



Models to apply Strategic Engineering at Digitalization Initiatives in Large Engineering Companies

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Abstract

This paper proposes to apply Strategic Engineering to Digitalization of a large company operating in big EPC Projects (Engineering, Procurement and Con) with special attention to Oil & Gas; an overview about criticalities and potential alternatives to overpass major shortfalls is proposed as well as an architecture based on AI, Modelling and Simulation to deal with this sector.

Keywords: Modelling and Simulation; Company Digitalization; Strategic Engineering, Digital Transformation

1. Introduction

The main objective of this research is to finalize quick high level Strategic Assessment during digitalization projects within Large Engineering Companies and to evaluate best approach to address these issues and how Strategic Engineering could solve the bottlenecks and maximize the returns. Indeed, the research aim is to identify how to identify available achievements, problems & existing shortfalls in order to advise on a way ahead for improving digitalization project within the company processes and especially innovative digital solutions into processes re-engineering; special attention is paid to the case of Industries active in Oil & Gas Off Shore Plant Engineering. Indeed, the engineering in Oil & Gas EPC (Engineering, Procurement and Con) is dealing with crucial issues related usually Piping, Structures and E&I (Electrical and Instrumentation) subjected to high degree of complexity and many changes and as it happens in critical Industrial Plant Engineering of large system.

2. Digitalization in Plant Engineering Industries

Most of these companies are quite conservative in renewing their business processes considering the complexity of their activities, therefore the technology evolution is pushing them ahead to develop new ICT solutions; therefore, this digitalization initiatives quite

often experience critical bottlenecks that requires an effective review in order to speedup the activation of the new services and overpassing major problems to summarize the real benefits from these efforts

Usually in these cases, it could be very useful to finalize a quick Strategic Assessment based on high level documentation review and stakeholders interviews to be coupled with models supporting the analysis. In facts the activities include knowledge acquisition and data collection related to the existing situation and ongoing plans, followed by confrontation with key persons and review by experts with support of models.

3. High Level Documentation Review

The Quick High-Level review of documentation on Company Processes is fundamental to understand the previous activities and the bottlenecks related to the implementation of digitalization projects; in addition, by this activity, it is possible to get the general picture related to the company ICT Architecture (Information & Communication Technologies) with specific attention to the areas subjected to the digitalization initiative and to review other existing project to renew the processes that usually run concurrently with the critical one and often generate interferences respect company digital transformation.

A major step forward with respect to the initial document



analysis related to the digitalization project history and bottlenecks, it is usually represented by a systematic mapping of Processes and to identify the requirements in terms of organization, procedures and software to guarantee continuous updates in relation to advances in digital automation of the activities. It results evident that this aspect allows to develop awareness on the whole organization and to identify the priorities and bottlenecks. The authors are used in this sense to constantly refer to a Models for Common Mapping of Processes (MCMP) as unique reference to understand the specific impact of Implementation Initiatives and Business Process Re-engineering (BPR).



Figure 1. Simulator Mapping Digital Processes

4. Interviews

Usually, during this high level assessment, it is convenient to restrict the interview to a limited number of key people (e.g. 10-20) in order to create quickly and intensively the base for understanding where digitalization initiative are going well and where are blocked in bottlenecks; obviously these people have usually different point of view, priorities, objective, sometime operate within an internal competitive framework and, almost always, are very busy. Do to these reasons the integration of the MCPM within Models to be used along the interviews for cross checking the consistencies and advances on the different elements of the transformation.

Indeed, the resulting analysis should be based on Stakeholder Interviews that represent the fundamental step forward to finalize the acquisition of knowledge, experiences, and expectations present within the companies subjected to digital transformation.

Usually, these interviews allow to enlarge the view on the management as well as on the process, providing a clarification respect the differences between the criticalities highlighted in the documentations

Another very important aspect is the possibility to use the interviews to verify the priorities of the stakeholders as well as the opportunity to further improve the processes by developing new ways ahead, such as automation of best practices through compact micro activities able to provide quickly returns in terms of savings and process improvements.

5. Assessment Targets

The High-Level Assessment on the current status of digital transformation initiative should usually address special aspects such as the potential achievements:

- Improve the Plant Engineering Processes
- Lean the Material Process Flow
- Rationalize the Software and their Interfaces
- Quickly the pending Implementation Criticalities
- Identify remaining criticalities
- Evaluate the value and timing on obtained Achievements and future benefits

Obviously, the high level targets deal with obtaining a Robust and Valid Software Solution respect company needs and considering specific aspects such as:

- Reduction of Errors and Reworking
- Automation of the Processes
- Automation of Reporting
- Reduction of Manual Data-Entry

6. Strategic Engineering & EPC

The EPC Projects offer good opportunities for big Savings on Resources, Times & Costs by Digitalization, but to be successful is necessary to have the capability to have a complete view comprehensive of many different aspect; nowadays the adoption of innovative approaches such as Strategic Engineering could be fundamental to overpass impasses and solve criticalities due to the complexity of the problem.

In general, EPC (Engineering, Procurement & Construction), as well as EPCC (Engineering, Procurement, Construction & Commissioning), could improve progressively by an iterative and continuously process among the different Groups to reduce errors and apply the Best Practices on Savings and Corrections. The Output, obtained from the different Processes, is concentrated on specific software modules to provide checks and corrections along the whole duration of the Projects. In these cases, the different EPC projects are managed through iterative activities over different divisions concurrently, this requires obviously to clearly the common framework for digitalization based on solution, database and procedures as proposed in figure.

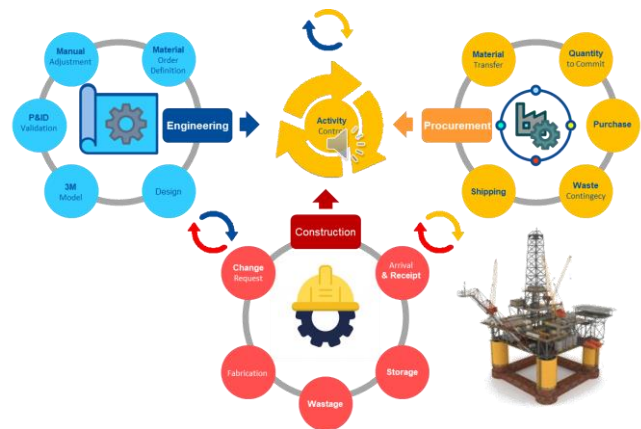


Figure 2. EPC Interactions among the Key Processes

In general, in this case, there are some major alternatives in terms on how to proceed when a digitalization initiative turns critical and they are summarized in simplified way over the following table.

In facts, the alternatives for Digital Transformation are usually generated by the necessity to being able to summarize the expected Results after significant Investments and delays.

Efficiency & Effectiveness	High	<ul style="list-style-type: none"> Adopted Solution based on Automated Procedures 	<ul style="list-style-type: none"> New ad Hoc Solution from Scratches Adoption of new Commercial Software Solution
	Low	<ul style="list-style-type: none"> Old Solution with No Further Improvements 	<ul style="list-style-type: none"> Continuous Improvements on Old Solution
		Low	High
Costs and Investments			

7. Model to finalize High Level Assessment

We create a dynamic model to estimate the advantages and disadvantages of these alternatives based on the estimates we obtain by benchmarking with our expertise after documentation review and interview; the general architecture is proposed hereafter.



Figure 3. Model Costs/Benefits of Alternatives for Digitalization

It is evident that these elements are not absolute and static, but they evolve dynamically along the digital transformation based on contingencies, but especially through the evolution of the knowledge on the real capabilities of the developers, software as well as on the real feasibility of original planning.

In this sense it is crucial to use the MCPM to evaluate the Digitalization Program & Risk Evolution based on a tree structure as proposed below

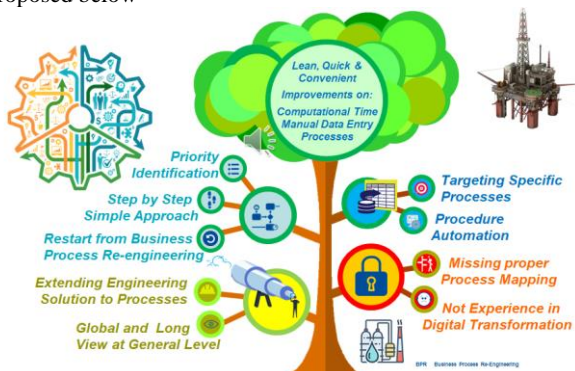


Figure 4. Tree on the Dynamic Evolution of Digital Transformation

The branches of the tree are a very effective way to identify where the digitalization project was blocked and why and based on the real facts and data, it is possible to finalize a SWOT Analysis not a priori, but consistent with the experience acquired. In the following it is proposed an example of SWOT for a specific case that outlines how different alternatives to address a bottleneck in digital transformation could evolve and what are the criticalities and major advantages of each one respect the specific boundary conditions. Indeed, it is fundamental to outline, that Strategic Engineering uses the experience to refine and fine tune the estimates continuously through Machine Learning, in order to correct evaluations about costs, times, efficiency on the ongoing and future activities, improving progressively the estimates and anticipating the problems.

SWOT Analysis on the adopted Solution outlines Benefits & Risks

SWOT	Helpful Conditions	Harmful Conditions
Internal Conditions	<ul style="list-style-type: none"> Ensemble of Best Practices (well know Methodologies) Few or no disruption on best practices and current workflows Flexibility Resilience Fast Implementation 	<ul style="list-style-type: none"> Unclear Accountability for Task out of the borders of a Department (need for RACI) Undocumented procedures and practices Ambiguous Identification on Part Codes
External Condition	<ul style="list-style-type: none"> Processes easy to replicate for other Projects Formalization of Best Practices as part of values Increased Accountability and Subsequent Inter Department Cooperation 	<ul style="list-style-type: none"> Knowledge depending on few individuals, risk to lose know-how and maintainability New Commercial Tools could create problems if their effects on the processes are not carefully evaluated and/or if the employees are not properly trained

Fig. 5. SWOT Example of Digitalization Project for EPC Contractors

This concept is very consolidated considering that Machiavelli was used to say that is necessary to address not only present, but future problems & to use all resources to solve, because prediction makes it easier to solve them, while waiting to cure them after they appear could result in being too late; therefore it is evident that nowadays, the use of Modeling, Simulation, Data Analytics and AI could integrate the activities of Prince’s advisors and Company consultants (Bruzzone et al.2020).

Based on previous considerations it is possible to identify the Strategic Correlation and the step forwards as proposed in the following scheme

8. Moving Forward EPC Processes

The authors applied this approach in multiple cases and identified some common aspect related to this context as well as the crucial need to proceed progressively, measuring in terms of facts real achievements to be used as basis for next steps. From this point of view, it results fundamental to design a roadmap to finalize the digital transformation respect the necessity to re-engineer the processes, improve efficiency and reduce times and costs.

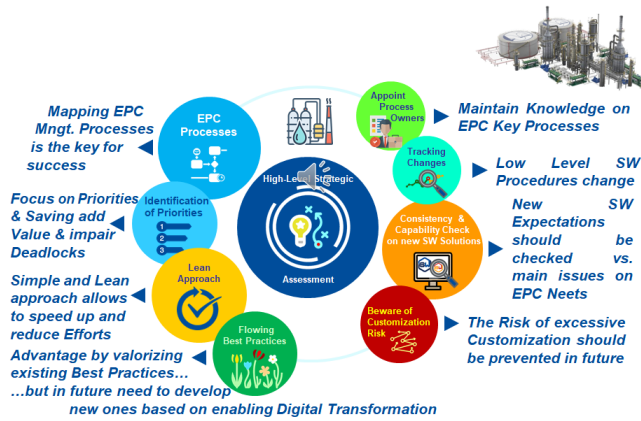


Figure 6. Key Elements for Digitalization of EPC Mngt. Processes



Fig. 7. Roadmap for Digitalization of Oil & Gas EPC Contractors

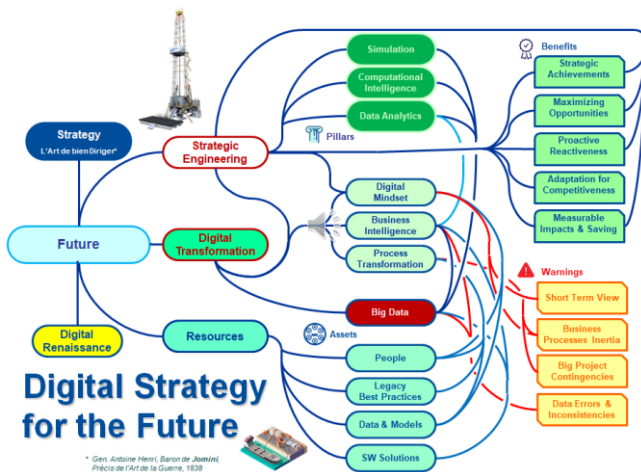


Fig. 8. Model of Key Elements within Digital Transformation Projects

This overview points out that as soon as the digital foundations turn to be enough strong it is possible to introduce Strategic Engineering even within the Company both in terms of mind set and software solution as summarized in the following scheme. In general, a fundamental aspect is to transform progressively the

MCPM into a Digital Twin able to support the evolution of the processes respect the possibilities enabled by digital transformation. Indeed, the integration within the company and digital solution of a Business Process Simulation Model (BPSM) as Digital Twin of the Plant Engineering processes allows to support Strategic Decisions & additional Digital Transformation Initiatives respect the global impact on large Projects and guarantees to have MCPM always up to date. The authors are currently working to integrate different AI Engine developed for specific sectors to be used also in supporting project management by acquiring information on Digitalization projects and corresponding savings and benefits obtained as consequence of their implementation within EPC Contracts

9. Conclusions

This paper represents a synthetic overview of the approach used to apply Strategic Engineering directive to solve criticalities during Digital Transformation initiatives within EPC operating on Oil & Gas. It is evident that this approach could be easily extended to many other sectors, with special attention to the ones that result critical due to the complexity of their products and the intensive technical and engineering elements. Currently the authors are developing further research to create multiple tiles to create a mosaic able to cover high level consulting through the use of Strategic Engineering in order to reduce risks, maximize profits and to cut the implementation times.

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