WHITE PAPER

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Beyond Total Cost of Ownership

The Best-Value Purchasing Model for Custom-Engineered Electrical Equipment

Introduction

Highly reliable power distribution equipment, custom-engineered for its specific application, is simply essential for productive mine and oil & gas operations. Material handling, dewatering, safety equipment, ventilation… in short, uptime… all depend on it, which in turn places crucial importance on supplier selection and engineering specification. In a recent survey conducted by Littelfuse among oil, gas, and mining engineers, 1 out of 3 respondents consider hidden costs such as repair, downtime, late delivery, or consulting into their purchase costs to determine the Total Cost of Ownership (TCO). These hidden costs typically add as much as 30% to the purchase price of their power distribution equipment.

While the traditional Total Cost of Ownership (TCO) model can be used to compare easily quantifiable costs associated with many purchases, hard experience suggests it falls woefully short in providing an accurate prediction of actual value when it comes to mission-critical power distribution equipment.

Consider, for example, the North Canada operation accessible only by a seasonal ice road. When the vendor missed his delivery date (which never should have been promised in the first place), the ice road had thawed and delivery by air added $35,000 to the real cost of the custom gear. (So much for narrow focus on low initial cost and simple TCO calculations.)

The Best Value (BV) model begins with a more sophisticated view of TCO, then includes additional key factors, like the consequences of delivery problems, which are not so easily quantifiable. Predicted reliability, design/engineering quality, customer service, “hidden” costs, supplier experience and safety are all possibilities. Considered in concert with TCO, these factors provide a far more complete reflection of the long-term performance of suppliers and their equipment.

Defining Best Value (BV)

The Best Value algorithm can be defined as:

Best Value (BV) = Total Cost ($) divided by Technical Score (%)

Total Cost ($) is the sum of net-present values of quantifiable hard costs including:

- Upfront design engineering time (Cdesign)
- Initial capital equipment cost (Ccapital)
- Installation and commissioning costs (Ccommission)
- Maintenance costs (Cmaintenance)
- Downtime costs (Cdowntime)
- Energy costs (Cenergy)
- Savings realized from Innovation (Cinnovation)

Any other easily quantified costs may also be included, so Total Cost can be defined as:

Total Cost ($) = Cdesign + Ccapital + Cschedule + Ccommission + Cmaintenance + Cdowntime + Cenergy – Cinnovation

Technical Score (%) is a way to place a relative value on difficult-to-quantify factors that nevertheless have a very large impact on real costs identified in the Total Cost ($), including:

- Quality-related costs and savings (Squality)
- Vendor experience and customer service/support (Sservice)
- Safety (Ssafety)
- Other factors such as aesthetics (Sother)

So the Technical Score (%) can be defined as:

Technical Score (%) = Squality + Sservice + Ssafety + Sother

Digging Deeper into Best Value: Costs

Upfront Design Costs (Cdesign)

Extensive preliminary engineering is commonly required to create specifications which ensure new equipment will meet load demands and provide seamless integration with electrical distribution systems in place. Vendors with deep design and application expertise can support this in-house effort and reduce associated engineering costs.

Initial Capital Costs (Ccapital)

Initial price is the easiest value to quantify, but too much attention to lowest initial cost can be highly counterproductive… as an open pit operation in Western Canada discovered when their equipment from a lower-cost foreign vendor arrived with a design, protective relays and transformer all in violation of Canadian electrical codes. How much valuable time and lost income ended up in the boneyard along with the gear?

Electrical transformers are another area where savings may be so-called. Undersized transformers – either physically or electrically - by nature may be less robust, with less heat dissipating capacity. When transformers fail in a catastrophic event, they can destroy the entire piece of power distribution equipment.

Schedule (Cschedule)

Costs (or savings) associated with beating, meeting or missing deadlines for delivery can rapidly escalate. (The previously mentioned loss of access via ice road is only one example.) Costs for downtime, idle employees and contractors and lost production must be captured, and vendors should be carefully evaluated for a proven track record of on-time delivery. This cost can be quantified as ($/day) late costs.

Commissioning/Installation vs. Reworking (Ccommission)

Commissioning costs can vary widely, depending on vendor competence. If equipment arrives out of specification, defective or of a design unsuited to actual conditions, extensive reworking/repair time and costs are inevitable.

Imagine discovering, as one potash mining company recently did, that a power distribution center meant to be pushed into position by a loader arrived with power cable couplers mounted precisely where the loader would damage them. Workers had to drill out, relocate and rewire the couplers, but the time and cost wasn't reported back to purchasing. Purchasing lower-cost equipment only to find it requires days of reworking before use can incur cascading costs for repair, wasted labor hours, downtime, etc.

Maintenance (Cmaintenance)

Equipment is purchased once, but maintenance costs go on and on. Beyond stated routine maintenance costs, it is vital to understand that different components in a given custom-designed electrical center may have vastly different maintenance requirements. Microprocessor-based components, for example, require far less lubrication, maintenance and testing (i.e., costs) than electromechanical components performing the same function. Drives and transformers require massive airflow for cooling, and unless specifically designed to keep particulate-laden mine air segregated from components, will require frequent filter changes. Such design sophistication should be considered in vendor selection to reduce maintenance costs.

Downtime (Cdowntime)

In any process industry, downtime is costly, but it is especially costly in the mining and oil and gas industries because of the high cost of operation. Some potash mines, for example, value downtime at $1 million per hour. But even at $10 thousand per hour, the failure of an electrical system will quickly dwarf the initial cost of the equipment. The vendor's reputation for making reliable equipment should be, therefore, an important consideration.

Energy Savings (Cenergy)

Energy savings are fairly easy to quantify. However, in large electrical equipment such as mining substations, transformers play a major role in energy loss. In Canada, transformer efficiency is clearly regulated by Natural Resources Canada, CSA standard C802.2; and in the USA, the Department of Energy (DOE) has published and released similar standards. Purchasers should maximize efficiency by choosing equipment only from suppliers that meet these standards as well as minimum electrical-code requirements. Keep in mind, too, that unless innovative load-management design techniques and/or components such as modern variable-frequency drives are specified, there will be no significant differences or advantages to be found in this area.

Innovation (Cinnovation)

Innovative new equipment has the potential to reduce costs in other areas; through direct or indirect labor cost reduction, lower maintenance costs, process improvement, higher output, etc. A higher initial cost for more productive equipment may be more than offset by savings through the innovation.

Digging Deeper into Best Value: Technical Scores

Quality (Squality)

Quality attempts to define the probability that equipment will function as intended for as long as intended… that the design and components are appropriate for the intended lifespan. Higher-quality design engineering, integrated components, manufacturing processes and assemblers all contribute to the quality that reduces the chance of catastrophic failure. Even if designed and fully specified in-house, it pays to ask, "How good are the people putting it together?" Quality Control in manufacturing is an essential element.

And make no mistake: avoiding electrical equipment failure means avoiding the total costs of repair or replacement, downtime and lost production, removal and reinstallation, delivery and engineering to integrate newer equipment. All of which should give quality a very high weighting in BV calculations.

Customer Service and Vendor Experience (Sservice)

Consider: oil fields and mines tend to be in remote locations where nothing comes easy. When problems arise, mine operators need answers, replacement parts, and engineering expertise immediately. The Sservice score relates to vendor ability to deliver needed customer service in order to avoid downtime. Some good questions to ask: is there deep engineering capability available on demand, or is the vendor just packaging parts? Can the vendor be counted on for upgrades, reprogramming and redesign? Will they have resources and expertise to deliver regular training for miners, so equipment is operated most efficiently and safely? Is it practical for them to travel to the site?

Safety (Ssafety)

Custom-engineered electrical systems can and should be designed with safety as a key consideration. Equipment can be designed with control panels and operator interfaces physically removed from breakers and hazardous zones. Advanced safety interlocks on doors and panels, which automatically reset safety set points lower to reduce hazards during maintenance, should be specified. Arc flash relays, ground-fault relays, and circuit protection devices should be part of the design.

Best Value in Action

The paper, "Unpacking Best Value" by Bitasek, Snelgrove, Evans, Tate, Keith and Holliman elaborates on Best Value purchasing with the following example.

After the 2007 collapse of the I-35/St. Anthony Bridge in Minneapolis, select contractors were invited to submit proposals. To award the contract, the Minnesota DOT used the BV model; in this case, including price and schedule as Total Cost values ($ per day multiplied by # of days), and safety, quality, environmental compliance and aesthetics as Technical Score values to be scored on a percentage basis by committee. The average score from the committee was then used as the Technical Score (%) value in the BV equation.

The resulting $234 million contract was awarded to the bidder with the highest technical score, longest schedule and highest cost; the project was completed three months ahead of schedule and has won numerous design-related awards.

Example of Calculating Best Value

Best Value is best compared to TCO using a real-world example. A procurement specialist is looking to purchase a new portable electrical substation for a mine. The mine has a high cost of downtime and needs the equipment delivered within the ice-road timeframe. To simplify the exercise, assume that this mine operation has its own internal engineering department that has fully developed the specifications.

Vendor 1

- Lowest-priced proposal
- Fairly new to the market, < 10 years
- Acceptable quality
- Meets customer criteria and specifications
- No innovations to drive improved safety or other cost savings
- Reputation for missing promised deadlines

Total Cost = C_{price} + $C_{commission}$ = $450,000 + $10,000 = $460,000

Vendor 2

- Highest-priced proposal
- Many years of experience, > 30 years
- Industry leader in quality
- Meets customer criteria and specifications
- Optional arc flash mitigation techniques added to design for improved safety
- Reputation for meeting or exceeding promised deadlines, data to back this up

Total Cost = C_{price} + $C_{commission}$ = $505,000 + $12,000 = $517,000

In this example, Vendor 1 has a lower initial cost than Vendor 2. However, the story changes after the weighted Technical Score factors are considered.

The procurement team has determined that because of the high cost of downtime and the remote location of the mine, they will give the highest factor weighting to quality and safety. In addition, a few extra points are assigned to the scheduling factor because of the potential cost of missing the ice road.

Figure 1.
Technical Score Factors

Factor (F)	Available Points (P)
$F_{quality}$	35
$F_{schedule}$	20
F_{safety}	40
$F_{experience}$	5
Total	**100**

The team "grades" each vendor based on these factors. Next, it multiplies the grade by the available points for each factor, then sums the results and multiplies by 0.01 to get the Technical Score.

Figure 2.
Technical Score Calculation

Factor (F)	Available Points (P)	Vendor 1 Grade (G)	P*G	Vendor 2 Grade (G)	P*G =
F_{quality}	35	75%	26.25	90%	31.50
F_{schedule}	20	55%	11.00	90%	18.00
F_{safety}	40	69%	27.60	85%	34.00
$F_{\text{experience}}$	5	69%	3.45	80%	4.00
Total	**100**		**Technical Score = P*G(0.01) = 0.683**		**Technical Score = P*G (0.01) = 0.875**

Once they have the Technical Score, the team members divide the Total Cost by the Technical Score to get an adjusted bid.

$$\mathbf{BV}_{\text{vendor1}} = \textbf{Total Cost/Technical Score} = \$460{,}000 / 0.683 = \$673{,}499$$

$$\mathbf{BV}_{\text{vendor2}} = \textbf{Total Cost/Technical Score} = \$517{,}000 / 0.875 = \$590{,}857$$

The Best Value model predicts that Vendor 2 will have a lower cost than Vendor 1 when all factors are considered. In this example, what at first appears to be the lower cost supplier is actually not the best choice.

Conclusion: “closing the loop” to achieve Best Value

Purchasing agents, and the purchasing committees that guide them, need to know more about operations, maintenance, service and safety in order to ask the right questions… the answers to which are invaluable guides to obtaining best value, and ROI, in specialized custom-designed electrical equipment.

Notes

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