

Is Cumulative Impact Assessment and Management (CIAM) a Myth?¹

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ABSTRACT

This paper has been conducted through the course entitled “International Project Contract”, for the Master of Science “Programme and Project Management and Business development” of Skema Business School.

The Purpose of this paper is to discuss the possibility and the options to perform a Cumulative Impact Assessment (CIA), as this is key to project success, especially within the construction industry. The lack of CIA can result either in Project cost increasing, Project delays, or eventually Project failure. Assessing potential Cumulative Impact resulting from the high number of Change Orders this industry requires seems to be a tremendous task, and needs to be done methodologically.

In order to conduct an effective CIA, Project's stakeholders may consider several options, the most efficient being the Matrix of Interactions, the Loop analysis, and System Dynamics. SD is the best method but it is the hardest to implement, thus for smaller projects, the Loop analysis and the Matrix of Interaction may be sufficient to have an overall overview of the Cumulative Impact.

CIA is far from being a myth. It is rather a complex key success factor that needs to be taken into account when considering doing a construction Project, in the continuously changing environment the world is.

Key words: Contract / Projects / CIA / Change Order / Cumulative Impact / Risks / Productivity

INTRODUCTION

It is highly common, within the construction industry, that Owners of a project requests Change orders, as the projects evolve. Such Change orders are often very useful and have a positive impact on the project. They are paid by the Owner, and formally accepted by the Contractor, by signing off a Change Order Form. As a result, the changes affecting the said

¹ *Editor's note: Student papers are authored by graduate or undergraduate students based on coursework at accredited universities or training programs. This paper was prepared as a deliverable for the course “International Contract Management” facilitated by Dr Paul D. Giammalvo of PT Mitratata Citragraha, Jakarta, Indonesia as an Adjunct Professor under contract to SKEMA Business School for the program Master of Science in Project and Programme Management and Business Development. <http://www.skema.edu/programmes/masters-of-science>. For more information on this global program (Lille and Paris in France; Belo Horizonte in Brazil), contact Dr Paul Gardiner, Global Programme Director paul.gardiner@skema.edu.*

project are measurable and logged so that the changes are quantifiable. What if the Owner keeps on requesting Change Orders? Such a behavior will result in potential loss of time, money, productivity, and altogether, the Cumulative impact will deeply change the project. As a result, a good assessment of the cumulative impact will be a clear success factor on a project life.

Cumulative impacts assessment and management should be a key point of concern in the construction industry. A cumulative impact is an effect resulting from successive actions on a project when added to other existing, or planned ones. It is a real challenge in the construction industry to have these potential cumulative impacts assessed, and mitigated when possible. Before requesting too many change order, an Owner has to assess the potential consequences of it, as for the project and for the Contractor. But when assessing those, he must not forget to take into account the previous nor future change orders he has or will request, if he wants to have a glimpse of the bigger picture, and have a chance to control the ripple effect he is initiating.

There are several questions this paper will try to find the answer to:

- 1) Are the consequences of cumulative impact foreseeable?
- 2) How can we assess them? What can the Owner or the Contractor do in order to avoid or limit the impact of change orders and their potential cumulative impact?

The answer to those questions is critical to maintain a good high-level assessment of the risks and maintain a good project health. Maybe those impacts are going to be small so that dealing with them would be too painful to be worth it. Maybe we will find a way to make project change order so that there is an overall positive cumulative impact. This paper aims at providing a clear understanding of the objectives and challenges the parties involved in a construction project face, and provide a concrete way of dealing with cumulative impacts.

METHODOLOGY

“One of the biggest risk management challenges currently facing project developers in emerging markets is the appropriate assessment and management of cumulative impacts and risks related to their business activities”² ». Conducting a cumulative impact identification and analysis seems to be the very first step of a difficult journey, in order to deal with cumulative impacts. The Risk management process should start as early as possible and should be updated regularly until the end of the project. A cumulative impact assessment has a direct impact on the risk's mitigation management. What are the different methods to assess the Cumulative impact and prevent the well-known ripple effect resulting from too many changes such as productivity losses?

² Dr. Pablo Cardinale, Introduction to Cumulative Impact Assessment and Management Retrieved from http://www.ifc.org/wps/wcm/connect/dd3f24004efaf0c987e3cf3eac88a2f8/120921_Cardinale_CumImpact_web.pdf?MOD=AJPERES

There are several methods can allow one contractor to handle change orders in order to reduce or handle the risk of Cumulative Impacts resulting from said changes.

- 1) **The Baseline alternative** is to pretend that Cumulative impacts are simply the result of the sum of all change orders, in terms of Time and Costs. This being said, Cumulative impacts would be the impact all change orders have had on the project's Duration and costs, and that there is no ripple effect associated with those changes.
- 2) **The Matrix of Interactions.** This can be conducted through a workshop thus showing direct and indirect effect, and which area (of the business or the environment) they might impact. They have to be ranked according to their likeliness to arise, which allow the owner to prioritize mitigations actions. Every time a change order is requested the matrix should be updated
- 3) **The Loop Analysis**, which is a flow diagram to identify cause to effect relationship within a "complex system that involves human and environmental components and interactions"³.
- 4) **System Dynamics (SD)**, which is an approach used to understand the non-linear behavior of complex systems, during a given period of time.

We will have a look at different attributes and assess how good each of the methods is in order to analyze them quantitatively. The chosen attributes are the following.

- **Precision:** this attribute has been chosen so that we can assess whether the estimation method used to allow one user to have a precise understanding of the potential cumulative impact.
- **Reliability:** this attribute aims at assessing whether the estimation technique can be relied on.
- **Accuracy:** the accuracy of the chosen method is key to assess and understand how deeply the cumulative impact will affect one's project.
- **Scoping of the potential cumulative impact:** this attribute will help understanding how good the method is, regarding the scope of the cumulative impact. A good method will allow one's party to have an overall view and implement potential mitigating actions.
- **Ease of implementation of the said method:** finally, this attribute has been chosen to help to know, before selecting and implementing a method, the complexity of putting in place the said method.

³ Barry Smit and Harry Spaling - *Environmental Impact Assessment Review* - Methods for cumulative effects assessment
Retrieved from <https://www.sciencedirect.com/science/article/pii/019592559400027X>

There are many pros and cons of each technique. During the analyze, every method is going to be compared to one another. A scoring system has been established, using Disjunctive reasoning. Out of the five selected attributes, a method with more red and yellow than green is not going to be considered as a fine way of calculating and assessing cumulative impact. The following matrix will help to discuss and analyze the different feasible alternatives against the chosen attributes.

MATRIX ANALYSIS				
Attributes	Baseline Alternative	Matrix of Interactions	Loop Analysis	System Dynamics
Reliability		1	1	1
Precision			0	1
Scoping the CI		1		1
Accuracy	0	0	1	0
Ease of implementing	1	1	1	

Looking at the Matrix analysis, we can see that a ranking order starts to come up. The preferred solution would seem to be the SD method, then we have two similar approaches, which are the Matrix of Interactions and the Loop analysis, and finally, the least usable method which is the Baseline Alternative. Thus, as the Baseline Alternative, the least desirable option, has more red than green/yellow attributes, it will be eliminated.

FINDINGS

Out of our four alternatives, we have eliminated the first option (BA) as being the least desirable alternative. A scoring system has been established according to the disjunctive analysis previously conducted. A score was given for each attribute, between zero and one, thus giving us for each alternative a total score of the method out of five (see fig below).

The Matrix of interaction has a score of 2,45 out of 5, and the Loop analysis, being a close alternative to the Matrix of interaction end up with a score of 2,3.

MATRIX ANALYSIS			
Attributes	Matrix of Interactions	Loop Analysis	System Dynamics
Reliability	1	1	1
Precision		0	1
Scoping the CI	1		1
Accuracy	0	1	0
Ease of implementing	1	1	
Attributes	Matrix of Interactions	Loop Analysis	System Dynamics

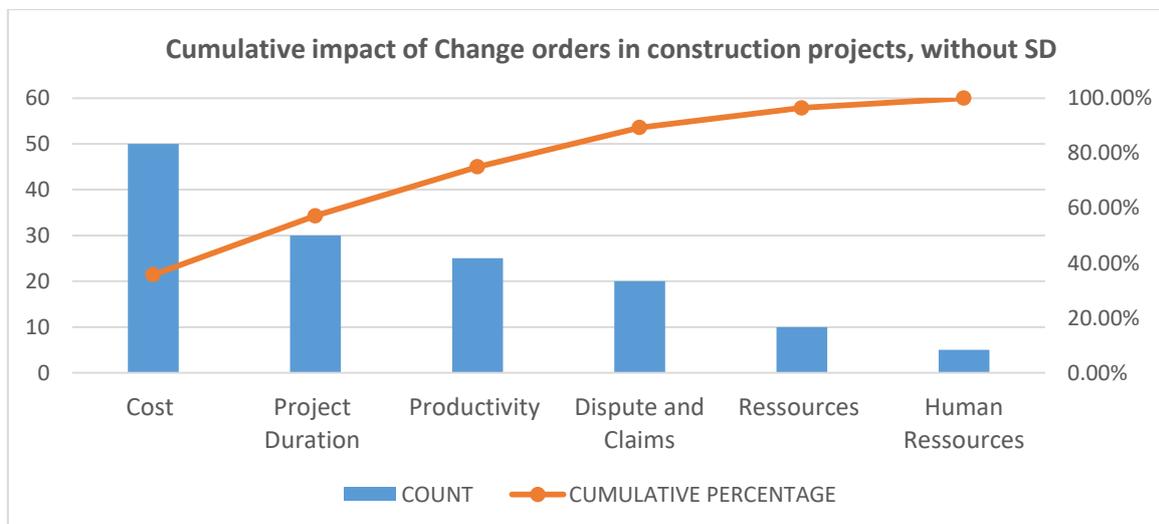
Reliability	1	1	1
Precision	0	0,3	1
Scoping the CI	1	0	1
Accuracy	0,45	1	0,7
Ease of implementing	1	1	0,2
TOTAL	2,45	2,3	3,7

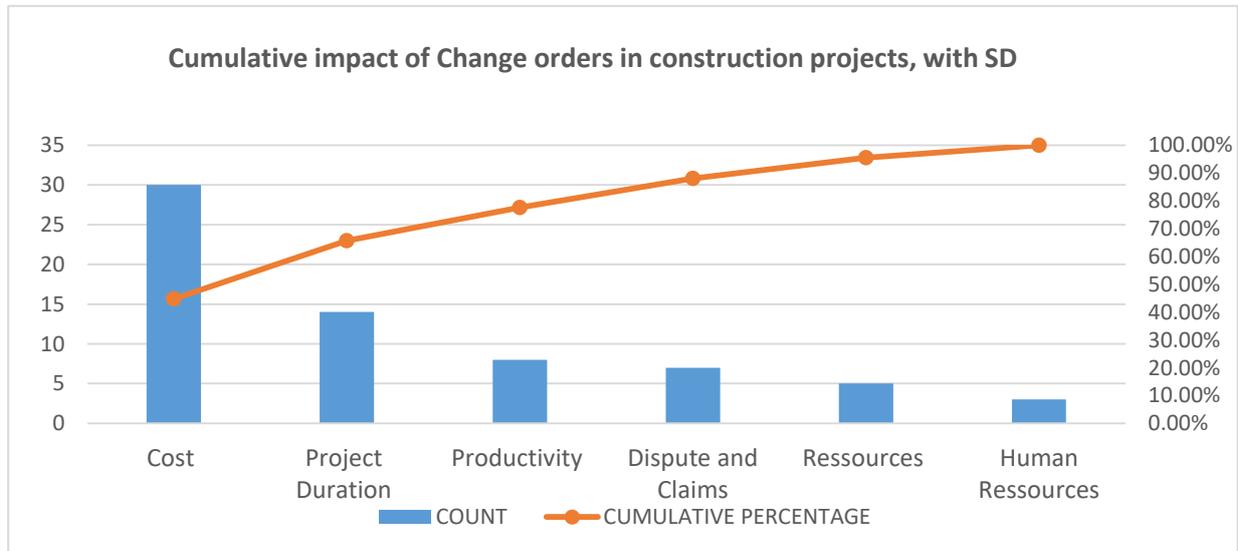
The preferred alternative clearly appears to be System Dynamics. Doing the maths, SD is approximately **151%** more effective than the Matrix of interactions, and **161%** more effective than the Loop analysis. As a matter of fact, this method, even though being a bit hard to put in place, allow one party to clearly define the potential cumulative impact. This is the most efficient technique if you wish to understand the impact change orders will have on one's project, as CI have a complex and changing non-linear behavior. The Matrix of interaction and the loop analysis are not bad methods, but rather simples one that will allow a simple overview of the CI and not a deep understanding.

As for a stakeholder of a project and especially a construction project, I would strongly recommend the use of System Dynamics to conduct the CIA.

In order to monitor closely what benefits a SD approach would have on the project, a Comparative Pareto analysis can be conducted. Below the Pareto analysis conducted throughout some research on the impacts Change orders can have one a project, without a good CIA, such as with the SD method.

On the First graph, a wrong approach to the Cumulative impact assessment results in high impacts of the change orders in Costs, Time, productivity, Claims, and resources. Such impacts are key to success failure. With the use of SD method, those impacts are clearly reduced, thus giving the Projects better chance of success and an overall better approach to Project and Risks Management.





CONCLUSION

Initially, this research effort was undertaken to answer the following questions:

1. Are the consequences of cumulative impact foreseeable?

It is now clear that with a rigorous methodology and a highly well-defined scope, Cumulative impacts can be foreseeable. It is indeed possible, with the narrowed scope of the relevant past, present, and reasonably foreseeable future projects, to define what can impact the project, and what to focus the risk management on, in order to provide mitigating actions. This task, far from being easy to implement, is key to Project success.

2. How can we assess them? What can the Owner or the Contractor do in order to avoid or limit the impact of change orders and their potential cumulative impact?

According to our matrix analysis, and the research conducted, there are three good options to conduct a CIA. One can use either a Matrix Analysis or a Loop Analysis for smaller projects, as they are easy to put in place and performant enough to give an overview of the changes and the risks a project may face regarding Change Orders. But the best way to assess and mitigate the cumulative impact remains the System Dynamics Method. Even though it is not easy to put in place it is still the best way to have a complete and deep understanding of the potential Cumulative Impacts, thus reducing the risks of costs increase productivity losses, and eventually project failure.

We would assume that the Project Owner would be the best to implement such approaches towards one project. But Change Orders and Cumulative Impacts affects both parties involved in the project. As a result, anyone being a stakeholder of the project success is entitled to have such an analysis conducted.

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