

Centralized HSE Cost Planning for Sustainable Safety Implementation: A Case Study of Cost Coverage, Pricing Gaps and Resource Readiness

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Abstract- Sustainable safety implementation depends on identifying and pricing required HSE resources early enough for them to be available when risk exposure begins. Centralized, reusable HSE cost catalogues improve consistency but can also reproduce unresolved master-data gaps across every dependent estimate. This single-organization documentary case study examined description overlap, price completeness, recurrent unit-rate exceptions and safety-resource implementation readiness in a connected HSE planning archive. Eight confidential workbooks were reviewed as one archive: one central materials reference, three material schedules each paired with a monthly staffing schedule, and one general manpower reference. Of 367 active material-line instances, 346 (94.3%) contained positive numeric rates. Among 125 distinct normalized descriptions, 119 (95.2%) appeared in all three configurations. Seven unique missing-rate descriptions occurred in each of the three dependent schedules, producing 21 schedule-level exception instances (7 x 3). Closing those defects at the master-record level requires seven source corrections instead of 21 schedule-specific corrections, a 66.7% reduction in master-record correction actions; when the three necessary schedule revalidations are also counted, the action count becomes 10 instead of 21, a 52.4% reduction. Traffic-management and training items together accounted for 12 of 21 recurring exception instances (57.1%). The findings support earlier conversion of HSE scope into complete, cost-ready manpower and material requirements so that required controls can be resourced before exposure begins. A separate normalized expenditure illustration demonstrates possible arithmetic associated with non-peak staffing adjustment and inspected material reuse; it is not an audited saving or measured safety outcome.

Index Terms- Construction safety, HSE cost planning, master-data quality, price completeness, resource readiness.

I. INTRODUCTION

Construction projects routinely price civil, mechanical and operational work against measurable scope, schedules and resource assumptions. HSE requirements need the same discipline because safety controls cannot be implemented reliably if manpower, materials, temporary protection, monitoring devices, welfare provisions and emergency resources are identified only after mobilization. Prior research has shown that competitive tendering can marginalize HSE when contract documents do not contain sufficiently detailed financial provision, while activity-based and risk-based approaches can improve early safety-cost estimation [1]-[4]. The practical problem addressed here is narrower: even where an organization maintains a reusable HSE cost catalogue, incomplete master data can be repeated across every dependent estimate.

Smallwood and Emuze [1] argued for explicit financial provision for construction H&S in contract documentation, and Malan and Smallwood [2] similarly supported project-specific H&S preliminaries. Gurcanli et al. [3] demonstrated activity-based safety-cost estimation during bidding, while Aminbakhsh et al. [4] linked risk prioritization with planning and budgeting. These studies show why safety expenditure should be derived from scope and risk rather than treated as an undifferentiated allowance. The present study contributes a documentary view of data readiness: how much of a centralized HSE catalogue is reusable, where pricing gaps recur, and how shared defects can be corrected once at source rather than independently in every project schedule.

Beyond rate completeness, safety implementation readiness depends on quantity validation, approved

specifications, timing of need, staffing phasing, availability of reusable assets and traceability between planned controls and the resources intended to deliver them. Procurement is one downstream mechanism, not the study focus. The contribution is an anonymized analysis of three connected safety-cost schedules dependent on a common catalogue, supported by a limited numerical illustration kept separate from the observed findings.

The study asks: (1) how much of the material catalogue is common to three related HSE planning configurations; (2) how many active lines contain positive numeric rates and how many pricing defects recur; and (3) what management checks can convert project safety scope into implementation-ready manpower, material and control requirements? The specific contributions are a reproducible exception-recurrence measure, identification of the master-record correction point, and a validation design for future linkage of costing data with field-control assurance.

II. MATERIALS AND METHODS

2.1. Planning archive, reporting period and unit of analysis

The single-organization archive comprised eight workbooks: one central material-cost schedule, three

related material schedules, three corresponding monthly staffing schedules, and one general manpower-cost reference. Projects A–C are anonymized schedule configurations under a common catalog and operating environment; they are neither independent company cases nor evidence of three completed, audited projects. The units of analysis are active material-line instances and normalized item descriptions, not projects as statistical replicates. All three material schedules use 11 comparable families. Staffing records distinguish direct and rented resources and include month-level planning and logistics fields. Names, project labels, proprietary quantities, prices, pay data, bid values and transaction identifiers were excluded.

The reporting and literature horizon was restricted to information available by 31 August 2024. Staffing entries beyond that date were excluded from the structural review. The analysis is retrospective and reports the supplied archive as a connected planning system; it does not treat the three configurations as statistically independent projects.

Table 1. Evidence sources and inferential boundaries.

Archive component	What was assessed	What it cannot establish
Three project material schedules	Active material quantity lines, valid unit-price status, cost categories, repeated descriptions	Approved orders, received stock, actual spend or field effectiveness
Three paired staff schedules	Month-based roles, direct/rented sourcing and vehicle/logistics fields	Actual payroll, attendance or HSE staffing performance
Central material reference	Standard category/description basis for project-specific planning	Actual cross-project reuse, inventory ownership or realized procurement savings
General manpower reference	Independent structural check on manpower cost planning	Verified staffing quantities on any specific site
Expenditure scenarios	Explicit 3.2–4.8% modeled reductions from staffing phasing and material reuse	Historical real-world cost saving, reduction in injury rates or causal improvement

2.2. Repeatable coding rules and confidentiality

A material line was active when it contained an item description and positive required quantity. A line was price-complete only when its unit-rate cell returned a positive numeric value; blanks, text values, unresolved formulas and error values were placed in a rate-exception group rather than treated as zero-cost materials. Item descriptions were normalized internally by case-folding and punctuation/spacing removal solely to count cross-project repetition. Individual descriptions are not published. One visible description repeated in different files indicates an opportunity for shared item governance, not proof that the same physical asset was reusable. Procurement-request, requested-amount and reserve columns were examined for populated active-line evidence rather than merely being counted as available fields.

No published figure uses underlying currency values. The observed results comprise nonfinancial line counts, description recurrence and rate-status flags only. Three schedules derive from a shared master and must not be pooled or presented as independent samples. The 346/367 figure is an aggregate completeness ratio across dependent schedule-line instances, not an estimated completeness rate for the broader construction industry. Description normalization uses internal text matching only; similarity is not proof of physical stock interchangeability. No sampling uncertainty or causal tests are appropriate.

2.3. Catalog management and analytical boundaries

The archive contains editable planning schedules but does not independently establish every catalogue-governance step used by the organization. For reproducible control, a centralized record should

identify the technical specification owner, commercial rate owner, unit of measure, rate-validity date, approval status and last review date. Before a work package is finalized, HSE and commercial functions should jointly review scope-relevant items for completeness; master-data revisions should then trigger revalidation of dependent estimates. ISO 45001 emphasizes controlled documented information and operational planning, making this type of traceable record management directly relevant to safety-management implementation [10].

The separate illustrative arithmetic in Section 4 uses normalized cost-index points. For each synthetic case, total expenditure equals assumed staffing expenditure plus assumed material expenditure; potential reduction is the difference between the 100-point baseline and that hypothetical total. The assumptions are independent of the confidential source rates and do not estimate realized savings.

III. OBSERVED DOCUMENTARY FINDINGS

3.1. Centralized catalog breadth and repeated project requirements

The three related material schedules contained 119, 125 and 123 active material-line instances, respectively, or 367 schedule-line instances combined. These are repeated uses of a shared catalog rather than 367 distinct products or independent projects. Across all three configurations, 125 distinct normalized descriptions were found, and 119 of them (95.2%) recurred in each configuration. Figure 1 shows the observed distribution of active lines by broad material family; Table 2 summarizes the schedule-level counts and description recurrence.

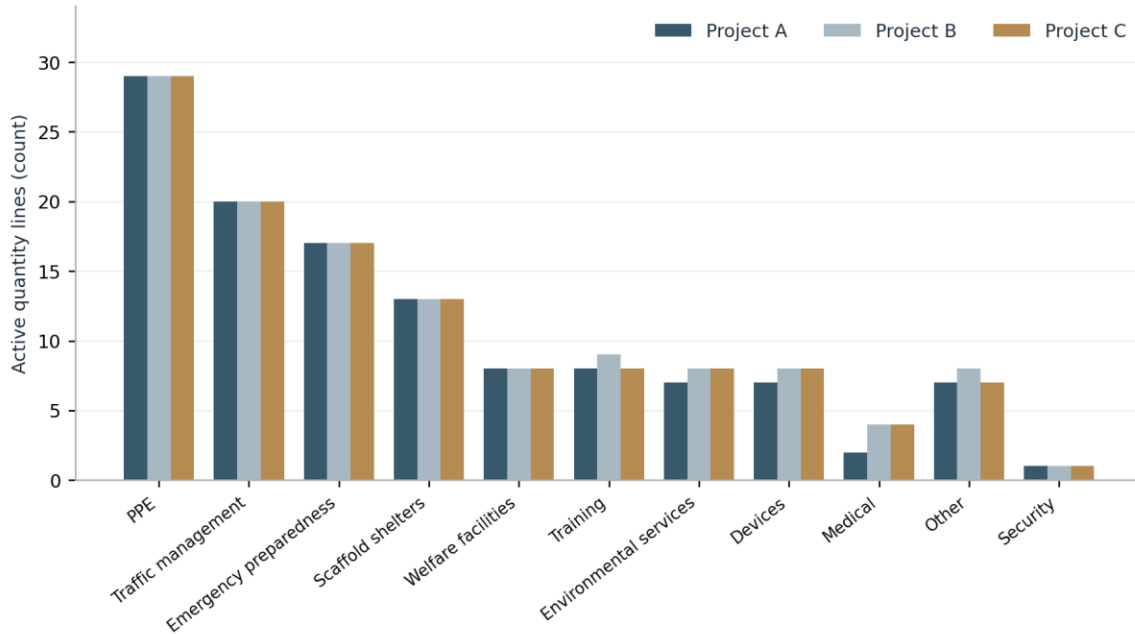


Figure 1. OBSERVED: number of active quantity lines by common material cost family and anonymized project; counts are not monetary expenditures.

Table 2. Material-estimate coverage and description recurrence across dependent configurations (observed).

Measure	Project A	Project B	Project C	Pooled / distinct
Active quantity lines	119	125	123	367
Positive numeric unit-rate lines	112	118	116	346
Rate exceptions	7	7	7	21 project-line instances
Price-completeness ratio	94.1%	94.4%	94.3%	94.3% pooled
Distinct descriptions across three plans	—	—	—	125
Descriptions present in all three plans	—	—	—	119 (95.2% of distinct)

PPE, traffic management, emergency preparation and temporary shelter/access represented 237 of the 367 active line instances (64.6%), showing why early review of recurring high-volume safety categories matters. This is a line-count concentration: no claim is made that these families account for the same share of money or risk. The consistent catalog allows category-based review during project planning and targeted technical review when a common safety specification changes.

Additional descriptive checks reinforce the standardization pattern. The aggregate exception density was 5.7% (21/367), while project-level price completeness varied by only 0.3 percentage points

(94.1–94.4%). Thus, the principal issue was not wide inconsistency between estimates but repeated inheritance of the same small set of missing master rates. This distinction matters operationally: variation control should focus first on the shared catalogue rather than on three separate estimating teams.

3.2. Seven shared pricing exceptions produce 21 project-level gaps

Seven unique exception descriptions were each present in all three dependent schedules. The archive therefore contained 21 schedule-level exception instances arising from seven underlying defects (7 x 3 = 21). This replication is a structural property of three schedules sharing one master catalogue and is reported

descriptively rather than as an independent performance metric. The operationally relevant result is the correction point: closing seven defects at source replaces 21 schedule-specific corrections. That is a 66.7% reduction in master-record correction actions. When the three schedule revalidations required after

master repair are also counted, the action count becomes 10 versus 21, equivalent to a 52.4% reduction. These percentages describe data-maintenance effort only; they are not financial savings.

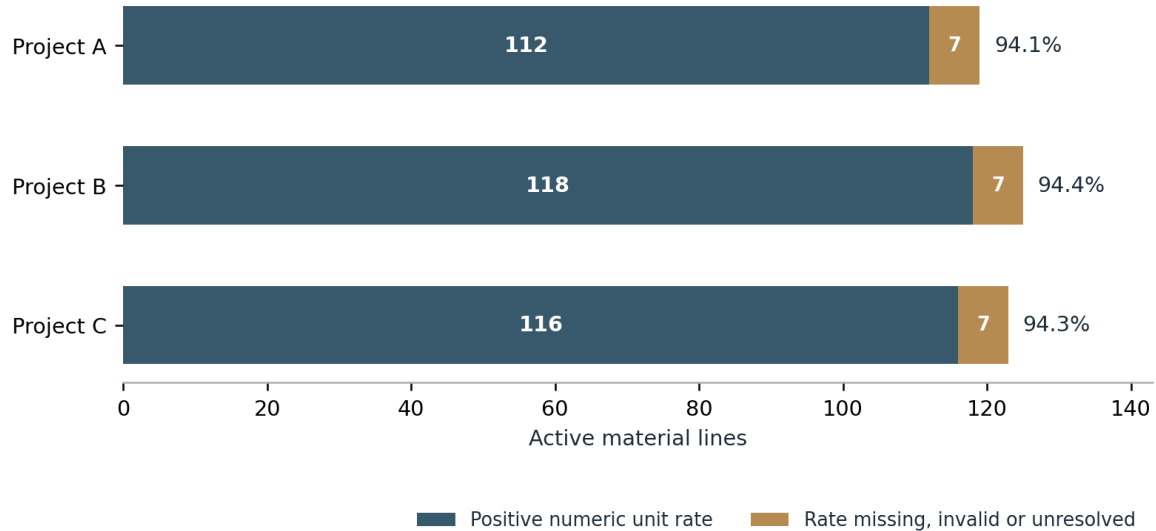


Figure 2. OBSERVED: priced and exception lines by project. A positive numeric rate is a data-completeness test, not proof that a line was adequately funded.

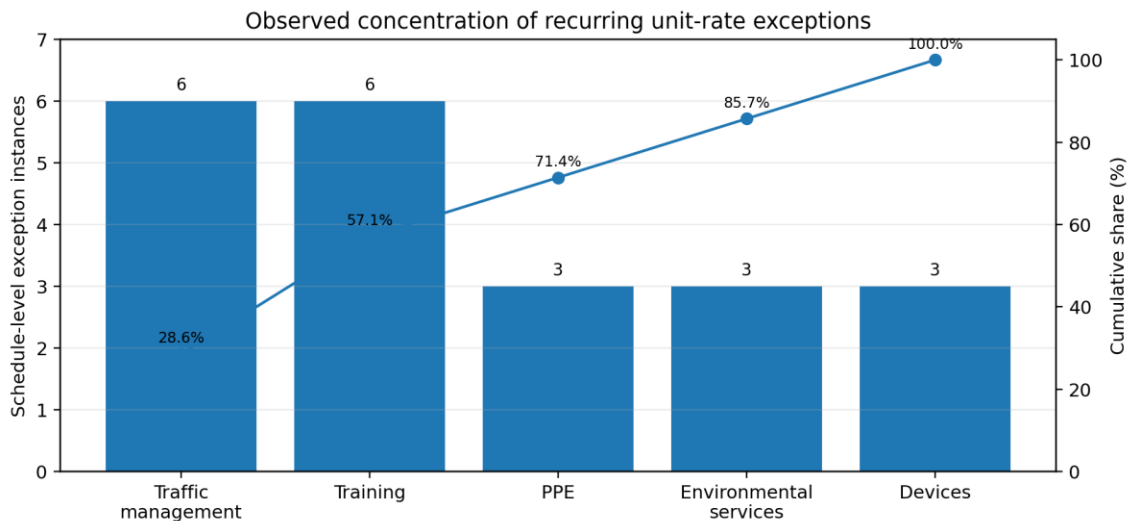


Figure 3. OBSERVED: concentration of the 21 recurring schedule-level rate exceptions by cost family and cumulative share. Counts arise from seven unique shared exception descriptions replicated across three dependent schedules.

Table 3. Shared rate exceptions and immediate estimating correction.

Cost family	Distinct recurring descriptions	Project-line instances	Correction needed before tender/procurement
Traffic management	2	6	Verify rate and any associated delivery/installation requirements
Training	2	6	Price course delivery, validity and affected headcount
PPE	1	3	Validate approved specification and replacement basis
Environmental services	1	3	Clarify service period, scope and applicable unit
Devices	1	3	Confirm acquisition/rental and calibration or servicing cost
TOTAL	7	21	Refresh master and revalidate all three dependent plans

The exception distribution was concentrated. Traffic-management and training records contributed six instances each, together accounting for 12 of the 21 schedule-level gaps (57.1%). PPE, environmental services and devices contributed three instances each. This concentration supports targeted catalogue review: the first two families explain more than half of the repeated gaps, while all affected families can be closed through seven unique master-record corrections.

Although the workbooks contain reserve-quantity and purchase-request fields, the assessed active lines did not provide approved purchase orders, goods receipts, stock-transfer evidence or paid invoices needed to establish actual implementation outcomes. The archive therefore supports diagnosis of safety-resource costing readiness, but not conclusions about purchase delays, expenditure variance or successful reuse.

Table 4 specifies the additional records needed to test those implementation questions.

3.3. Staffing structures permit exposure-matched forecasts, not verified cuts

The paired manpower schedules distinguish direct/rented resources, roles, planned monthly staffing and support/vehicle fields. That structure permits planners to revise requirements when working hours, headcount, concurrent work fronts, worker accommodation and hazard exposure change. The supplied records do not include verified paid timesheets or independent minimum staffing requirements for each activity. It would be inappropriate to convert the existence of a monthly forecast into a claim that personnel were actually reduced or that reductions maintained HSE performance.

Table 4. Budget input and proof needed to convert a plan into an expenditure finding.

Decision area	Planning data present	Additional implementation evidence needed
Manpower phasing	Role, sourcing class, planned month and logistics	Approved HSE coverage matrix, shift roster, actual payroll/invoices and workfront activity

Decision area	Planning data present	Additional implementation evidence needed
Materials procurement	Description, quantity, unit-rate field and category	Approved requisition, quotation, purchase order, receipt and installation/issue record
Inter-project reuse	Common catalog descriptions across projects	Condition check, transfer voucher, inspection, certification, ownership and suitable specification
Budget change control	Editable planning quantities and rates	Approved change register, actual variance explanations and final close-out
Safety performance	Cost categories tied to controls conceptually	Inspection completion, critical-control assurance, competency, PPE suitability and incident context

IV. ILLUSTRATIVE EXPENDITURE ARITHMETIC

4.1. Three synthetic examples normalized to 100

Table 5 presents the explicit synthetic assumptions. The chosen cost shares are examples only and are not transformed versions of source salaries, rates or budgets. Staffing reductions are attributed to appropriate non-peak adjustment; materials reductions to suitable, inspected items already owned or transferred from earlier jobs. Planned controls at peak exposure remain funded, and the example excludes unspent mandatory training, deferred maintenance, reduced inspection frequency and missing rescue provisions as acceptable saving mechanisms.

Table 5. Illustrative assumptions; all monetary proportions are SYNTHETIC cost-index points.

Project	Estimated staffing	Estimated materials	Non-peak staffing reduction	Inspected stock-reuse reduction
A	62.0	38.0	2.1	1.1

Project	Estimated staffing	Estimated materials	Non-peak staffing reduction	Inspected stock-reuse reduction
B	58.0	42.0	2.3	1.8
C	65.0	35.0	3.0	1.8

Table 6. HYPOTHETICAL baseline-to-expenditure arithmetic; no project actual expenditure was available.

Project	Budget baseline	Modelled staffing spend	Modelled material spend	Modelled total spend	Potential reduction
A	100.0	59.9	36.9	96.8	3.2%
B	100.0	55.7	40.2	95.9	4.1%
C	100.0	62.0	33.2	95.2	4.8%

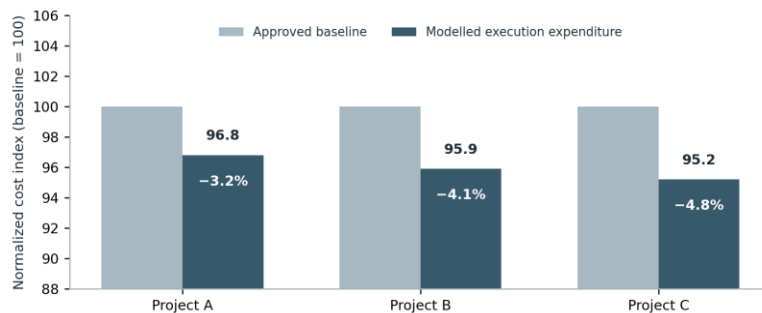


Figure 4. HYPOTHETICAL ONLY: normalized budget versus assumed expenditure; these are not observations or validated savings.

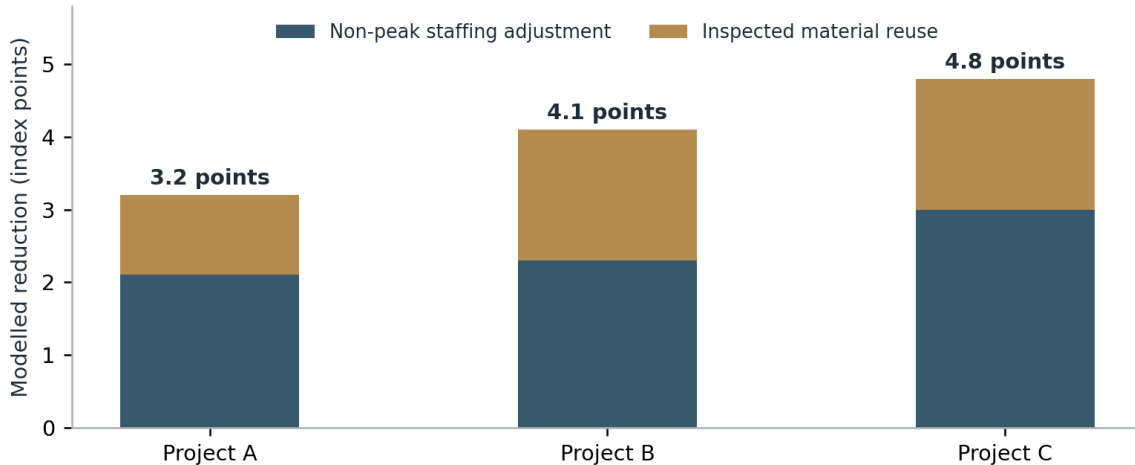


Figure 5. HYPOTHETICAL ONLY: assumed cost-index contributions from non-peak staffing and conditional reuse; not actual spend.

Within the constructed examples, expenditure totals fall by 3.2%, 4.1% and 4.8% relative to normalized 100-point baselines. These values were chosen only to illustrate arithmetic for non-peak staffing adjustment and conditional material reuse. They are not observed savings, parameter estimates, recommended safety-cost percentages, or values that should be compared with published safety-cost shares.

4.2. Timing matters: how an apparently small saving can arise

The synthetic Project B example is expanded into four stages in Table 7 and Figure 6 to show how staffing phasing and conditional reuse might contribute to the assumed 4.1-point reduction. The two peak-stage staffing allocations remain unchanged by construction; the lower staffing allocation appears only at mobilization and demobilization. All stage values are illustrative and must not be mistaken for archived project costs.

Table 7. Project B phase-based illustrative cost reconciliation (index points).

Phase	Baseline staff	Baseline material	Modelled staff	Modelled material	Stage reduction
Mobilization	8.7	21.0	7.9	20.1	1.7
Peak stage 1	20.3	12.6	20.3	12.3	0.3
Peak stage 2	20.3	6.3	20.3	5.9	0.4
Demobilization	8.7	2.1	7.2	1.9	1.7
TOTAL	58.0	42.0	55.7	40.2	4.1

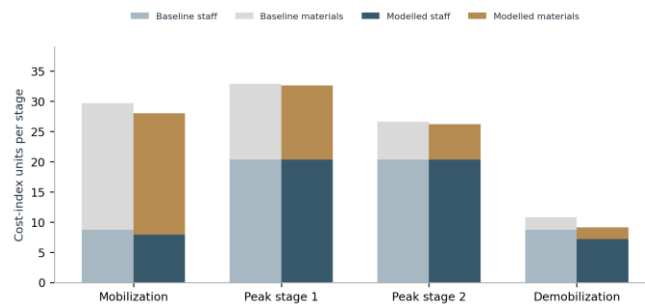


Figure 6. HYPOTHETICAL ONLY: synthetic phase-level example; high-demand stage staffing is held constant by assumption.

The modeled 2.3-point staffing reduction comes from 0.8 points at mobilization and 1.5 points at demobilization. The model is only applicable where a documented exposure schedule and competent coverage plan permit those changes. Any new workforce, night shift or simultaneous high-risk operation requires reforecasting before reducing staff or other critical resources.

V. PRACTICE IMPLICATIONS

5.1. Solve the rate problem once rather than three times

The seven shared defects provide the clearest actionable result. Treating every schedule independently creates 21 schedule-level corrections. Correcting the shared catalogue requires seven master closures, followed by three dependent-schedule revalidations. This reduces master-record closures by 66.7% and total correction-plus-revalidation actions by 52.4%. The benefit is improved data governance and safety-resource readiness; it is not evidence of money saved.

5.2. Material reuse requires an inspected transfer, not a reduced purchase order alone

Common catalog descriptions reveal potential standardization and make it easier to compare materials available from completed projects, but they do not establish that stock exists or is safe to reuse. Before any credit is taken, the receiving project should record material identity, stock quantity, service condition, certification/calibration where applicable, compatibility with the intended hazard, transport cost and residual service life. Damaged fall-protection equipment, expired items and other nonconforming critical controls must not be reused to reach a savings target. Each accepted transfer should reduce the new-

procurement quantity while preserving the planned control requirement.

5.3. Control staffing through workforce demand, not a payroll target

Monthly staff budgets create an opportunity to distinguish fixed minimum HSE coverage from activity-driven additional resources. The planner should link each role to shift requirements, supervision ratios where prescribed, simultaneous operations, emergency coverage, workforce locations and contractor interfaces. Reductions should occur only when exposure actually falls and should be reversed as activity rises. Comparing approved staffing forecasts with payroll and access/shift records would establish whether reduced non-peak cost occurred; checking critical-control inspections and the competence of the remaining team would assess whether the saving was safety-equivalent.

5.4. Future validation: how cost and control performance should be measured

An HSE improvement claim requires operational measures rather than a falling expense line. OSHA's 2019 guidance emphasizes leading indicators as proactive measures of whether safety activities are implemented effectively [8]. The metrics below turn safety budgeting and resource-planning decisions into verifiable tests: required controls should be available before exposure, training and equipment should be valid, open exceptions should be eliminated, and verified stock reuse should not increase defects or downtime. The baseline figures available in the archive are limited to price coverage and exception recurrence; all proposed targets and additional indicators remain unmeasured until supporting operational records are linked.

Table 8. Future study indicators and validation records; none are measured by this case study.

Indicator	Current archive evidence	Proposed verification	Safety significance
Active-line price completeness	346/367 = 94.3%	All approved active lines have an acceptable rate or approved justified exception before tender freeze	Reduces late unpriced required controls
Recurring master exceptions	7 descriptions; 21 project-line instances	Zero unresolved common exceptions at tender release	Prevents repeated downstream procurement uncertainty

Indicator	Current archive evidence	Proposed verification	Safety significance
Pre-start critical-control readiness	Not measured	Required critical controls checked and available before each relevant activity starts	Verifies planned budget became actual protection
Approved reuse compliance	Not measured	100% of reused safety-critical stock has documented technical acceptance	Avoids transferring defective/unsuitable controls
Exposure-matched HSE staffing	Monthly staff plan structure only	Approved coverage matrix compared with daily staffing and live workfront hazards	Checks that non-peak savings do not erode coverage
Purchase-to-installation lead time	No populated procurement proof on assessed active lines	Record request, approval, receipt and issue dates for each required critical item	Tests whether early costing removes mobilization delay
Cost variance with assurance	No actual spend or control evidence	Reconcile variance against paid invoices, transfers and control-verification records	Separates genuine efficiency from underimplementation

5.5. Safety implementation readiness and untested SME implications

ILO analyses report that micro, small and medium-sized enterprises often have limited financial, technical and institutional resources to deliver OSH [7]. For these firms, late recognition of site welfare, training, temporary protection, specialist monitoring and emergency equipment can produce acute cash-flow and implementation pressure even when a contract requires full compliance. The present archive does not contain firm-size or payment records and cannot measure this effect directly. It nevertheless

identifies a testable safety-management solution: convert the project HSE scope into a priced, time-phased resource schedule before work starts; distinguish fixed setup, reusable/shared resources, peak manpower and scope-change requirements; and verify that critical controls remain available when exposure increases. For smaller organizations, the same structure can also support stage-linked payment terms for defined safety deliverables, converting an otherwise unfunded compliance obligation into a scheduled cash requirement without relaxing the required control standard.

Table 9. Directly implementable corrections derived from the findings.

Observed or modelled issue	Specific management action	Evidence needed before marking complete
Shared missing/invalid rates	Maintain one approved cost owner for seven common exceptions; refresh dependent project estimates	Master record + project-specific estimator and HSE sign-off
Cross-project catalog duplication	Use consistent specification IDs and periodic price validity checks	Controlled catalog release and exception log
Potential double-purchase	Inspect, certify where needed and transfer suitable reusable stock before new purchasing	Approved stock ledger, transfer evidence and receipt
Non-peak staffing variance	Align role numbers with the approved risk/exposure calendar	Shift roster, workfront plan, hours and control inspections
Procurement audit trail absent from assessed files	Link each approved estimate to requisition, receipt and issue/installation	Time-stamped purchasing and field acceptance evidence

Observed or modelled issue	Specific management action	Evidence needed before marking complete
SME tender cash constraints	Price HSE at bid stage and consider stage-linked payments for defined safety deliverables	Signed HSE cost schedule, commercial agreement and milestone proof

VI. DISCUSSION

The observed contribution is specific. In one shared operating environment, a common HSE cost catalogue supported very high description reuse while seven unresolved rate descriptions appeared in all three dependent material estimates. The 95.2% common-description ratio, 94.3% price completeness, 5.7% aggregate exception rate and only 0.3 percentage-point spread in schedule-level completeness indicate a highly standardized planning structure. The seven underlying defects produced 21 schedule-level gaps. The analytical value lies in locating the correction point: source-level repair reduces repeated data-maintenance effort and improves readiness before safety controls are required in the field.

This finding extends earlier work on H&S financial provision, activity-based safety-cost estimation and risk-informed budgeting [1]-[4]. Those studies address how safety should be financially recognized and allocated. The present case addresses a preceding data-quality problem: whether the reusable safety-cost records feeding project estimates are sufficiently complete and consistent. A centralized catalogue does not guarantee adequate funding, but it creates a single control point through which recurrent pricing gaps can be detected and resolved.

The hypothetical 3-5% expenditure range remains useful only as sensitivity arithmetic. A lower expenditure figure is not evidence of net savings without a valid comparator. Staff removed from a non-peak month may be redeployed elsewhere; reuse may incur inspection, transport, recertification and ownership costs; and unit prices may change between tender and purchase. Any future net-benefit calculation should deduct these costs, adjust for approved scope changes, and verify that the same quantity and effectiveness of safety controls was delivered. Unspent budget arising from an omitted or

late control should be classified as a delivery failure, not efficiency.

From a safety perspective, procurement lead time, control availability at task start, retained staffing competence, stock conformity and critical-control verification are more meaningful initial tests than incident-rate changes in a sample of three related planning schedules. Longitudinal work could subsequently compare before/after price-exception closure, on-time purchasing and actual invoices with the necessary case-mix adjustments. Injury and illness outcomes would require substantially larger exposure records, credible comparators and careful handling of reporting bias.

VII. LIMITATIONS

This is a single-organization documentary case containing three non-independent planning configurations drawn from one shared catalog. Their overlap partly reflects template reuse and cannot be generalized to unrelated organizations or to industry-wide budgeting practices. The source archive contains no independently verified purchase orders, paid invoices, actual payroll, inter-project stock-transfer receipts, complete scope-change logs, incident records, procurement delay logs or validated field-control performance. It therefore cannot establish realized cost savings, safety-equivalent expenditure reductions, better HSE outcomes, causal effects or whether seven rate gaps affected any purchase. The timestamps of each material revision are not independently authenticated for the August 2024 horizon. Matching descriptions may be common template entries rather than independently justified site needs, and shared rate defects may result from one source-reference failure.

The 3-5% range and every related percentage and stage breakdown are deliberately constructed sensitivity examples; they do not originate from

audited accounts, de-identified spending, observed stock transfers or a fitted forecasting model. The scenarios are separate from the documentary results and cannot be tested without matched transaction and safety assurance records. The observational dataset has correlated entries, with no independent comparison group and no basis for causal inference. Only the observed nonfinancial counts are empirical. The literature cutoff is 31 August 2024, but present manuscript creation and source-workbook version dates are not backdated.

VIII. CONCLUSION

In one shared operating environment, three related HSE material-planning configurations recorded 367 active line instances, of which 346 (94.3%) had positive unit-rate values. Across 125 normalized distinct item descriptions, 119 (95.2%) recurred in every configuration. Seven unique recurring descriptions appeared in each of the three dependent schedules and therefore accounted for 21 unresolved rate instances (7 x 3). Correcting those defects centrally requires seven master-record closures rather than 21 schedule-specific corrections, a 66.7% reduction in master-record correction actions. When the three dependent schedules are then revalidated, the total action count is 10 rather than 21, corresponding to a 52.4% reduction in the combined correction-and-revalidation workload. Traffic-management and training items represented 57.1% of recurring exception instances. The practical message is one of sustainable safety implementation and resource readiness: resolve shared HSE pricing defects at source, revalidate dependent estimates, phase manpower against workfront exposure, and verify reusable materials before transfer so required controls are available when needed. The archive does not establish realized financial savings, procurement-delay reduction or improved HSE performance. The separate 3-5% expenditure illustration remains hypothetical and should not be interpreted as a benchmark or audited outcome.

DECLARATIONS

Data availability. Proprietary source workbooks are not publicly disclosed because they contain

confidential commercial and project information. The manuscript reports only anonymized, nonfinancial aggregate metadata. A supplementary aggregate dataset provides the active, priced and exception counts by anonymous configuration and the distribution of recurring exception records by broad cost family, allowing verification of the published descriptive calculations without revealing project identities, item descriptions, unit rates, salaries, quantities or total budgets.

Ethics and permissions. This study is a retrospective documentary analysis of planning records. It involved no human participants, interventions, interviews or identifiable personnel-level data. Only anonymized, aggregate, nonfinancial metadata are reported. Confidential source records remain undisclosed and were used solely for the analytical purpose described in this manuscript.

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Author contribution. Shajahan Abdul Salam: conceptualization, methodology, data curation, formal analysis, visualization, interpretation, writing—original draft, and writing—review and editing.

Reporting date. Evidence, staffing-plan screening and literature considered in this manuscript were restricted to material available by 31 August 2024. The manuscript is presented for an August 2024 publication horizon; no later evidence is used as empirical support.

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