



Construction Industry Institute®

Achieving Zero Rework through Effective Supplier Quality Practices Phase II

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ACHIEVING ZERO REWORK THROUGH
EFFECTIVE SUPPLIER QUALITY PRACTICES
PHASE II

by

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The University of Texas at Austin

Under the Guidance of
CII Research Team 308
Achieving Zero Rework through Effective Supplier Quality Practices

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1. Introduction

The original question answered by RT 308 was “What are the most effective processes and practices for ensuring that project materials and equipment are produced, manufactured, or fabricated in strict accordance with all applicable specifications, and that they are delivered to the project site without any need for rework?” The results of this effort can be found in Research Summary 308-1, Research Report 308-11, and Implementation Resource 308-2.

The project extension has investigated, in more detail, how the fabrication and inspection capability of suppliers are defined and how they impact the quality of the final product. The team decided to revisit the purchase order (PO) data collection instrument and analyze a few question of interest that had not been extensively discussed in the first phase of the project. More specifically, the team decided to take a closer look at the supplier selection process and the data provided by respondents about their practices related to supplier selection and assessment.

Furthermore, the expansion focused on further clarification of ‘how’ to determine the probability the item is fabricated correctly (P_{fab}) and the probability the inspection activities can catch and repair non-conformance (P_{insp}). The end result, presented in the new Implementation Report 308-3, will allow for any industry, contractor, or owner/operator to easily assimilate the findings defined within IR 308-2 in ‘Estimating the Impact of the Cost of Non-quality’ on a capital project. This report addresses the additional research tasks carried out to develop the method and the beta version of the tool presented in IR308-3.

This report is structured in four main parts: Chapter 1 – Introduction, Chapter 2 – Supplier Selection and Evaluation, Chapter 3 – Analysis of Hypotheses, and Chapter 4 – Conclusions. Chapter 2 presents data on the current state of supplier evaluation and how that informed the definition of a set of supplier evaluation and selection criteria used in this project. Chapter 3 discusses results obtained from the PO instruments, used in the original project and the extension, regarding supplier evaluation and selection. Chapter 4 outlines the conclusions of this project extension and what the team accomplished.

2. SUPPLIER SELECTION AND EVALUATION

Considering that the goal of the project extension was to define parameters to estimate P_{fab} and P_{insp} , the team started the discussion about how they should be defined by revisiting the results of the work presented in RR308-11 (Walsh et al. 2015) and the purchase order (PO) instrument, which gathered 108 responses from CII member companies in 2013. The discussion about the definition of supplier evaluation criteria used in the new PO instrument (Alves et al. 2016b) are presented in this chapter.

2.1 Additional analysis of the original PO instrument

Four questions from the PO instrument were initially used to specifically analyze the background of respondents and their supplier selection and assessment practices:

- Q6-original. Indicate your role in the project (contractor, owner, supplier, owner/contractor).
- Q32-original. Did you include ratings of prior performance in determining whether or not to select this supplier for this specific P.O.? (yes/no)
- Q33-original. If yes for question 32, what characteristics of the prior performance did you consider? (give a list)
- Q40-original. What other practices that you believe are critical to your procurement quality process were not identified or recognized by (previous) questions? Explain.

The analysis of answers from Q6-original (role in the project) and Q32-original (use of ratings of prior performance) indicated that very few of the owners who answered the original PO instrument used prior ratings of supplier performance to select suppliers (Figure 2.1). In contrast, owner-contractor (those who own and build) often used ratings of prior performance to make these decisions. This might be attributed to the fact that the owner-contractor role bears the technical responsibility for what they are building and also own it. That might make them more inclined to use previous data to make sound selections. Contractors' and suppliers' responses indicated that they use these ratings about half the time when selecting suppliers.

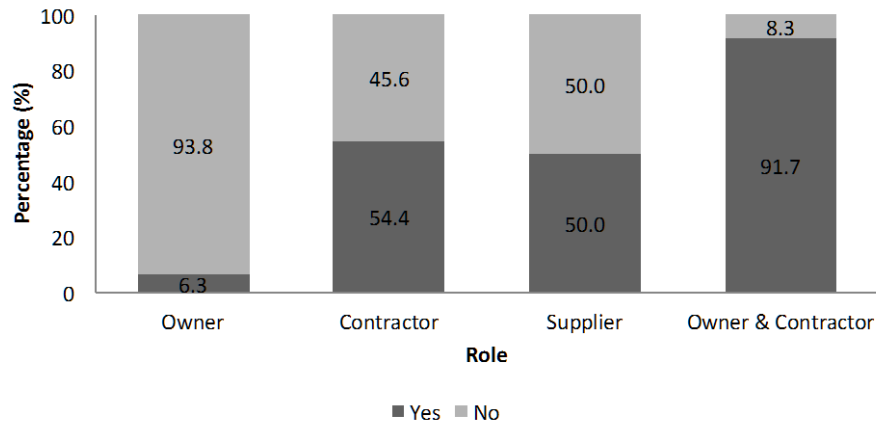


Figure 2.1: Use of prior performance rating during supplier selection (%), by role of respondent

Regarding the characteristics of prior performance used by respondents to inform the supplier selection (Q33-original), their answers are summarized in Table 2.1. RT 308's SMEs suggested that the data should be grouped into four major categories for discussion, namely: Procurement, Quality, Engineering, and Health, Safety & Environment (HSE). The team developed Table 2.1 by grouping the characteristics cited into these four categories:

- Procurement: delivery performance, experience and reputation, cost, service support, capacity and competitiveness, financial stability, compliance and acceptance of terms and conditions (T&Cs), and shop loading.
- Quality: quality of fabrication, packaging and documentation, cooperation during production and order execution and material storage and control.
- Engineering: technical engineering project, performance, design capabilities, compliance with specification, document control system and compliance to specifications.
- HSE: safety, cleanliness of facility and environmental health.

The analysis of responses shown in Table 2.1 revealed that 57 entries (47%) were categorized by the SMEs as Procurement-related, followed by 39 entries as Quality (32%), 18 as Engineering (15%), and 8 as HSE (7%). Based on this analysis, Procurement and Quality are the categories of prior performance that contain characteristics used most often by respondents to select suppliers. These results helped the team to identify common characteristics of prior performance that can be used by organizations to develop their own supplier selection procedures. They also informed the definition of supplier selection criteria, used in the new PO instrument, to gather data to support the definition of a P_{fab} number for each supplier.

Table 2.1: Additional characteristics of prior performance used to select supplier

Reported characteristic	Category	Entries	Percent
Quality (fabrication, packaging overall)	Quality	28	23
Delivery time (schedule)	Procurement	21	17
Experience (reputation, project reference, history)	Procurement	12	10
Cost (price, price level for change order)	Procurement	11	9
Technical, engineering, project Management Capabilities (equipment and/or machinery adequate for type of work performed, workers abilities)	Engineering	8	7
Cooperation during production, order execution, PO execution, trending	Quality	6	5
Performance	Engineering	5	4
Safety	HSE	4	3
Service support	Procurement	4	3
Quality (documentation)	Quality	3	2
Environmental health	HSE	3	2
Capacity	Procurement	3	2
Competitiveness	Procurement	2	2
Material storage and control	Quality	2	2
Design Capabilities	Engineering	2	2
Compliance with specification	Engineering	2	2
Financial stability (Status)	Procurement	2	2
Compliance/Acceptance of T&C's	Procurement	1	1
Cleanliness of facility	HSE	1	1
Shop loading	Procurement	1	1
Document Control System	Engineering	1	1
Total		122	100

Respondents also indicated in an open-ended question (Q40-original) additional practices, not covered in the original PO instrument. Their responses transcribed from the survey included:

- *The complexities of coordination of inspections and deliveries based on the amount of sub-suppliers.*
- *Criticality of item, quantity of items, PO value.*
- *Reliability, quality and reputation of supplier on previous jobs.*
- *Project reviews of suppliers weld procedures, welder qualifications, inspection and testing plans (ITPs) and quality plans.*
- *Sub-suppliers, location of sub-suppliers, more planning of sub-suppliers.*
- *Budgeting of supplier quality, sub-tiers poorly identified, shipping.*

- *Financial stability of the supplier, verification of the suppliers' ability to produce the required products to the satisfaction of <company name>'s technical specifications.*
- *Importance and value of <company name>. Contract flowdown clauses being imposed on the supplier and consequently being passed on to eventual supplier sub-vendors.*
- *Were proper notifications provided for witness/hold points? Were critical issues identified during execution of witness and hold [points]?*
- *Compliance check, HSE Performance.*

2.2 Analysis of the supplier selection process

Given the analysis of responses from the original PO instrument, the team decided to investigate further how supplier selection and evaluation is done. An abridged and generic process map was developed to show different steps of this process and indicate where the criteria previously discussed might be used (Figure 2.2). In figure 2.2 item (1), the purchaser identifies the need to select a supplier, and depending on whether or not qualified suppliers are available (2), the purchaser will either release an RFQ (3) or prequalify new suppliers (2b).

Suppliers that are not prequalified by the buying organization, represented by the purchaser, will not be able to submit responses to the RFQ. In (4), suppliers submit responses to the RFQ, and the purchaser evaluates acceptable suppliers by conducting technical and commercial (T&C) analyses (5). SMEs indicated that they initially verify if the RFQ is acceptable (6) before verifying if the supplier is qualified for that specific PO (7). SMEs highlighted that suppliers might be on the list of prequalified suppliers for different jobs, but need to be vetted for different types of POs and products to be supplied. Next, if a supplier is qualified, the Procurement team negotiates with the supplier (9). If the supplier is not qualified, a site survey and an assessment are conducted (8). If the supplier meets the survey and assessment requirements the Procurement team follows up with the negotiation (9), if not the supplier is not considered and the process ends (12).

The SMEs indicated that it is important to note that surveys are being done at the sites to vet suppliers. However, in some cases, salespersons are completing these surveys and, as a consequence, the quality of the data may not be accurate. Other sources of data to define P_{fab} and P_{insp} include inspection reports that record the problems found in suppliers' facilities; this information is added to company's databases. In the end, the supplier performance resulting from these analyses will dictate the adjustments to P_{fab} and P_{insp} .

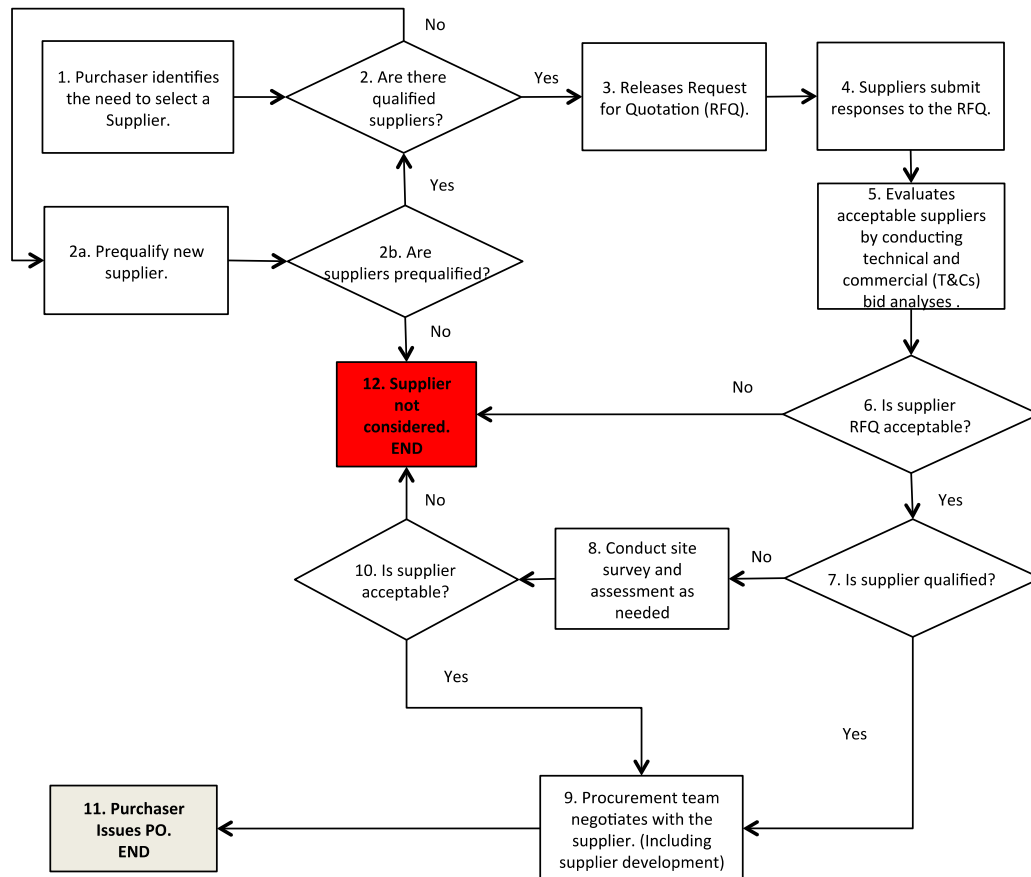


Figure 2.2: Supplier Selection and Evaluation Map (SSEM) for the EPC Industry - Developed by RT308

2.3 Analysis of current supplier evaluation practices

The map presented in Figure 2.2 represents the supplier evaluation and selection process as described generically by SMEs. However, it does not mean that in the industry at large that process is always followed and that useful data to define P_{fab} is readily available from organizations. The team gathered additional data on this topic during the extension, by asking a new set of questions related to supplier evaluation before and after a PO is issued:

- Q14-new. Did you perform a supplier evaluation before the P.O. was issued?
- Q15-new. If **NO**, please explain why.

In 63% of the POs reported, suppliers were evaluated before the PO was issued and 37% were not. However, respondents indicated that data from the evaluations were not available (to be reported when they answered the PO instrument) for multiple reasons. Comments obtained from 42 POs were gathered regarding supplier evaluations and whether they are performed or not, and when.

Answers from those who do not have data regarding the supplier evaluation for the POs considered (question Q15-new) indicated a number of reasons why data about supplier evaluation was not available for these POs. Their comments included the following:

- “It was project decision that we do not perform Supplier Evaluation for any vendor because the vendors were on the <Client’s> approved vendors list.”
- “Ongoing work with another facility under this vendor's network made selection a better solution.”
- “Client issued purchase order.”
- “Vendor had another project for the client underway. It was felt that addressing issues from that project to ensure nothing repeats to this project were simple tasks. Same inspector was used.”
- “Was not in the budget.”
- “Supplier evaluation was not performed due to previous experience with this supplier.”
- “Pre-award ratings are usually nonexistent once the Suppliers performance has been updated.”
- “The reason a supplier evaluation was not performed before the PO was placed was because the supplier is an approved supplier by our client and was not required. On my project, our client performs evaluations on suppliers and develops an approved suppliers list for us to choose from. These specific PO's were single sourced to one supplier and not put out for competitive bid.”
- “An evaluation was not required by our client and <Contractor’s procurement department> had prior experience with the suppliers’ proposed facility. It should be noted that the majority of the work scope ended up being executed in another fabrication facility that <Contractor> was not initially aware of but that our client accepted prior to use without the need for an evaluation.”
- “Suppliers were evaluated by the client and placed on an Approved Manufacturers List that was used to choose suppliers.”

The analysis of this list reveals that respondents often did not conduct an evaluation and, therefore, did not have data about the supplier evaluation because of two main reasons: the owner had already selected the supplier or they had done business with the supplier before.

The lack of historical data is a challenge to define P_{fab} and P_{insp} as it will be discussed later in this report. During RT-308’s extension the team worked to define a platform that underscores the need to keep a consistent database that can be used to support predictive analysis. This report

argues that historic data on supplier performance is one key piece of information to define P_{fab} , as historic data on non-conformances is one important component to define P_{insp} .

2.4 Definition of technical attributes for supplier evaluation

The following nine categories of technical attributes were identified for P_{fab} . They were defined based on a review of procedures provided by RT-308 members, a discussion of common characteristics used in their procedures as well as those identified in the original PO instrument. The SMEs agreed that these criteria could be used as a means to help gauge the supplier fabrication capability. Next to each criterion, the factors considered in its analysis are described:

- **Plant operations / Building and infrastructure** – Storage and shipping, Structure for QA/QC personnel and records, Examination and testing, Housekeeping, Security.
- **Manufacturing capability** – Machining capability, Fabrication capability (including welding, coatings, etc.), Capability to manufacture per user requirements, Calibration records and procedures, Non-destructive testing and inspection capability and quality, Shop capacity.
- **Experience and qualifications** – Geographical areas in which supplier is qualified to work, Familiarity with codes specific to certain geographic regions, Certifications (ASME, API, etc.), Work history.
- **Workforce** – Documented training of the workforce, Craft types available at location, Qualifications of the workforce, Source of backup workers.
- **Engineering capability** – Professional/technical specialties held in house, Compliance with documents and specifications, Cooperation, responsiveness of requests, and turnaround documents, Robust document management system.
- **Material control** – QA/QC manual for material control, Process for material substitution, Material verification, Prevention of counterfeit materials, Material certification.
- **Adherence to procedures and standards** – Adherence to codes and specifications, quality, legibility and completeness of documentation, non-conformance control, proper notification of inspection and hold points, Identification of parts – traceability.
- **Safety adherence and record** – written safety, health and environmental program, compliance to local/governmental safety and environmental requirements, experience Modification Ratio (EMR), total recordable incidence rate (TRIR).
- **Handling of subcontractors/sub-suppliers** – outsourced/subcontracted product/service control, procedure to check subcontractor compliance with quality requirements, documented evidence of compliance, auditing subcontractors, ability to schedule and expedite subcontractors/sub-suppliers.

These criteria were used in the PO instrument to ask industry practitioners to rate suppliers for a specific purchase order based on actual observation and existing documentation about the supplier's work, BEFORE the P.O. was issued and AFTER the PO was issued. Respondents were asked to use the following scale: 1 = poor, 2 = below average, 3 = average, 4 = above average, 5 = excellent.

2.5 Summary

This chapter presented the analyses and discussions the team had before it could develop a common understanding of the supplier selection and evaluation processes. It also presented the analysis of questions related to the PO instrument developed in the original project, which had not been discussed before but informed the development of the work during the project extension. Data revealed that few owners (6.3%) who responded to the original survey used ratings of prior supplier performance to make decisions, and about 45% of contractors and 50% of suppliers use these indicators to make decisions.

The SMEs suggested that the data collected from those who use characteristics of prior performance to evaluate suppliers be grouped into four categories: Procurement, Quality, Engineering, and Health, Safety & Environment (HSE). The end result of this analysis was a list of characteristics presented in Table 2.1 relating the characteristics cited and the four major categories defined by the SMEs. In the end, Procurement and Quality are the main categories used to analyze suppliers' prior performance.

The chapter closed with the definition of nine categories that combine technical attributes, which were later used by the team in the development of the new PO instrument (see Appendix) and the tool presented in IR308-3.