White Paper 2021-01

How to Measure Project Complexity?

While it is easy to develop a feeling about project complexity (and thus unpredictability), having clear criteria for that purpose is more difficult. On the basis of available literature, we have developed a tentative set of criteria to determine the degree of complexity of a project, and thus anticipate the need for a different approach to project management and leadership.

Reminder about complexity

Complexity in a given system is directly related to the number of contributors and their alignment to the overall purpose. Complex as a concept is different from complicated. A complicated system can be quite reliable and predictable (such as a watch or a complicated industrial facility).

Complex systems demonstrate specific behaviours such as for example:

- Emerging properties (the system is more than the sum of its parts)
- Possible transitions of state that create deviations far beyond normal statistical deviations; thereby creating unpredictable outcomes.

Complex projects require different approaches than simple projects in terms of planning and management. Risk management also require specific approaches involving systemic approaches. In any case, complexity should aim to be minimised as much as possible at the onset and shaping phases of the project.

Dimensions and influencers of complexity

John Hollmann [1] refers to the following criteria to determine the complexity transition:

- Project size (above 1B$ is considered to be risky)
- Governance alignment and decisiveness
- Project team integration and staffing
- Aggressiveness of cost and schedule estimates, compared to benchmark
- Facility complexity (mainly related to the number of successive steps in a continuous industrial process)

An important article in [2] analysing the Boeing 787 project refers to five dimensions of project complexity:

- Structural complexity
- Uncertainty
- Dynamics
- Pace
- Socio-political complexity (stakeholder management, number and alignment of contributors)

The same article also refers to the "diamond of innovation" as a way to identify complexity and the need for specific approaches, with the following dimensions:

- Technology (from low-tech to super high-tech)
- Complexity of deliverables (from component to assembly, system, and array or system of systems)
- Pace (schedule aggressiveness)
- Novelty (from derivative of existing, new platform, new-To-Market and New-to-World).

From our own observations and literature on major parameters influencing project outcome [3], when it comes to industrial projects, remoteness and regulatory requirements (including permitting) are also important complexity factors.

Many of the dimensions mentioned above are not independent, therefore there is a need to rationalise them. The following is an attempt at rationalisation based on a pragmatic approach with the objective of obtaining an operational definition of project complexity. It will certainly evolve over time based on experience.

PVD approach to complexity measurement for industrial projects

From the previous discussion, the most important, independent parameters to assess complexity appear to be the ones listed in the table below (page 2).

If points are allocated to each parameter and added, a score is calculated between 0 and 24.

We have applied these criteria to a portfolio of typical projects we have been involved in as consultants. Our experience suggests that projects become complex above a threshold score of approximately 10 to 12.

Conclusion

Assessing project complexity is a difficult endeavour and not adequately addressed in existing literature. Based on our experience in combination with available literature we propose an operational scoring system to assess the actual complexity level of an industrial project. We plan to use this framework in the future to further refine it and ensure its applicability across multiple industrial project types and industries.

Complexity parameter	0	1	2	3
Project size	Less than 50M$	Above 200M$	Above 1B$	Above 5B$
Scope complexity	Component	Assembly	System (multiple sub-scopes)	System of systems / array
Innovation	Repeat of mature technology	Industrial prototype, mature technology	One process step innovative	Overall innovation (new-to-the-world)
Project remoteness (as per PVD measurement – includes environmental conditions)	Low	Medium	High	Extreme
Schedule and cost aggressiveness	Low: Within benchmark Or Low penalty on delays	Medium: >10% under benchmark Or medium penalty on delays	High: >20% under benchmark Or Fixed delivery date	Extreme: >30% under benchmark
Execution plan complexity (contractors)	Single contractor & greenfield	Main contractor + separate small EPC scopes Or single contractor & brownfield	Several contractors with relatively independent scopes	Several contractors with enmeshed scopes
Regulatory / Licensing	Basic licensing requirements, no project / design oversight	Design validation requirement	Specific license required for start-up	Very high licensing oversight during project execution and for startup
Governance complexity (4 aspects: - owner partnership, - financing setup, - stakeholders influence, - governance decisiveness)	All aspects simple and effective	One aspect challenging	Two aspects challenging	Most aspects challenging

References

[1] "Project Risk Quantification – A Practitioner's guide to realistic cost and schedule management" John K. Hollmann – Probabilistic Publishing, 2016

[2] "The Oxford Handbook of Megaprojects management" Edited by Bent Flyvbjerg

[3] "Industrial Megaprojects – Concepts, Strategies and Practices for Success" Edward Merrow - Wiley, 2011

Links to useful White Papers

White Paper [2012-01] "Why you can't Just Scale Up Your Way from Small, Simple to Large, Complex Projects"

White Paper [2013-13] "Minimizing complexity – the core of complex projects preparation"

White Paper [2013-16] "How to Transition Successfully from a Simple Projects' Company to a Complex Projects' Company"

White Paper [2018-13] "How to Rate the Remoteness of Project Sites"