ASSET PERFORMANCE NETWORKS

HOW BENCHMARKING CAN HELP ESTABLISH MORE RELIABLE COST ESTIMATES

By

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Introduction

Several recent Industry and financial research studies point to a significant increase in capital expenditure, and projects in an environment where projects are already currently facing significant cost escalation and supply chain issues. The International Energy Agency forecasts that annual energy investment will increase from pre-pandemic levels of just over $1.5 trillion to nearly $2 trillion in constant dollars between 2025 and 2030, with climate policy impacting the investment in energy source more than the overall investment in energy.

Cost Overruns Are Systemic

A recent article in Bloomberg highlighted the continuing challenges that the largest energy companies are having with cost overruns.[1] The industry has suffered from these overruns for more than a decade and there is no evidence that this trend is improving. A recent AP-Networks survey of US Oil and Gas megaprojects (over $1 billion) indicates that almost all of them suffered major overruns and delays, even though they had governance and assurance processes in place. In addition, cost and schedule risk are likely to be exacerbated by current inflationary and supply chain pressures.

The Bloomberg article also highlighted the role of overly optimistic assumptions and intentional under-estimating to greenlight projects as primary drivers of these overruns. Risk analysis techniques have not effectively captured or accounted for these overrun risks. The current environment makes the development of accurate estimates even more important. AP-Networks data shows a drop in construction labor productivity and high-cost escalation over the last three years.

Escalation may start to cool, but improving productivity will be difficult given the shortages in the labor market. Pre-pandemic, labor productivity had stagnated for over a decade. A pre-pandemic article by *The Economist*, "The Construction Industry, Least Improved," August 18, 2017, concluded that some construction industry practices and structural problems increase costs for buyers, but hamper investment in improving productivity. Moreover, AP-Networks' analysis of projects from the last decade found degrading labor productivity for heavy revamp projects.

Can Benchmarking Help?

Industry has been benchmarking capital project performance to support improvement initiatives for over two decades. Still project cost and schedule predictability, and productivity have not improved. Cost benchmarking methods have stagnated and are not providing actionable insights. A common traditional approach to benchmarking capital

[1] Leaked Study Shows Exxon, Partners Overspent by $138 billion, Bloomberg, Sept. 23, 2022

cost is the Lang Factor Analysis. The Lang Factor, which is the ratio of the total project cost to total equipment cost, is an estimating tool developed 7 decades ago (Lang, H.J., *Chemical Engineering* (1947)). Lang Factors can be found for various types of plants (see Table 1). Project teams and estimators compare these Lang factors, after making adjustments for escalation, location, and size, to their project estimates and actual costs to benchmark performance. In theory, higher Lang Factors indicate that a project was more expensive; lower Lang Factors indicate competitive results, or, in the case of an estimate, cost risks that may result in an overrun.

Table 1: Typically Used Lang Factors

Process Type	Range of Lang Typical Lang Factors
Solid Process Plant	3.10 – 3.89
Solid-Fluid Process Plant	3.63 – 5.04
Fluid Process Plant	4.47 – 6.21

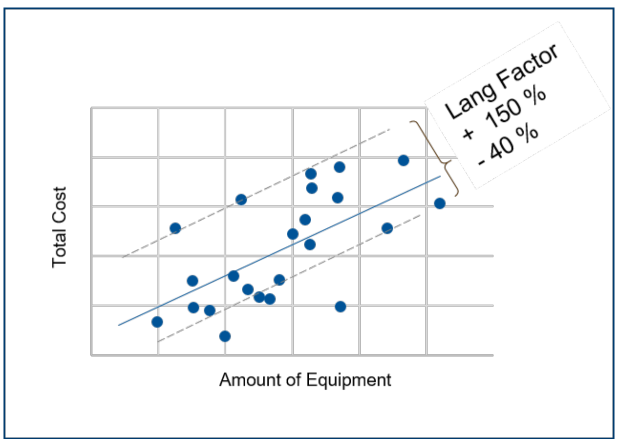


Figure 1: Benchmark Relationship between Equipment Cost and Total Cost

Traditional benchmarking methods relying on some variant of the Lang Factor work on the assumption that equipment costs fully describe a project's scope and can be used to factor up to total capital costs. Statistics show that in general as more equipment is installed total costs increase, however, as Figure 1 shows there is a large degree of variability in the equipment to total cost relationship. Indeed, the variability is more than 100 percent.

Using traditionally based benchmarking, such as the Lang Factor to improve performance is challenging. Too often benchmark results are not understandable. The results do not provide enough specificity to help project teams improve performance and deliver successful outcomes. Clearly equipment costs alone do not fully explain total project costs.

A Better Approach: Advanced Benchmarking Methodology (ABM)

ABM provides more specific, actionable benchmarks than traditional project cost benchmarking. Our research shows that how much a project costs depends primarily on two things: the amount and kinds of materials installed and the productivity of the indirect and direct labor doing the work. AP-Networks' ABM uses the amount of equipment, piping, steel, concrete, electrical and instrumentation being installed to benchmark the required amount and productivity of indirect and direct labor. This scope-based approach offers distinct advantages.

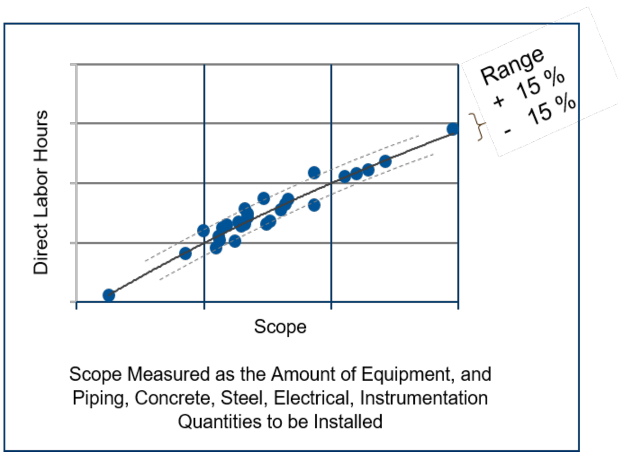


Figure 2 Advanced Benchmarking Methodology

- Fully accounts for the project's scope by considering the mix of material being installed (Figure 2).
- Focuses on indirect and direct labor thereby providing actionable insights to management.
- Transparent comparison of your project to other similar scope projects.
- Uses advanced statistical methods to improve the accuracy of benchmarks.
- Can be applied to a wide variety of projects.

ABM enables understanding directly how construction labor productivity for specific disciplines as well as project indirects to total project costs. This information helps the project team understand specific project risk areas, and or project cost relative to peers.

For example, benchmarks for an $80 million refinery revamp project are based on the quantities of equipment, concrete, steel, pipe, electrical, and instruments. That is, the quantities are independent variables in the ABM regression models. The dependent variables are the Industry average benchmarks for the construction labor hours and project indirects.

Figure 3 illustrates the discipline level metrics that result from ABM and the comparison to the project. In this case, the estimated piping hours appear to be substantially less than the industry norm. The project has either struck an estimate that is too aggressive or has plans to achieve better piping labor productivity than its Industry peers. Figure 4 shows the benchmarks for the refinery revamp project indirect hours.

Figure 3: Refinery Revamp Project Direct Hour Benchmarks Illustration

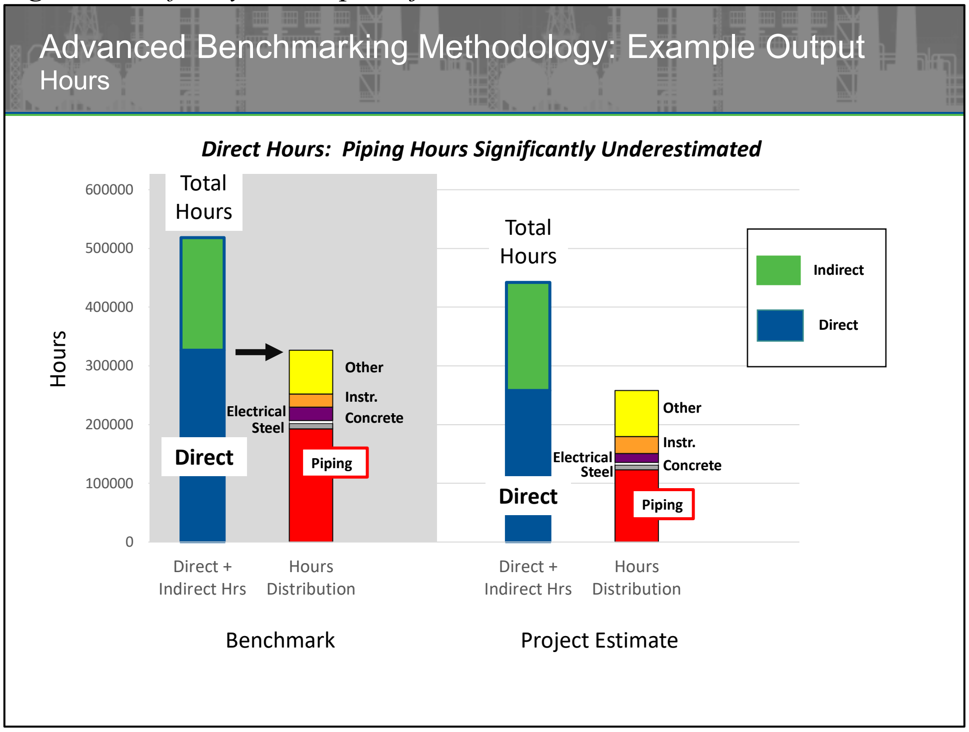
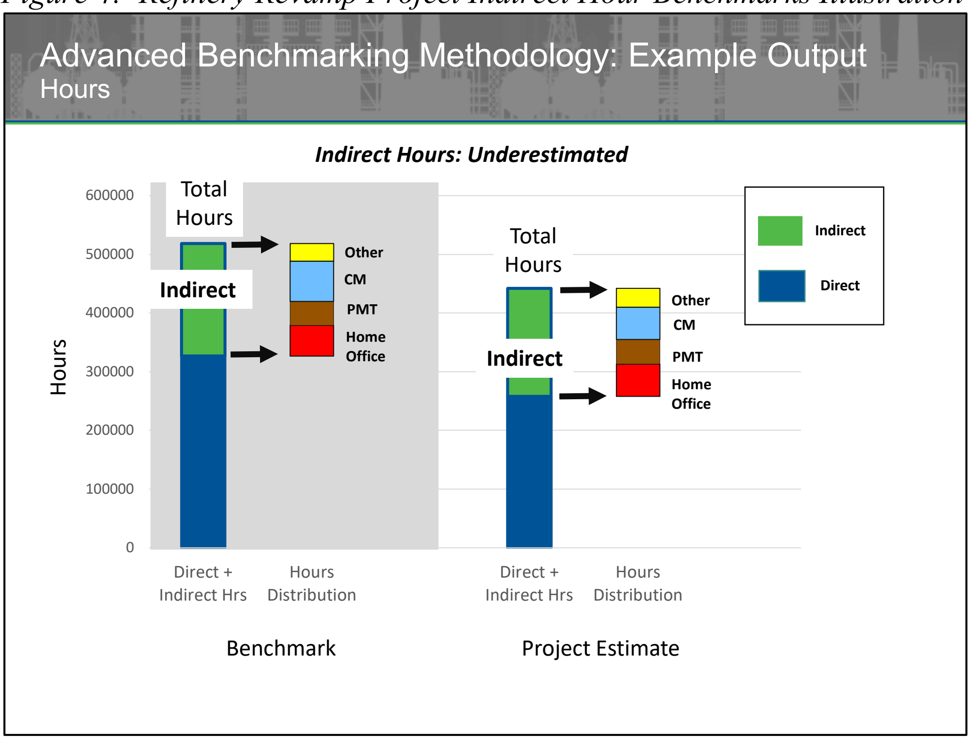


Figure 4: Refinery Revamp Project Indirect Hour Benchmarks Illustration



As illustrated in Figure 5, ABM also uses the resulting project hour benchmarks to benchmark the total project cost relative to industry. Figure 5 shows that the estimate project direct labor costs are low. As indicated, the estimated piping labor hours are aggressive. Figure 5 also shows that the total project cost and the project indirect costs are also aggressive.

Figure 5: Project Cost Benchmarks Illustration

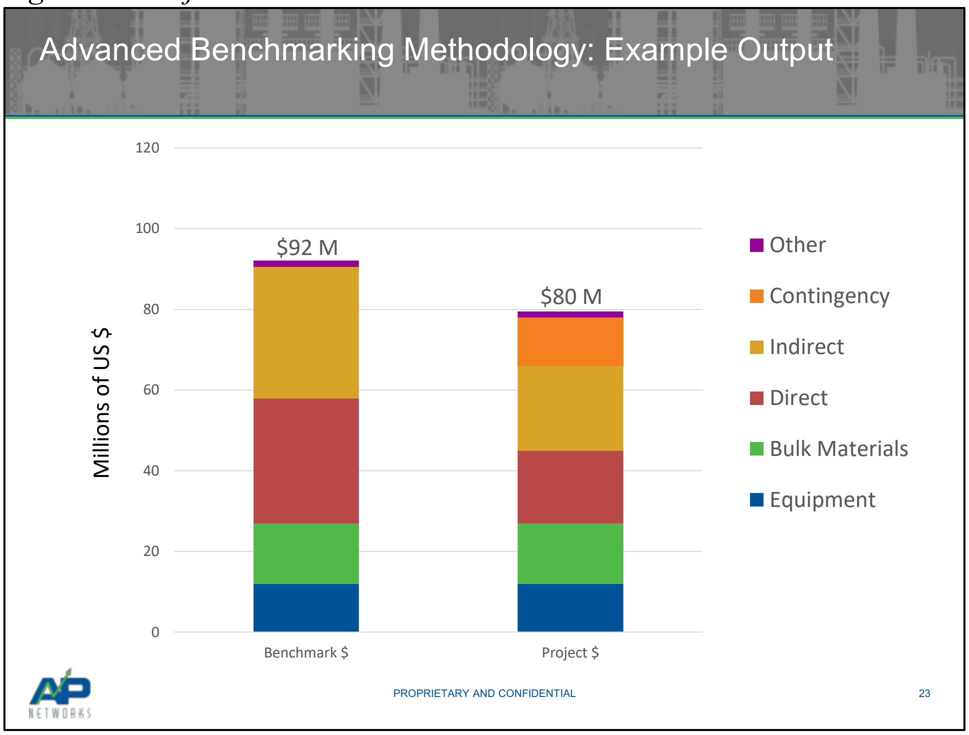


Figure 5 provides an illustration of the summary results for the ABM for the refinery revamp project. The cost target is aggressive for the materials that the project is engineering and constructing. Most of the aggressiveness can be attributed to the aggressive piping labor productivity target. The engineering and construction schedule is reasonable for the quantities but is at risk because the piping labor hours are aggressive. This example project overran cost by 30 percent. Piping field labor hours grew substantially, causing the project to become longer, and project indirect costs to overrun as well. There was inadequate contingency to cover the overrun.

Conclusions

Setting the right targets is critical to achieving project success in the current highly uncertain project environment. ABM provides competitive insights and identifies the levers to improve a project's competitive position. ABM provides credible and reliable project cost and schedule benchmarks that fully address project scope, and account for piping and mix of other materials. The ABM covers a wide range of projects from greenfield to revamp projects, which are particularly problematic for traditional cost ratio analyses. These industry benchmarks are transparent, because they are related directly to the project quantities. The transparency of the benchmarks enables identifying risk areas and taking action to improve performance.