literature [7] presents operations management from the perspective of construction contractors. The paper argues similarly to paper [6] through direct interviews to several job categories within a construction contractor in a project and repeated the same method to a few other projects. That is basically knowledgeable human resources within organization is among importance of operations strategy. Following to it is its integration within the organization, and how the organization facilitates the process. One interesting point to be noticed here that process technology was rarely mentioned. This is already known, yet to re-emphasize, that construction technology usually brought-in that category rather than developing it. Construction contractors are commonly technology user rather than technology developer. Here project scheduler professionals should take considerations views from wider perspective.

It was between 2007 – 2010 during subprime mortgage crisis [8] or commonly known as *credit crunch* event and, construction was among industries related to the crisis. The epicentrum of the crisis was actually in the US but, since US dollar was associated in many other investments around the world, the crisis also contributed to the global financial crisis within the period. The Middle East region is known for its main earnings from petroleum industry and uses it to boost its construction industry. Construction industry was hit badly almost everywhere globally including in the Middle East. Here, deeper analysis about what happen in the Middle East during that crisis shows that the construction industry was affected partially. Partially in the sense that it affected mostly the privately funded projects. The government funded projects remained progressing as usual. It is known that the crisis was bank issues. The scale of impact of the crisis in construction projects is linear with how much the construction funding related with banks and US Dollar. Small suburbs nearby oil recovery zone could remain calm. People who work in oil and gas industry were stable buyer or user of property business. Financial support to construction had been secured before the crisis hit. Therefore, construction activities in the suburbs progressed as usual. In this example, this paper suggests construction industry whose support from property business, would retaliate to impacts related to the property business.

In some cases, also happen that construction contractors are more bounded to expenses limit than bounded to time completion. The situation tells that during project scheduling, time does not always go along expenditure budget. In places where abundant supply labor is available, allocated budget limitation for construction contractors could be separately calculated from time limitation. Labors could be employed on and off without significant financial consequences for the employer. For this kind of situation, basic scheduling likely to have complexity in a sense that the uncertainty is not unexpected events that could disrupt the operation. The uncertainty here is whether the contractor along with the consultant and especially the owner altogether is committed to follow the agreed timetable. The resource constraint here is basically financial related factor but what make it more complex is that the factor is unexpected in the sense of nobody knows the when this issue is intended. There are regions with very lenient regulations on such situation, meaning whenever the owner feels like to take a break from regular payment obligation to his project due to his own business agenda, then all of sudden the project is paused for unclear period and everyone else in the project simply takes it and find other earning activities to sustain themselves. Addressing the situation in term of hierarchical framework in figure 2, this could be put in operational - resource capacity planning but, if the time delays -

say- has become more than a year and, the owner has yet provided no sign of continuing or stopping the project and, everyone seems agree and has no plan to make it a legal case or, -for example- the time constraint is implicitly not considered then the scheduling sounds very complicated.

These days, there becomes construction contractors that build agreements with investors who both have similar business strategy as a consortium and internally appoint the designer consultant. This effort is to make the construction process within one roof of management. The joint business consortium usually requires each member to pledge a certain amount of capital as a bound among them. Theoretically, they want to make sure, the involved entities commit to same vision within at least the agreed period in which by doing it they reduce the fragmentation and make less noise to their schedule.

5. PARTIAL RISK INCLUSION WITH FUZZY MATHEMATICAL MODEL

As an opposed to a common binary "yes" or "no", taking in a risk partially could be a very complex problem. The final objective of formulating risk in a way that represent the reality better is not adding complexity. There is a method called fuzzy method that has been developed since 1965. In its description, a fuzzy subset A of a set X is a function of A: where $X \rightarrow L$. A here describes a subset of activities which is part of a set activities in a bigger set X with L as the interval measure. The L interval here is the factor that can cover when a certain risk should be calculated though it would likely be a little more difficult to cover unscheduled intended factors.

Scholars such [9] have introduced the use of fuzzy techniques to incorporate the risk partial inclusions within project scheduling to measure the success probability. Other report [10] presented a summary of the use of fuzzy mathematics in several categories within construction project management. The report [10] concludes that the use of fuzzy mathematics is rarely applied in actual project management despite its helpful features in decision making and reducing uncertainties. Yet, the later paper [10] also found that the use of fuzzy mathematics alone cannot characterize the reality. It is suggesting that the use of the method is combined with other management methods to correspond the quantitative analysis with qualitative information.

6. CONCLUSION AND FUTURE RESEARCH

Project scheduling is affected by risk management. Knowing how the risks behave, what they possibly cause, and the forecasted when would improve significantly the scheduling accuracy. Uncertainties exist in many aspects of construction management. The analysis is approachable quantitatively and qualitatively.

The main messages of this paper elaborated above are concluded as a qualitative suggestion applicable to risk quantification during project scheduling process. Risks are defined in broad terminology understanding by PMBOK. This paper suggests that risks are uncertainties in many ways. It could be when they occur, how they happen and what drives them and impacts they could cause. Understanding those then ideally, risks should not be assumed constant. This is something we all aware but many times we missed due to focus on schedule bounded target.

Mitigating risks are not always reflected from key technical elements in project scheduling (supply chain, equipment, labours availability, price, location, targets, etc.) that commonly thought. Factors such project integration, communications, knowledge and understanding, human resources, safety, financial, and cost management drive more significant impact on project scheduling performance.

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