

A Heuristic Logistics Prioritization Tool for Procured Material in Industrial Projects

Mohammed Ayed Aldossary

Senior Engineer, Upstream Gas Project Management

Saudi Aramco

Fadhili, Saudi Arabia

Mohammed.aldossary.42@aramco.com

Sultan Abdulrahman Alankari

Project Engineer, Upstream Gas Project Management

Saudi Aramco

Fadhili, Saudi Arabia

sultan.alankari@aramco.com

Abstract

Material procurement is mainly considered the critical path of industrial projects. However, the logistics phase that moves the purchased material from the vendor's gate to the site usually receives less attention than the purchasing process. Project procedures define how cargo must be packed, documented and expedited, but give no method for deciding which purchase orders (POs) deserve the most logistics attention, forcing teams to rely on previous experience. The closure of the Strait of Hormuz in early 2026 cut the main maritime artery of Saudi Arabia's Eastern Province projects and showed the cost of this gap. This paper introduces a heuristic Logistics Criticality Score (LCS) that ranks every PO using seven factors identified from the supply-chain disruption literature and available data in industrial projects material register. The factors identified are namely; monetary value, inspection level, engineered/bulk, oversize cargo, heavy cargo, lead time, and routing or geopolitical risk. The factor weights were derived from a survey of 78 practitioners, who ranked routing and geopolitical risk first and monetary value last. In addition, 83% of them have experienced logistics-driven late, damaged or out-of-sequence deliveries, and only 30% assess logistics risk early. The method was implemented on a Saudi Aramco gas megaproject – Fadhili Increment Sulfur Recovery Unit. The project is \$ 1.2 Billion worth and consists of 111 Pos. The most critical fifth of the POs carries nearly twice its proportional share of total logistics criticality, and the 51% of POs shipped through maritime chokepoints carry 60% of it. The resulting watchlist helps the team focus on most critical POs, and objectively facilitates decisions such as route changes, freight mode change.

Keywords

Logistics Prioritization, Material Procurement, Supply Chain Disruption, Maritime Chokepoints, and Industrial Projects.

1. Introduction

Industrial projects depend heavily on the availability of engineered equipment and bulk material. A project schedule is built based on the expected delivery dates of the material, and material-related delays are identified as one of the major causes of delay in construction and industrial projects. However, procurement is only the first half of the challenge. A purchase order that has been placed, fabricated and inspected still delivers no value until it reaches the laydown yard at site. The logistics phase of packing, export clearance, forwarding, ocean or overland transport, port handling, customs and inland delivery is where a correctly procured item can still arrive late, damaged, or not at all.

On most projects this phase is governed by detailed procedures. For example, the case-study project examined in this paper is controlled by a Packing and Shipping Procedure and a Procurement Plan and Procedure. These two documents prescribe packing standards, hazardous- and heavy-cargo notification, export-license obligations, freight-forwarder appointment, expediting reporting and material control. The procedures describe in detail the rules that apply once a shipment is moving. However, they do not answer a more basic question; which purchase orders should the team watch most closely? None of them provide a tool to rank POs according to an objective scoring method. In practice, this decision is left to the judgment and previous experience of the team handling the project at the time. Experience is valuable, but it is not documented, it varies from one person to another, and it gives the project no defensible answer when a portfolio holds a hundred or more POs with different values, complexities, lead times and shipping routes. The cost of this blind spot has recently moved from the theoretical to the immediate. The Strait of Hormuz is the sole maritime gateway to the Arabian Gulf, and it carries roughly a fifth to a quarter of global seaborne oil in addition to a large share of liquefied natural gas and other commodities (EIA 2025; UNCTAD 2026). Following regional military escalation, the strait became effectively closed from early March 2026. The International Maritime Organization reported that around two thousand vessels and up to twenty thousand seafarers were stranded in the Gulf, and analysts described the episode as the largest disruption to global energy supply since the 1970s (UNCTAD 2026; Brookings Institution 2026).

Traffic moving into and out of the Gulf cannot easily be rerouted since the Gulf has only one sea entrance (CSIS 2026). Saudi Arabia's Eastern Province megaprojects are served by the Arabian Gulf ports of Jubail and Dammam, which are located inside the strait. Hence, every heavy and oversize cargo imported for those projects from East Asia or Europe must transit Hormuz, and a closure leaves the project owner with costly and slow alternatives such as discharge at Red Sea, Oman, and UAE ports followed by long inland haulage.

This experience exposes the central problem addressed in this paper. Before a disruption occurs, the project team needs a simple and defensible way to answer a practical question: among all the open purchase orders, which ones carry the greatest logistics criticality, so that contingency planning can be concentrated where they matter? The aim of this paper is to introduce such a tool, a heuristic Logistics Criticality Score that ranks every PO from data the project already holds, and to implement it on a real megaproject portfolio.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 presents the methods, including the practitioner survey and the proposed scoring model. Section 4 describes the data collected from the case-study project and from the survey. Section 5 presents and discusses the numerical and graphical results, the proposed improvements and the validation. Section 6 concludes the paper.

1.1 Objectives

The objectives of this research are to: (1) confirm, through an examination of governing project procedures and a practitioner survey, that industrial projects lack a formal method for prioritizing purchase orders by logistics criticality, and that this decision is currently left to individual experience; (2) identify the factors that drive the logistics criticality of a PO from the supply-chain disruption literature and practitioner input; (3) develop a heuristic scoring model that computes a Logistics Criticality Score for every PO using data that a typical industrial project holds, with factor weights derived from experienced practitioners; (4) implement the model on the full PO portfolio of a real industrial megaproject and quantify the concentration of logistics criticality and the exposure to maritime chokepoints; and (5) propose how the resulting watch-list should be embedded in the existing expediting and material-control procedures.

2. Literature Review

Material management is a decisive contributor to project performance. Material procurement is estimated to account for roughly half to sixty percent of total project cost and to influence project planning and scheduling. Hence, adopting effective material-management tools is essential to meet schedule targets and open work fronts at site (Caldas et al. 2015). Standard project-management guidance on procurement and schedule control makes the same point (Project Management Institute 2021). However, this body of work concentrates on the procurement phase itself, namely placing requisitions, evaluating bids and tracking fabrication progress. The logistics phase that moves a completed order from the vendor's gate to the construction site receives far less structured attention. It is in this downstream phase that a correctly procured item can still arrive late, damaged or out of sequence, and this is where this paper focuses.

A parallel body of work addresses supply-chain disruption and resilience. Christopher and Peck (2004) framed supply-chain resilience as the ability to return to a stable state after disruption and emphasized visibility and the identification of critical paths and nodes. Sheffi and Rice (2005) characterized the resilient enterprise in terms of redundancy and flexibility and stressed that firms must understand their exposure before an event rather than improvise during one. The COVID-19 pandemic renewed attention to how localized shocks propagate through global networks. Ivanov (2020) modeled how an epidemic outbreak ripples through a supply chain and showed the value of anticipating which flows are most exposed. The common message of this literature is that resilience begins with prioritization, which means knowing in advance which elements of the chain carry the greatest consequence if interrupted.

The supply-chain risk management literature formalizes this idea. It frames risk as the product of the likelihood of a disruption and the severity of its consequence, and it argues that the limited managerial attention should go to the exposures that score highest on that product. Jüttner et al. (2003) set out an agenda for the field and distinguished the sources, consequences and drivers of supply-chain risk. Chopra and Sodhi (2004) provided a managerial classification of risk categories and stressed the need to weigh each category by its likelihood and impact before committing mitigation resources. Kleindorfer and Saad (2005) developed principles for managing disruption risk, and Tang (2006) surveyed quantitative approaches to the problem. Wagner and Bode (2008) confirmed empirically that the relationship between exposure and performance loss is measurable across several dimensions of risk, and Pettit et al. (2010) linked these exposures to the resilience capabilities of a firm in a conceptual framework. This body of work supports two design choices adopted in this paper: logistics risk should be expressed as a combination of severity and exposure factors, and those factors should be combined in a way that identifies the consignments where multiple exposures coincide.

Maritime chokepoints are a recurring and concrete source of such interruptions. The 2021 obstruction of the Suez Canal showed how a single blockage at a narrow passage can halt a substantial share of world trade and cascade into weeks of schedule disruption far downstream (UNCTAD 2023). The 2026 closure of the Strait of Hormuz is a more severe instance that is directly relevant to Gulf projects, with stranded vessels, withdrawn war-risk insurance and contested rerouting (UNCTAD 2026; CSIS 2026; Congressional Research Service 2026). Since the Gulf has a single sea entrance, Eastern Province project cargo is structurally exposed to this chokepoint in a way that limits re-routing options once shipments are in transit. Thus, the origin and routing of each PO must be treated as a logistics-risk variable of its own.

Finally, the operations-research literature offers established multi-criteria methods for weighting and ranking alternatives against several factors, such as the supplier-selection methods reviewed by de Boer et al. (2001), and simple techniques for converting expert importance rankings into weights (Stillwell et al. 1981). These methods provide structured ways to derive and combine factor weights. However, they are typically applied to supplier selection or sourcing decisions rather than to the operational monitoring of an existing PO portfolio.

The existing tools measure procurement progress, build resilience strategy, or select suppliers. None of them provides a simple, project-level scoring method that combines cargo-handling difficulty and geopolitical routing risk with value and lead time to tell the project team which open POs to watch most closely. The method proposed in this paper fills this gap while remaining simple enough to run in a spreadsheet alongside the existing project controls.

3. Methods

The study followed the stages summarized in Figure 1. First, the supply-chain and logistics-risk literature was reviewed, and a survey of experienced project practitioners was designed and conducted. Together, the literature review and the survey identify the factors that drive the logistics criticality of a purchase order, weight those factors based on how practitioners rank their importance, and establish how widely the prioritization gap is felt across projects. Second, a scoring model was constructed from the identified factors to express the logistics criticality of each PO as a single comparable score. Third, the model was implemented in a case study on a real industrial megaproject, where the governing procedures were first examined to confirm that the prioritization gap exists in practice, and the model was then applied to the full purchase-order portfolio. Finally, the resulting ranking was discussed against the current practice and against the project exposure to maritime chokepoints, and conclusions were drawn.

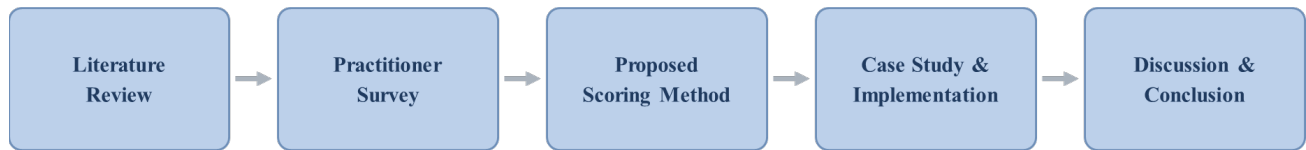


Figure 1. Methodology followed

3.1 Identification of Logistics-Criticality Factors

The factors that drive the logistics criticality of a purchase order were drawn from the supply-chain risk literature reviewed in Section 2 and from the cargo attributes that the procurement and shipping procedures. The relative importance of these factors was then put to the practitioner survey described in Section 3.2. Seven factors were retained, and each of them is available for every PO in the project material register without any new data collection: monetary value, inspection level, engineered/bulk, oversize cargo, heavy cargo, lead time, and routing or geopolitical risk. Since the survey provides an importance ranking across all seven factors, the factors are combined additively, where each factor is normalized to a common scale and multiplied by the weight its survey ranking implies. This weighted-sum structure lets every factor contribute in proportion to the importance practitioners assign it and makes the weights easy to restate or adjust depending on the project it is used for.

3.2 Practitioner Survey

To place the factor weights, and the gap itself, on an empirical basis, a structured practitioner survey was designed and administered as an online questionnaire. The survey served two purposes. The first is to test whether the prioritization gap motivating this study is experienced on other industrial projects. The second purpose is to capture from experienced practitioners the relative importance that each of the seven factors should carry in the score. Surveying domain experts is an established way to convert professional judgment into explicit and defensible weights, and the instrument follows accepted survey-design practice (Dillman et al. 2014).

The questionnaire was organized into four parts. A background section recorded the primary role of each respondent, the years of experience on industrial projects, the largest project worked on and the typical role of the respondent's organization. A practice section established the gap with yes/no and single-choice questions, namely: whether the respondent's projects place purchase orders with vendors in several countries, whether the project procedures define how cargo must be packed, shipped and expedited, whether logistics or transport problems have caused material to arrive late, damaged or out of sequence, when in the project cycle logistics risk is first formally assessed, and whether a simple tool that ranks POs by logistics criticality would be useful. The core section asked each respondent to rank the seven factors of Section 3.1 from 1 (most important) to 7 (least important) based on their effect on the logistics of a PO. A final section recorded which maritime chokepoints have affected the respondent's projects, how disruptive the experience was, and whether the project had a plan identifying its most exposed POs before the disruption occurred.

The ordinal rankings were converted to factor weights by the rank-sum method, which is a standard approximation for turning importance ranks into weights (Stillwell et al. 1981). The ranks of each factor were averaged across all respondents, the average was subtracted from eight so that the most important factor receives the largest score, and the results were normalized to sum to one, as expressed in Equation (2) of Section 3.3. The yes/no practice questions were summarized by the share of respondents answering each way, to confirm or qualify the gap.

3.3 The Proposed Logistics Criticality Scoring Model

For each purchase order i , a Logistics Criticality Score (LCS) is calculated as the weighted sum of the seven factors, as shown in Equation (1) and summarized in Figure 2. Each factor is first normalized to a score between 0 and 1 so that all factors are expressed on a common scale. Each normalized score is then multiplied by the weight the practitioner survey assigns to that factor. The sum is scaled by 100 so that the score reads naturally on a 0–100 scale, where 100 would represent a hypothetical PO at the maximum of every factor.

$$LCS_i = 100 \times \sum_f (w_f \times s_{f,i}) \quad (1)$$

Here $s_{f,i}$ is PO i 's normalized score on factor f and w_f is the weight of that factor. The seven factors were normalized as follows; Monetary value is divided by the largest PO value in the portfolio. Inspection level, which is recorded on

the standard zero-to-four scale, is divided by four. The engineered, oversize and heavy attributes are binary, and each of them takes the value 1 when the attribute applies and 0 otherwise. Lead time in weeks is divided by the longest lead time in the portfolio. The routing factor is mapped from the three-tier scale defined in Table 1, where a domestic overland PO scores 0, a PO shipped through a single critical chokepoint scores 0.5, and a PO whose route transits two or more chokepoints scores 1. Where a PO is sourced from multiple countries, the most stringent applicable tier is assigned.

Table 1. Routing risk Tiers factors

G	Routing-risk tier	Definition
1	Domestic / overland	In-Kingdom vendors delivered by road; no maritime chokepoint
2	Single chokepoint	Sea route transiting one critical chokepoint (Strait of Hormuz) to reach Arabian Gulf ports (e.g., Indian-Ocean origins).
3	Multiple chokepoints	Long sea routes transiting two or more chokepoints, such as East Asia (Malacca + Hormuz) and Europe (Suez / Bab-el-Mandeb + Hormuz).

The weights are derived from the practitioner survey by the rank-sum method, as shown in Equation (2). The average rank $\bar{r}_f$ of each factor across the respondents is subtracted from eight (7 factors +1) so that the factor ranked most important receives the largest score, and the results are normalized to sum to one (Stillwell et al. 1981). The numerical weights obtained from the survey are reported in Section 5.1.

$$w_f = (8 - \bar{r}_f) / \sum_g (8 - \bar{r}_g) \quad (2)$$

Finally, to express the criticality of each PO as a share of the project total, the raw score is normalized into a logistics weight, as shown in Equation (3). The logistics weights sum to 100% across the portfolio and provide an intuitive ranking and a basis for setting monitoring thresholds.

$$\text{Logistics Weight}_i (\%) = (LCS_i / \sum LCS) \times 100 \quad (3)$$

Seven register factors, normalized 0–1, weighted by the practitioner survey (n = 78)

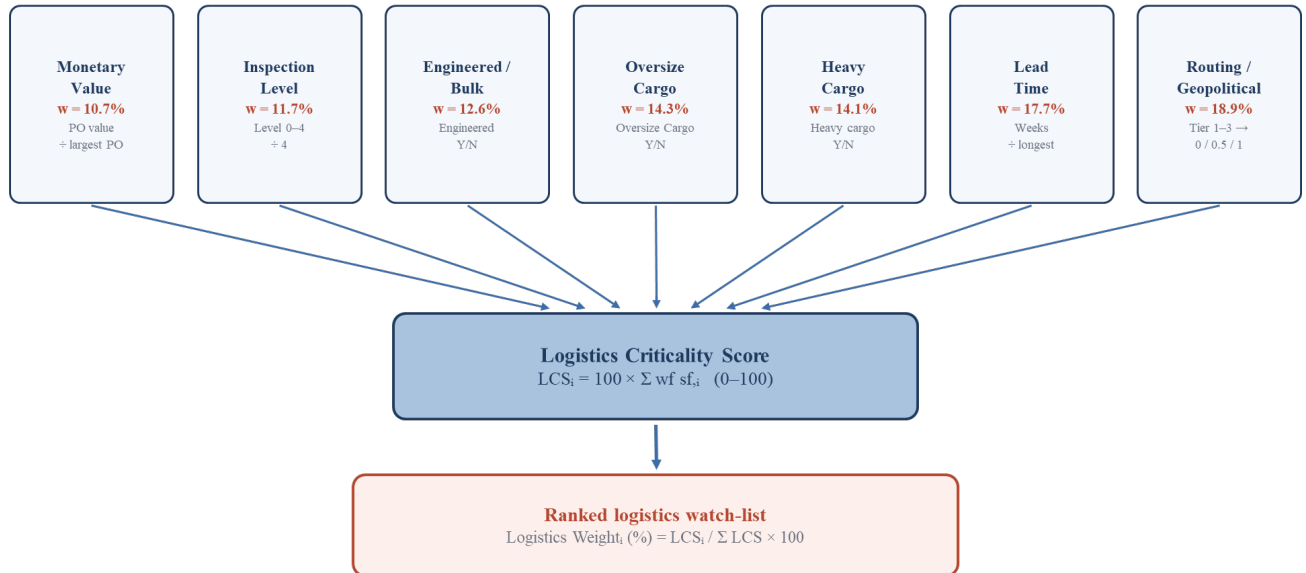


Figure 2. Logistics Criticality Scoring framework

4. Data Collection

4.1 Case-Study Project Data

The model was tested on data from a real gas increment megaproject executed for Saudi Aramco by an engineering, procurement and construction contractor. The material was sourced both in-Kingdom and from international vendors

across twelve countries. The portfolio comprised 111 purchase orders with a combined value of USD 665.8 million. For every PO, the following attributes were extracted from the project material register, and each attribute corresponds directly to a field the governing procedures already capture: the PO value, the inspection level, whether the PO is engineered or a non-engineered commodity, the oversize-cargo (pieces exceeding 15.25 m x by 3.35 m x 3.65 m), heavy-cargo (a single piece of 45,000 kg or more), the manufacturing lead time in weeks, and the vendor location. Table 2 summarizes how these attributes are distributed across the portfolio.

Table 2. Logistics factors and their distribution across the 111-PO case-study portfolio

Logistics factor	Data field	Distribution across the 111 POs
Monetary value	PO value (USD)	USD 9,143 to 69.3 M; total portfolio USD 665.8 M; mean USD 6.0 M
Fabrication / QA complexity	Inspection level (0–4)	L0: 28, L1: 10, L2: 29, L3: 29, L4: 15 purchase orders
Engineered/bulk	Engineered / Non-engineered	53 engineered (custom) vs. 58 non-engineered (bulk)
Oversize cargo	Oversize (Y/N)	10 oversize purchase orders (pieces exceeding 15.25 m x by 3.35 m x 3.65 m)
Heavy cargo	Heavy (Y/N)	19 heavy purchase orders (≥ 45 t)
Lead-time exposure	Lead time (weeks)	0 to 111 weeks; mean 58 week
Routing / geopolitical risk	Vendor location	12 supply countries; 57 of 111 POs (51%) shipped through chokepoints

Table 2 shows that the value varies from small commodity orders of a few thousand dollars to a single PO of USD 69.3 million. The inspection level varies widely, and roughly half of the portfolio is engineered to order rather than bulk. A meaningful minority of the POs carry oversize or heavy attributes that trigger special handling under the shipping procedure. The lead times range from immediate delivery to 111 weeks, and just over half of all POs travel by sea through one or more maritime chokepoints.

4.2 Survey Responses

The survey was distributed to practitioners across owner, contractor, vendor, logistics and consulting organizations, and 78 complete responses were received. Every response contained a ranking of each factor out of the seven factors. Around 49% of the respondents work in program or project management, 17% in procurement and contracts, 12% in expediting and 8% in logistics, and the remainder work in engineering and construction. In addition, 46% of the respondents have more than ten years of experience on industrial projects, and 45% have worked on projects exceeding one billion dollars. Owners and operators (35%) and EPC contractors (33%) together supply two-thirds of the sample, and the balance comes from consultants, vendors and freight forwarders. The rankings and practitioners answers collected from these respondents are analyzed in Section 5.

5. Results and Discussion

The scoring model was applied to all 111 purchase orders in the portfolio described in Section 4, and the complete ranked register is provided in Appendix A. This section first reports the numerical results, which include the survey-derived weights, the contrast with the current practice, a worked example, and the concentration and exposure statistics. After that, the section presents the graphical results, proposes how the tool should be embedded in the project procedures, and validates the contribution against the survey evidence and the published literature.

5.1 Numerical Results

Applying Equation (2) to the 78 respondents rankings gives the factor weights reported in Table 3. The respondents placed routing or geopolitical risk first (average rank 2.71, weight 18.9%) and lead time second (3.05, 17.7%), followed by the two special-cargo attributes, with engineered/bulk, inspection level and monetary value carrying the least weight. Two observations can be made on this ordering. First, the highest weight attaches to the factor this paper adds to the conventional practice, which is route exposure. This indicates that practitioners regard route exposure as the dominant logistics concern in the current environment. Second, monetary value, which is the attribute mostly concerns the purchasing process, was ranked least important for logistics. Since a high value PO is not necessarily the

hard one to move. The factors weights are adjustable, and any project team can adjust according to their internal priorities and produce a logistics criticality score.

Table 3. Factor weights derived from the practitioner survey

Factor	Average rank (n = 78)	8 – average rank	Weight w (%)
Routing / geopolitical risk	2.71	5.29	18.9
Lead time	3.05	4.95	17.7
Oversize cargo	3.99	4.01	14.3
Heavy cargo	4.05	3.95	14.1
Engineered/bulk	4.47	3.53	12.6
Inspection level	4.73	3.27	11.7
Monetary value	5.00	3.00	10.7

The governing procedures assign no monitoring priorities, and the decision of which of the 111 POs to watch most closely rests on the judgment and previous experience of the team. For comparison in what follows, a uniform reference line of 1 / 111, or about 0.90%, is used. This is the share each PO would carry if the criticality were spread evenly across the portfolio. This line does not describe the current practice. It simply gives the ranking a fixed value to be measured against.

To illustrate the calculation, consider the highest-ranked PO in the portfolio, which is an incinerator air blower fabricated in Japan with a value of USD 19,406,517, an inspection level of 3, oversize and heavy cargo, engineered rather than bulk, an 89-week lead time, and a multi-chokepoint route. Its normalized factor scores are as follows: value $19,406,517 / 69,314,277 = 0.280$ against the largest PO in the portfolio, inspection $3 / 4 = 0.75$, engineered, oversize and heavy each equal to 1, lead time $89 / 111 = 0.802$ against the longest lead time, and routing 1.0 for a Tier-3 route. Applying the weights of Table 3 in Equation (1) gives $LCS = 100 \times (0.107 \times 0.280 + 0.117 \times 0.75 + 0.126 \times 1 + 0.143 \times 1 + 0.141 \times 1 + 0.177 \times 0.802 + 0.189 \times 1.0) = 85.9$, which is the highest score in the portfolio since nearly every factor sits at or near its maximum. By Equation (3), its logistics weight is $85.9 / 3,890.3 = 2.21\%$ of the total portfolio criticality, which is about two and a half times the 0.90% uniform reference share.

Across the whole portfolio, the ranking is decisive. Every PO in the top fifteen scores between 66 and 86 on the 0–100 scale, which is roughly double the portfolio average score of 35, and each of them carries between 1.7% and 2.2% of the total criticality against the 0.90% uniform reference. The most critical 10% of the POs carry 20% of the total logistics criticality, the most critical 20% carry 37%, and the most critical half carries 70%. The 57 POs (51% of the portfolio) that travel by sea through one or more maritime chokepoints carry 60% of the total logistics criticality on only 38% of the portfolio value, and 55% of the POs in the top fifth of the ranking are chokepoint-exposed. These figures are examined graphically in Section 5.2.

5.2 Graphical Results

Figure 3 shows the fifteen highest-criticality POs and their individual logistics weights. The ranking is headed by the incinerator air blower from Japan (LCS 85.9), followed by the domestically fabricated incinerator package with the longest lead time in the portfolio. After that comes a mix of imported rotating equipment and heat exchangers from Korea, Japan, France and Italy alongside the largest in-Kingdom fabrications, namely the columns and vessels, the reaction furnace and the analyzer package. As illustrated in the figure, six of the fifteen are chokepoint-exposed imports lifted by the routing factor, while the domestic entries earn their place through the combination of long lead times, engineered fabrication and heavy or oversize attributes.

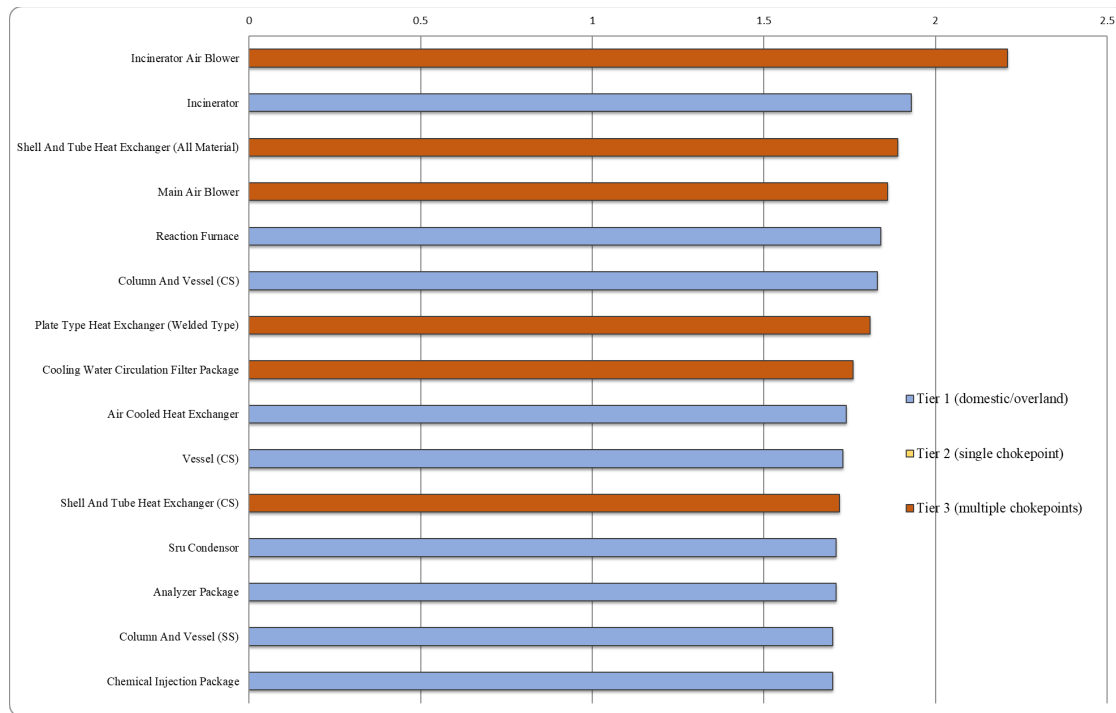


Figure 3. Logistics weights of the highest 15 PO in the portfolio

Figure 4 plots the cumulative share of logistics criticality against the cumulative share of POs, ranked from most to least critical, alongside the diagonal that a perfectly uniform spread would produce. The top fifth of the ranking carries nearly twice its proportional share of the project logistics risk. A team that directs its intensified expediting, route surveys and contingency planning at the 22 watch-list POs covers more than a third of the total criticality. Unlike the experience-based monitoring, this coverage can be demonstrated since the ranking is documented. Hence, the ranking reflects how hard each PO is to move rather than how much it cost.

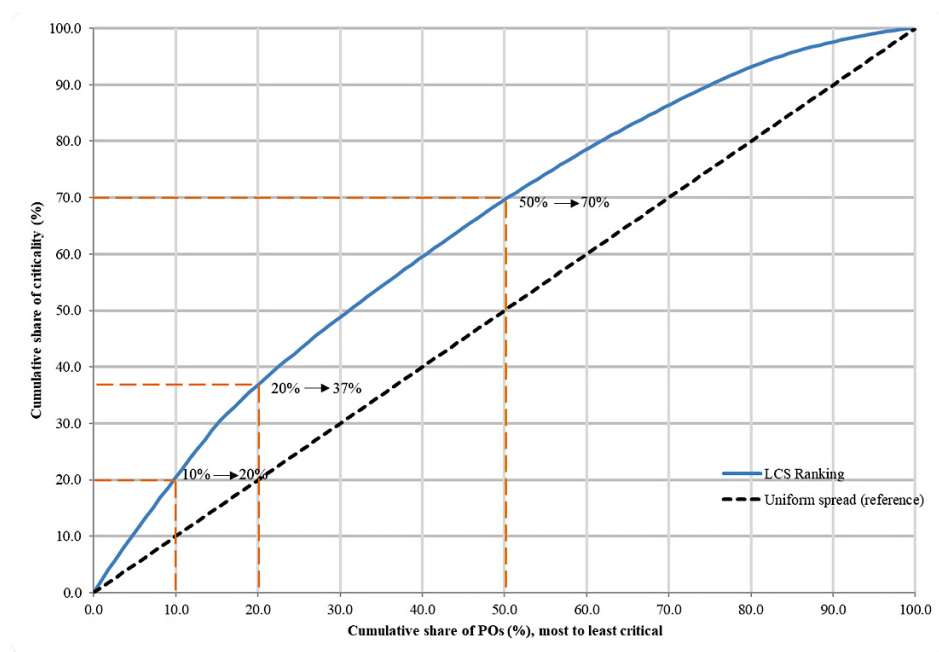


Figure 4. Concentration of logistics criticality

Figure 5 breaks the portfolio down by routing-risk tier. The domestic overland POs make up 49% of the count and 62% of the value. However, the sea-shipped POs that transit one or more chokepoints, which are 50% of the portfolio, carry 58% of the total logistics criticality on only 36% of the value. The inversion between the value and criticality shares is the routing factor. The imported POs are not the most expensive part of the portfolio. They are, however, the part a chokepoint closure can actually stop.

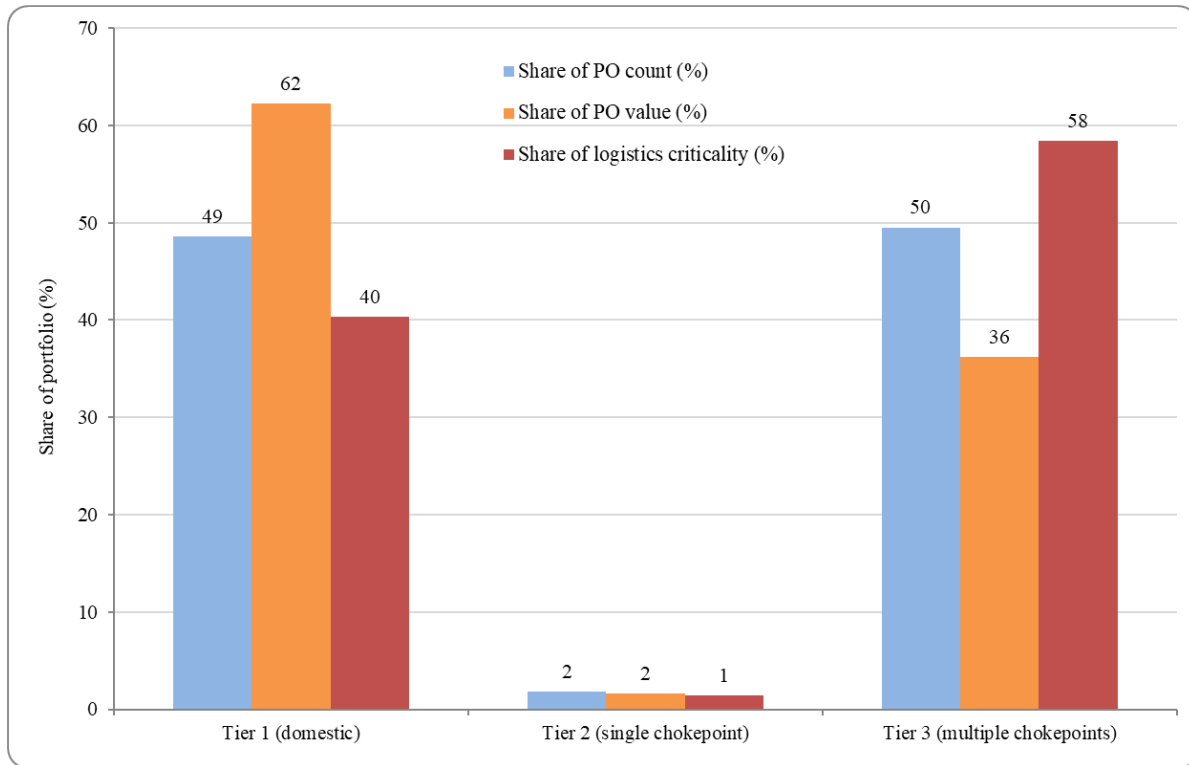


Figure 5. Exposure to maritime chokepoints by routing tier

Figure 6 presents the factor ranking of the survey as the derived rank-sum weights. On the project procedures 83% of the respondents reported that their procedures define how cargo must be packed, shipped and expedited, and 81% place purchase orders with vendors in several countries. Regarding the early and differentiated attention to logistics risk, a third of the respondents reported that logistics risk is never formally assessed on their projects, and a further 28% report that it is first assessed only after PO placement. Only 30% assess it during early planning, and 9% at PO placement. The consequences are visible, where 83% have experienced logistics or transport problems that caused material to arrive late, damaged or out of sequence. Around 92% of the respondents reported that at least one maritime chokepoint has affected their projects (the Strait of Hormuz alone was selected by 85%), and 23% describe the resulting disruption as major since it delayed the project completion date. However, 56% report that their project had no plan identifying its most exposed POs before the disruption occurred. Consistent with all of this, 81% say that a simple tool that ranks POs by logistics criticality would be useful to their team.

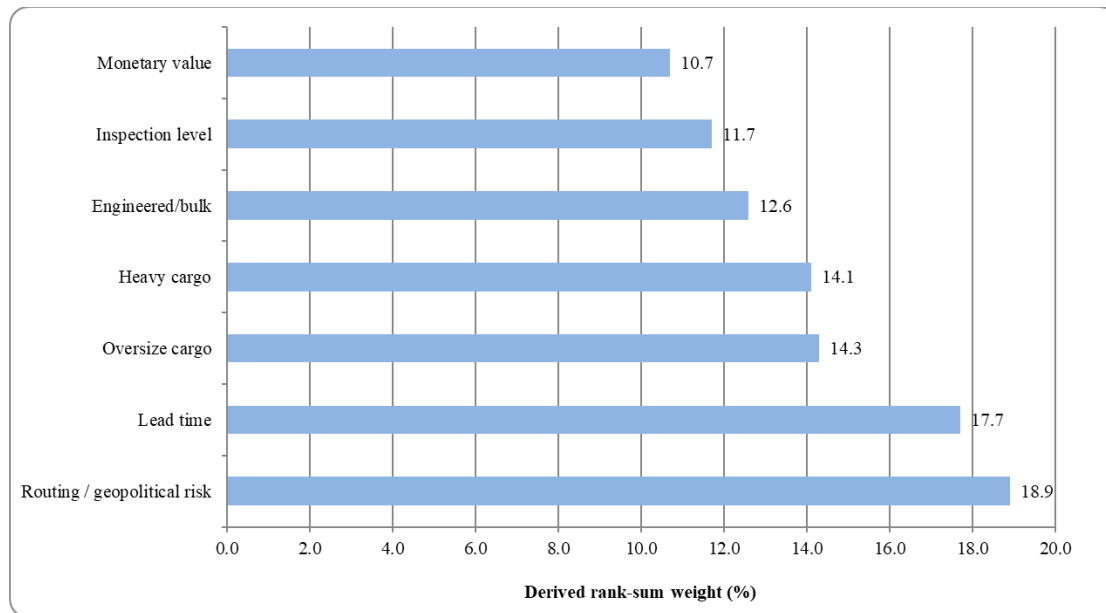


Figure 6. Practitioners ranking of the seven logistics factors

5.3 Proposed Improvements

Two controlled documents govern the material flow on the case-study project. The Procurement Plan and Procedure define the procurement organization, the requisition-to-delivery execution process, an Expediting Plan and a Material Control section, and it provides standard status-report templates. The Packing and Shipping Procedure defines the packing specifications, the export-licence and hazardous-material obligations, the freight-forwarder appointment, the shipping documentation, and the special-handling requirements for heavy cargo (a single piece of 45,000 kg or more), intermediate cargo (20,000–45,000 kg) and oversize cargo (pieces exceeding 15.25 m x by 3.35 m x 3.65 m). These procedures describe the required actions for each shipment and the thresholds at which special handling is triggered. However, they do not rank purchase orders or allocate the monitoring effort differentially, and where to look first is decided by individual experience rather than by a documented method. The proposed model enhances existing procedures and supplies a prioritization layer using available data.

The recommended improvement is to embed the score in the routine project controls. The model is run across the whole portfolio to produce a ranked logistics watchlist, and the project team sets a monitoring threshold. For example, the top fifth of the ranking can be treated as the high-priority tier that is subject to intensified expediting, early forwarder engagement, route surveys, buffer planning and pre-arranged contingency routing, while the remaining POs receive the standard monitoring practice. Since the score is recomputed from a typical PO factor, it can be refreshed whenever the lead times, the values or the geopolitical picture change, which keeps the watch-list current as the project and its risk environment evolve.

The practical value is evident in the chokepoint scenario. Without a documented ranking, a sudden closure forces the project team into a reactive scramble across the entire portfolio while trying to assess the exposure, identify alternatives and reroute shipments under time pressure. With the scoring model in place, the team already holds a ranked and chokepoint-tagged watch-list and can act before or at the onset of the disruption by staging contingency routing through Red Sea ports such as Yanbu with onward inland haulage, reserving air freight for the small number of critical and time-sensitive items where it is justified, building buffer for the highest-criticality POs, engaging forwarders early, and qualifying alternative vendors in lower-risk locations where the lead time allows.

5.4 Validation

The contribution is validated in three ways. First, the practitioner survey validates the central design choices of the model independently of the judgment of the authors. The highest weight attaches to routing and geopolitical risk, which is the factor this paper adds to the conventional project attributes, and this provides direct empirical support for treating route exposure as a first-class logistics variable. In addition, 81% of the respondents' state that a tool of exactly

this kind would be useful to their team. Second, the case-study results are consistent with the published disruption literature reviewed in Section 2, which holds that resilience begins with knowing in advance which flows carry the greatest consequence (Christopher and Peck 2004; Sheffi and Rice 2005; Ivanov 2020). The concentration result, where the top fifth of the POs carries nearly twice its proportional share of the criticality, quantifies the critical few that this literature argues should receive the limited resources attention. Third, the ranking behaves sensibly at the level of the individual POs. The items it places at the top are the long-lead, engineered, special-cargo and chokepoint-exposed POs that the project procedures flag for special handling.

6. Conclusion

This paper has addressed a practical gap in project material management. From a project detailed packing, shipping and procurement procedures, there is no formal method for deciding which purchase orders deserve the most intensive logistics attention, and this decision has traditionally rested on the previous experience of the team. Against the objectives set in Section 1.1, the gap was confirmed both in the governing procedures of the case-study project and by the practitioner survey. Seven driving factors were identified from the literature and typical project data. A heuristic Logistics Criticality Score was developed to rank each PO as the weighted sum of those factors. The model was implemented on a megaproject POs portfolio, resulting in a watchlist in that can be embedded existing project controls. The survey of 78 practitioners validated the gap as well as the weights. Around 83% of the respondents have experienced logistics-driven late, damaged or out-of-sequence deliveries, 61% report that logistics risk is assessed only after PO placement or not formally assessed, 56% faced a chokepoint disruption with no plan identifying their most exposed POs, and 81% say that a PO-ranking tool would be useful. Most importantly, the practitioners placed routing and geopolitical risk first among the seven factors and monetary value last. When the tool was applied to a real Saudi Aramco megaproject of 111 purchase orders worth USD 665.8 million, it turned a clear and actionable ranking of the purchase orders. The most critical fifth of the POs carries nearly twice its proportional share of the total logistics criticality, and the 51% of the POs shipped through maritime chokepoints carry 60% of it on only 38% of the value, which is exactly the exposure made concrete by the 2026 closure of the Strait of Hormuz.

In the future, the factor weights can be re-derived within individual organizations, and the sensitivity of the ranking to them can be tested. The project register can also be enriched so that further logistics factors, such as, customs-clearance complexity, and construction-sequence criticality, can be incorporated alongside the seven factors used in this paper. The static score can be extended into a dynamic measure that is refreshed as the schedule and the geopolitical conditions evolve, and the watchlist can be integrated with the existing expediting and material-control reporting so that prioritization becomes part of the routine controls. Implementing the method on additional projects and disruption scenarios will avail opportunities for practitioners to enhance it and realize its full benefits. Even in its present form, the tool offers project teams a simple and immediately usable way to protect their most critical material flows.

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Biographies

Mohammed Aldossary is a Senior Engineer in Upstream Gas Project Management at Saudi Aramco, where he has worked since 2017, with experience in project management. He obtained his Bachelor of Science degree in Civil Engineering from King Fahd University of Petroleum and Minerals. He holds two Master of Engineering degrees, one in Construction Engineering and Management and the second in Sustainable and Renewable Energy, both from King Fahd University of Petroleum and Minerals. He is certified as a Project Management Professional (PMP) and Professional in Business Analysis (PMI-PBA) from the Project Management Institute, and as a Planning and Scheduling Professional (PSP) from AACE International.

Sultan Al Ankari is a Project Engineer working in Upstream Gas Project Management at Saudi Aramco, where he has worked since 2019, with experience in operations, project management. He obtained his Bachelor of Science degree in Chemical Engineering from King Faisal University and is FE certified in Chemical Engineering.

Appendix A. Ranked Logistics Criticality Register

Table A1 lists all 111 purchase orders in the portfolio, ranked from most to least critical, with each PO's origin, inspection level (I), lead time in weeks (L), routing-risk tier (G), engineered (Eng), oversize (OS) and heavy (HV) indications, Logistics Criticality Score (LCS) and logistics weight. The top fifth of the ranking (the first 22 rows, shaded) constitutes the proposed watchlist.

Table A 1. The complete ranked register of 111 purchase orders (top 22 shaded: the proposed watchlist)

#	PO description	Origin	I	L (wk)	G	Eng	OS	HV	LCS	Wt (%)
1	Incinerator Air Blower	Japan	3	89	3	Y	Y	Y	85.9	2.21
2	Incinerator	KSA	4	111	1	Y	Y	Y	75.1	1.93
3	Shell And Tube Heat Exchanger (All Material)	Korea	4	85	3	Y	N	Y	73.4	1.89
4	Main Air Blower	Japan	3	93	3	Y	N	Y	72.2	1.86
5	Reaction Furnace	KSA	4	99	1	Y	Y	Y	71.5	1.84
6	Column And Vessel (Cs)	KSA	4	97	1	Y	Y	Y	71.1	1.83
7	Plate Type Heat Exchanger (Welded Type)	France	4	75	3	Y	N	Y	70.5	1.81
8	Cooling Water Circulation Filter Package	Italy	3	81	3	Y	N	Y	68.4	1.76
9	Air Cooled Heat Exchanger	KSA	4	78	1	Y	Y	Y	67.6	1.74
10	Vessel (Cs)	KSA	4	87	1	Y	Y	Y	67.2	1.73
11	Shell And Tube Heat Exchanger (Cs)	Korea	3	77	3	Y	N	Y	66.9	1.72

#	PO description	Origin	I	L (wk)	G	Eng	OS	HV	LCS	Wt (%)
12	Sru Condensor	KSA	4	79	1	Y	Y	Y	66.7	1.71
13	Analyzer Package	KSA	3	64	1	Y	Y	Y	66.6	1.71
14	Column And Vessel (Ss)	KSA	4	80	1	Y	Y	Y	66.1	1.70
15	Chemical Injection Package	KSA	3	89	1	Y	Y	Y	66.0	1.70
16	Stripping Air Blower	Korea	3	52	3	Y	N	Y	63.8	1.64
17	Plate Type Heat Exchanger (Gasket Type)	Japan	2	68	3	Y	N	Y	62.3	1.60
18	Sealless Pump	Japan	2	82	3	Y	N	N	51.4	1.32
19	Column Internal	KSA	2	101	1	Y	N	Y	49.4	1.27
20	On-Off Valve - Butterfly (Including Aov)	Italy	3	48	3	Y	N	N	48.8	1.25
21	Mov - Gate	KSA / ITALY	3	48	3	Y	N	N	48.4	1.24
22	Refractory Lining Materials	Germany	0	92	3	Y	N	N	46.2	1.19
23	Desuperheater Package	JAPAN	2	46	3	Y	N	N	44.8	1.15
24	Ejector	Korea	0	77	3	Y	N	N	43.9	1.13
25	Sulfur Pump	Korea	0	74	3	Y	N	N	43.8	1.13
26	Pipe, Stainless Steel Smls	CHINA	4	71	3	N	N	N	42.9	1.10
27	Electrical Heat Tracing System	USA	0	69	3	Y	N	N	42.7	1.10
28	Ac Ups & Battery Charger	ITALY	1	49	3	Y	N	N	42.5	1.09
29	Crane And Hoist	KSA	2	57	1	Y	N	Y	41.7	1.07
30	Cooling Tower	France	0	55	3	Y	N	N	41.5	1.07
31	Pipe, Carbon Steel Welded	1) GERMANY / 2) CHINA	3	66	3	N	N	N	39.9	1.03
32	Centrifugal Pump (Api)	KSA	4	87	1	Y	N	N	39.9	1.02
33	Pipe, Stainless Steel Welded	CHINA	3	69	3	N	N	N	39.5	1.01
34	Crms (Corrosion Monitoring Sytem)	USA	0	43	3	Y	N	N	38.9	1.00
35	Plug Valve	ITALY	3	68	3	N	N	N	38.8	1.00
36	Flange & Blank	KSA / SPAIN	2	68	3	N	N	N	38.0	0.98
37	Afd System	Korea	0	38	3	Y	N	N	37.8	0.97
38	Pipe, Carbon Steel Smls	1) CHINA / 2) SPAIN	4	30	3	N	N	N	37.8	0.97
39	480V Swtichgear, 480V Controlgear, Ats	KSA	4	75	1	Y	N	N	37.7	0.97
40	Steam Trap & Steam Manifold	BELGIUM	2	74	3	N	N	N	37.4	0.96
41	Non Slam Check Valve	ITALY	3	58	3	N	N	N	37.1	0.95
42	Fitting, Forged Steel	ITALY	2	74	3	N	N	N	36.9	0.95
43	Butterfly Valve, High Performance	ITALY	3	51	3	N	N	N	36.5	0.94
44	Parallel Slide Gate Valve	ITALY	3	53	3	N	N	N	36.5	0.94
45	Structural Steel	KSA	4	87	1	N	N	N	36.3	0.93
46	Flow Element	KSA / ITALY	2	72	3	N	N	N	36.3	0.93
47	Butterfly Valve, Concentric	ITALY	3	53	3	N	N	N	36.1	0.93
48	Ball Valve, 26 Inch & Above	ITALY	3	48	3	N	N	N	35.9	0.92
49	Dual Plate Check Valve	ITALY	3	50	3	N	N	N	35.6	0.92
50	Process Control System	KSA	2	94	1	Y	N	N	35.6	0.91
51	Tilting & Stop Check Valve	ITALY	3	49	3	N	N	N	35.5	0.91
52	Cooling Water Pump	KSA	3	83	1	Y	N	N	35.4	0.91
53	Fitting, Wrought Steel	KSA / KOREA	2	37	3	N	N	N	34.5	0.89
54	Blowdown Valve	ITALY	3	43	3	N	N	N	34.5	0.89
55	Ram Type Sample Valve	GERMANY	3	41	3	N	N	N	34.2	0.88
56	Tube & Tube Fitting(Ss)	Korea	2	47	3	N	N	N	32.6	0.84
57	Special Thermocouple (Multi, Skin, Ceramic)	Germany	2	48	3	N	N	N	32.5	0.83
58	Tube And Fitting	Korea	1	63	3	N	N	N	32.4	0.83
59	Pipe, Nickel Alloy	CHINA	3	27	3	N	N	N	32.0	0.82
60	13.8Kv & 4.16Kv Switchgear, 4.16Kv Controlgear	KSA	2	75	1	Y	N	N	31.8	0.82
61	Flowmeter - Magnetic & Vortex	China	2	42	3	N	N	N	31.6	0.81
62	Gas Detector	Germany	0	0	3	Y	N	N	31.5	0.81
63	On-Off Valve - Ball Type	KSA	3	52	1	Y	N	N	31.0	0.80
64	Fitting, Wrought Steel For Cross Tee	ITALY	2	37	3	N	N	N	30.6	0.79
65	Hvac System	KSA	2	57	1	Y	N	N	30.6	0.79

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#	PO description	Origin	I	L (wk)	G	Eng	OS	HV	LCS	Wt (%)
66	Pipe, Carbon Steel Smls For Underground	1) CHINA / 2) SPAIN	2	30	3	N	N	N	29.6	0.76
67	Pipe, Low Alloy Steel Smls	SPAIN	2	28	3	N	N	N	29.5	0.76
68	Power & Distribution Transformers (13.8Kv/ 4.16Kv/ 0.48Kv, 2.5/3.125 Mva, 15/20 Mva) & Ngr	KSA	2	64	1	Y	N	N	29.3	0.75
69	Multi Cable Transit (Mct)	Sweden	0	55	3	N	N	N	28.4	0.73
70	Firewater Valve (Ul/Fm)	China	2	22	3	N	N	N	28.3	0.73
71	Cable Tray	KSA / ITALY	0	53	3	N	N	N	27.7	0.71
72	Level Transmitter	Germany	0	53	3	N	N	N	27.6	0.71
73	Gate/Globe/Check Valve, Casting Steel, 24 Inch & Below	1)KSA / 2)INDIA	3	48	2	N	N	N	27.3	0.70
74	Control Valve - Globe & Butterfly	KSA	2	50	1	Y	N	N	27.1	0.70
75	Control Valve - Non General	KSA	2	51	1	Y	N	N	26.7	0.69
76	Bolt & Nut	CHINA	1	24	3	N	N	N	26.5	0.68
77	Gate/Globe/Check Valve, Casting Steel, 26 Inch & Above	INDIA	3	49	2	N	N	N	26.3	0.68
78	Flowmeter - Coriolis	Germany	0	45	3	N	N	N	26.2	0.67
79	Diesel Engine Generator	KSA	1	65	1	Y	N	N	26.1	0.67
80	Mct (Multi Cable Transit)	Sweden	0	41	3	N	N	N	25.6	0.66
81	Safety Relief Valves (Pzv) Conventional & Pilot Operated	KSA	2	42	1	Y	N	N	25.5	0.66
82	Communication System	KSA	0	69	1	Y	N	N	24.5	0.63
83	Cathodic Protection	KSA	1	54	1	Y	N	N	24.3	0.62
84	Industrial Type Panelboards	KSA	0	68	1	Y	N	N	24.0	0.62
85	Explosion Proof Lighting Outdoor Panel	KSA	0	52	1	Y	N	N	23.5	0.60
86	Centrifugal Pump (Asme B73.1)	KSA	0	65	1	Y	N	N	23.1	0.59
87	Power System Automation	KSA	0	54	1	Y	N	N	21.3	0.55
88	Fdas (Fire Detection And Alarm System)	KSA	0	49	1	Y	N	N	20.8	0.53
89	Control Valve - Self Regulating	KSA	0	50	1	Y	N	N	20.6	0.53
90	Equipment Platform And Ladder	KSA	3	69	1	N	N	N	20.0	0.51
91	Control Valve - Rotary Ball	KSA	0	44	1	Y	N	N	19.7	0.51
92	Rtr Piping	KSA	4	33	1	N	N	N	17.3	0.44
93	Gate/Globe/Check Valve, Forged Steel	KSA	3	50	1	N	N	N	17.2	0.44
94	Ball Valve, 24 Inch & Below	KSA	3	42	1	N	N	N	16.0	0.41
95	Contro Trace	KSA	1	57	1	N	N	N	14.4	0.37
96	Mv Cables	KSA	1	58	1	N	N	N	14.3	0.37
97	Local Instrument	KSA	2	48	1	N	N	N	13.7	0.35
98	Level Gauge	KSA	2	42	1	N	N	N	12.6	0.32
99	Instrument Cable	KSA	0	73	1	N	N	N	12.4	0.32
100	Fixed Fire Fighting Equipment	KSA	1	53	1	N	N	N	12.2	0.31
101	Flange For Ug	KSA	2	36	1	N	N	N	11.6	0.30
102	Mv & Lv Cable Bus	KSA	1	48	1	N	N	N	10.6	0.27
103	Fitting, Wrought Steel For Underground	KSA	2	28	1	N	N	N	10.4	0.27
104	Ductile Iron Valve	KSA	1	44	1	N	N	N	10.0	0.26
105	Junction Box & Junction Box Ff	KSA	0	59	1	N	N	N	9.6	0.25
106	Cable Trays, Ladders & Accessories	KSA	0	53	1	N	N	N	8.7	0.22
107	Field Transmitter (Pt, Pdt, Te, Tw, Tt)	KSA	0	51	1	N	N	N	8.6	0.22
108	Hdpe Piping/Hdpe Fittings	KSA	2	13	1	N	N	N	8.0	0.21
109	Lateral Tee	KSA	0	50	1	N	N	N	7.9	0.20
110	Gasket	KSA	0	28	1	N	N	N	4.6	0.12
111	Cpvc Piping	KSA	0	15	1	N	N	N	2.4	0.06