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A Lean Process Re-Engineering Model for Reducing Cycle Time and Revenue Leakage in Customs Duty Drawback Recovery

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Abstract
Customs duty drawback depends on accurate import-export matching, retrievable shipment evidence and timely filing. This paper develops a Lean process re-engineering model for reducing administrative delay and revenue leakage in a manufacturing drawback workflow. The model combines process mapping, value-stream analysis, a leakage taxonomy, shared transaction records and an owned filing cadence. Representative stage durations produce a current-state cycle of 110 elapsed days and a future-state projection of 33 days, equivalent to a projected 70 percent reduction. Value-adding time remains approximately 6.5 days, increasing projected process cycle efficiency from 5.9 to 19.7 percent. The practitioner-reported annual saving is $143,000; it is distinct from the reconstructed cycle-time illustration. The contribution is a decision framework that connects flow improvement to evidence retention and recovery control. The illustrative durations do not establish a measured treatment effect, and the reported saving requires transaction-level reconciliation before it can support a causal estimate. The model provides a basis for prospective validation using filing timestamps, eligible-duty denominators, recovery records and implementation costs.

Keywords: duty drawback, Lean, value-stream mapping, business process re-engineering, trade compliance, revenue leakage, cycle time

1. Introduction

1.1. Duty Drawback, Trade Costs and The Cost of Delay

Firms that import components, assemble or process them, and then export finished goods pay customs duties on the way in that they are entitled to recover on the way out. In the United States, this entitlement is codified in Section 313 of the Tariff Act of 1930 (19 U.S.C. 1313) and administered by U.S. Customs and Border Protection (CBP). For a manufacturer with a global footprint, the sums involved can be material. Yet drawback is widely regarded as one of the most under-used trade programs, because the recovery process is document-heavy, requires precise linkage between import and export transactions that may be years apart, and operates under strict filing deadlines (Jones & Ominyi, 2020; Lawal & Oduleye, 2018b; U.S. Customs and Border Protection, 2018). The administrative burden creates two distinct kinds of loss. The first is delay: refunds that are eventually recovered arrive months later than they could, tying up working capital and consuming staff time in queues, rework, and handoffs. The second is leakage: refunds to which the firm was entitled but which are never received, because supporting evidence was not retained, records could not be matched, the claim window expired, or the claim was rejected. Delay and leakage are usually treated as separate problems, the first as an efficiency issue and the second as a compliance or finance issue. This paper argues that both are symptoms of the same underlying process design and can be addressed together with Lean methods. This framing echoes work on treasury and working capital management, which treats the timing of cash receipts as a variable to be managed rather than an accident of administration (Dada *et al*., 2021a; Tonoyan *et al*., 2021b).

The stakes have grown with the structure of world trade. A rising share of exports embodies imported inputs, so duties paid on components are increasingly a cost on exported goods (Hummels *et al*., 2001; Koopman *et al*., 2014; Baldwin & Lopez-Gonzalez, 2015). Lower costs for imported inputs raise manufacturing productivity (Amiti & Konings, 2007), which is the economic rationale for refunding input duties when the output is exported. The tariff increases introduced by the United States in 2018 and 2019 were passed almost entirely to domestic importers (Amiti *et al*., 2019;

Fajgelbaum *et al*., 2020), sharply raising the value of every dollar of unrecovered drawback. Time itself is also a trade cost: each additional day of delay in border and documentary procedures measurably reduces trade (Djankov *et al*., 2010; Hummels & Schaur, 2013), and the same logic applies to refunds that sit unrecovered in a slow internal process.

Lean thinking, originating in the Toyota Production System, focuses on identifying the value a customer requires, mapping the stream of activities that delivers it, eliminating waste, and establishing flow and pull (Womack & Jones, 1996). Value-stream mapping (VSM) is the principal diagnostic tool, making visible both the material and information flows and the ratio of value-adding to total time (Rother & Shook, 1999). Lean has been extended from the shop floor to administrative and transactional settings, where the product is information rather than physical goods (Tapping & Shuker, 2003; Piercy & Rich, 2009). Business process re-engineering (BPR), in contrast, calls for more radical redesign of processes around outcomes (Hammer, 1990; Hammer & Champy, 1993). Drawback recovery sits at a distinctive intersection: it is a transactional, information-intensive process that is also bound by legal rules that cannot be redesigned, only designed around.

1.2 The U.S. drawback regime and its operational demands

Drawback is a refund of duties, certain taxes, and fees paid on imported merchandise when that merchandise, or merchandise made from it or substituted for it, is exported or destroyed under CBP supervision. The Trade Facilitation and Trade Enforcement Act of 2015 (TFTEA), signed in February 2016, substantially modernized the program. Its implementing regulations, codified in 19 CFR Part 190, became mandatory in February 2019 after a transition period. Among the key changes were a uniform five-year window from the date of import for filing claims, a refund ceiling of 99 percent of eligible duties, a broadened substitution standard based on eight-digit Harmonized Tariff Schedule (HTS) classification, and the requirement to file electronically through the Automated Commercial Environment (ACE) (U.S. Customs and Border Protection, 2018). Legislative changes of this scale show why firms need structured ways to translate new rules into operating procedures and to assess their effect on day-to-day compliance work (Akinola *et al*., 2020; Uchechi & Ominyi, 2020).

Table 1 summarizes the principal claim types relevant to a manufacturer.

Table 1: Principal U.S. drawback claim types relevant to manufacturers

Claim type	Statutory basis	Core requirement
Manufacturing, direct identification	19 U.S.C. 1313(a)	Imported material is used in manufacture of an exported article and traced to it
Manufacturing, substitution	19 U.S.C. 1313(b)	Domestic or imported material of the same eight-digit HTS classification is used in manufacture of an exported article
Unused merchandise, direct identification	19 U.S.C. 1313(j)(1)	Imported goods are exported or destroyed without being used in the United States
Unused merchandise, substitution	19 U.S.C. 1313(j)(2)	Substituted goods of the same classification are exported unused
Rejected merchandise	19 U.S.C. 1313(c)	Goods not conforming to sample or specification, or shipped without consent, are returned

Drawback is conceptually simple and operationally demanding. A valid claim must link a designated import entry, with its duty paid, quantity, and HTS classification, to an export or destruction event, with proof that the goods left the country, and, for manufacturing claims, to a bill of materials or manufacturing ruling that establishes how much imported material is contained in or attributable to each exported unit. These records typically live in different systems owned by different functions, a fragmentation that end-to-end visibility and traceability frameworks identify as a leading cause of compliance failure in global supply chains (Aneke & Adesemoye, 2021; Nnabueze *et al*., 2021): the customs broker and import compliance team hold entry data; logistics and freight forwarders hold export documentation; engineering and production hold bills of materials; and finance holds the duty payment records. The claimant must also avoid designating the same import more than once, respect the five-year window, and be prepared to support every line under audit. Drawback also sits close to other cross-border tax questions, such as transfer pricing and customs valuation, where the same transaction data must be defended to more than one authority and shared responsibilities span several jurisdictions (Lawal & Oduleye, 2019a; Ominyi *et al*., 2021). Accelerated payment, which allows refunds before liquidation of the claim, is available to approved claimants who post a bond, but it does not relieve the documentation burden.

Drawback is also one element of a broader trade facilitation agenda. Trade facilitation research treats customs procedures as processes whose cost and duration can be reduced through simplification, automation, and better information flow (Grainger, 2011; Wilson *et al*., 2003). Improvements in this soft infrastructure raise export performance (Portugal-Perez & Wilson, 2012), firm-level evidence shows that customs processing delays depress exports (Volpe Martincus *et al*., 2015), and redesign of customs procedures has been shown to shorten clearance and increase trade (Fernandes *et al*., 2021). The WTO Trade Facilitation Agreement and the spread of electronic customs systems have made such simplification a policy priority (Beverelli *et al*., 2015; Urciuoli *et al*., 2013). Where duty relief is granted up front rather than refunded, as in processing trade regimes, firms avoid the refund cycle altogether, but at the cost of tighter controls and reduced flexibility (Manova & Yu, 2016). For U.S. manufacturers, drawback remains the principal route, which makes the internal efficiency of the refund process decisive.

The operational features of drawback described above produce exactly the conditions under which Lean diagnostics are most useful: long elapsed times dominated by waiting, many handoffs across organizational boundaries, frequent rework when data do not reconcile, and quality failures that surface only at the end of the process, when the claim is rejected or found to be under-supported.

1.3. Lean Thinking in Administrative and Service Processes

Womack and Jones (1996) set out five Lean principles: specify value from the customer's perspective, identify the value stream, make value flow, establish pull, and pursue perfection. Waste, or *muda*, is classified in the Toyota tradition as overproduction, waiting, transport, over-processing, inventory, motion, and defects, with unused human talent often added as an eighth category (Ohno, 1988; Liker, 2004). Rother and Shook (1999) formalized VSM as a method for drawing a current-state map, identifying waste, and designing a future-state map with defined flow, pull, and pacemaker points. A core VSM measure is process cycle efficiency (PCE), the ratio of value-adding time to total lead time, which in administrative processes is often below 10 percent (George, 2002).

Holweg (2007) traces how these ideas spread from Toyota into a general management approach, and Shah and Ward (2007) define Lean as an integrated socio-technical system rather than a toolkit. Reviews of the Lean literature document both its breadth of application and persistent gaps in implementation (Bhamu & Sangwan, 2014; Arlbjørn & Freytag, 2013). Hines and Rich (1997) set out seven complementary mapping tools that extend VSM beyond physical flow, and a cross-sector review shows that VSM is now used in construction, healthcare, logistics, and services as well as manufacturing (Shou *et al*., 2017). Related improvement traditions converge on the same aims: continuous improvement develops as an organizational capability over time (Bessant *et al*., 2001; Bhuiyan & Baghel, 2005), and Six Sigma contributes a structured problem-solving method, specific goals, and statistical measurement (Linderman *et al*., 2003; Schroeder *et al*., 2008; Snee, 2010).

Applications of Lean outside manufacturing have grown steadily. Tapping and Shuker (2003) adapted VSM to office processes, emphasizing that in administrative work the inventory is information waiting in queues and inboxes. Piercy and Rich (2009) showed in financial services call centers that Lean methods improved both quality and cost. Bicheno and Holweg (2009) catalogued tools for transactional settings, including standard work, visual management, and error proofing (*poka-yoke*). A recurring theme in this literature is that information flow is harder to see than material flow, so mapping must be complemented by data on queue times, error rates, and rework loops. Recent work extends these ideas to regulated and resource-constrained settings, including a Lite-DMAIC adaptation of Lean Six Sigma for small enterprises (Ambali *et al*., 2021), the removal of distribution bottlenecks in healthcare supply chains (Obukadata *et al*., 2021b), and port logistics, where cutting waiting time directly avoids demurrage charges (Okonkwo *et al*., 2020). The demurrage case is a close analogue to drawback: in both, time spent waiting converts straight into money lost. Comparable gains have been reported from standardizing high-volume legal and regulatory workflows, such as dispute resolution, statutory bidding, and contract review, where long queues and inconsistent rules were the dominant sources of delay (Uchechi *et al*., 2018, 2019, 2021).

Systematic reviews of Lean service confirm that back-office and transactional processes are a fertile but under-studied field of application (Suárez-Barraza *et al*., 2012; Gupta *et al*., 2016). In government, Radnor (2010) showed that Lean can be transferred into rule-bound, document-heavy administrative work, although subsequent studies caution that such programs often favor internal efficiency over the value delivered to the end user (Radnor & Johnston, 2013) and can fail when tools are copied without adaptation (Radnor & Osborne, 2013). Evidence from knowledge work shows that Lean principles still apply when tasks are less visible and less repetitive (Staats *et al*., 2011), and Hicks (2007) adapts the categories of waste specifically to information management, identifying searching, re-keying, and correcting records as dominant forms of waste. Bortolotti and Romano (2012) recommend that service firms apply Lean first and automate afterwards, a sequence the present model follows. Six Sigma has likewise been applied to service and financial processes (Antony, 2006; Antony *et al*., 2007; Delgado *et al*., 2010), and recent conceptual work extends Lean and data-driven improvement to procurement, profitability analysis, and operations management in other sectors (Akin-Oluyomi *et al*., 2020; Efobi *et al*., 2021; Okonkwo *et al*., 2018a; Agbabiaka *et al*., 2019).

1.4. Re-Engineering and Digitally Enabled Process Redesign

Hammer (1990) argued that automating existing processes merely accelerates their inefficiencies and that organizations should instead redesign work around outcomes. Hammer and Champy (1993) defined re-engineering as the fundamental rethinking and radical redesign of business processes. Davenport (1993) framed similar ideas as process innovation enabled by information technology. Later scholarship has argued that Lean and BPR are complementary: Lean provides the diagnostic discipline and continuous improvement culture, while re-engineering supplies the willingness to restructure handoffs and information systems (Hines, Holweg, & Rich, 2004). Process redesign enabled by automation and analytics has since been documented widely in operations management (Agboada *et al*., 2018; Obukadata *et al*., 2021a), including in procurement, where automated workflows have improved both speed and transparency (Akinleye & Adeyoyin, 2021) and integrated ERP platforms have reduced manual handoffs between functions (Ahiaeke Patrick *et al*., 2020). Data integration underpins such redesign: extract, transform, and load (ETL) pipelines that consolidate records from several source systems are what make rule-based processing possible (Badmus *et al*., 2019a), and supply chain digital transformation proves most durable when compliance controls are built into the new architecture rather than added afterwards (Mbonu *et al*., 2020).

Empirical studies of re-engineering show that results depend heavily on implementation: management commitment, change management, and alignment with information systems separate success from failure (Grover *et al*., 1995; Al-Mashari & Zairi, 1999; O'Neill & Sohal, 1999). Business process management has since absorbed many of these lessons, treating processes as cross-functional assets managed through a lifecycle of discovery, analysis, redesign, implementation, and monitoring (Zairi, 1997; Trkman, 2010; Dumas *et al*., 2018). Reijers and Limam Mansar (2005) catalogue redesign heuristics such as task elimination, integration, and parallel processing, several of which are used in the future-state design below. Process modeling guidance helps ensure that maps are understandable and free of errors (Aguilar-Savén, 2004; Mendling *et al*., 2010), and process mining uses event logs from enterprise systems to measure actual cycle times and find bottlenecks (van der Aalst, 2016).

Digital technology has added new options. Robotic process automation suits high-volume, rule-based back-office tasks such as matching records across systems (van der Aalst *et al*., 2018; Syed *et al*., 2020), while enterprise resource planning platforms supply the integrated data on which such automation depends (Holland & Light, 1999; Umble *et al*., 2003). The relationship between Lean and information technology was once seen as a contradiction, but later work shows that IT can strengthen Lean in information-heavy processes (Riezebos *et al*., 2009) and that mature Lean practice tends to accompany wider digital adoption (Buer *et al*., 2018; Mayr *et al*., 2018; Tortorella & Fettermann, 2018; Rossini *et al*., 2019). Shared service centers offer a further organizational option, consolidating transactional work into a specialized unit (Richter & Brühl, 2017). Adjacent studies of digital procurement, vendor evaluation, supply chain resilience, and platform governance make the same point from a practitioner perspective: data integration and controlled tooling are what allow redesigned workflows to scale (Ahiaeke Patrick *et al*., 2021; Ogunwole *et al*., 2021; Okonkwo, Agbabiaka, *et al*., 2021; Badmus *et al*., 2020; Badmus *et al*., 2019b; Mayo *et al*., 2021).

1.5. Revenue Leakage, Data Quality and Financial Control

Revenue leakage refers to revenue that an organization has earned or is entitled to but does not collect, commonly arising from billing errors, contract non-compliance, or process gaps. In trade compliance, the analogous loss is unclaimed refunds and preferences. Trade practitioners have long observed that a considerable portion of eligible U.S. drawback goes unclaimed each year, and the scale of the TFTEA rulemaking reflects how complex the program had become to administer (U.S. Customs and Border Protection, 2018). Academic treatment of drawback is thin and tends to be legal or macroeconomic in focus, examining the effect of duty remission schemes on export competitiveness (Ianchovichina, 2007). Adjacent research shows that translating tax and regulatory requirements into repeatable compliance workflows reduces both errors and missed entitlements (Eyetsemitan *et al*., 2021; Lawal & Oduleye, 2018b), and that well-designed accounting systems are a precondition for detecting financial leakage (Bola-Sadipe *et al*., 2019). Reconciliation controls and financial workflow redesign have been proposed as direct remedies for such leakage (Dogbatsey *et al*., 2019), while technology-enabled audit and risk-based internal control models show how organizations can detect missed value before external reviewers do (Akomolafe & Agu, 2018, 2019a). Standardizing duty-related policies has been shown to reduce enterprise financial exposure (Uchechi, 2018), and reviews of statutory reporting point to process gaps, rather than the complexity of the rules themselves, as the main source of non-compliance (Dogbatsey & Ebhojie, 2018).

The concept of revenue leakage is most developed in revenue assurance practice, where it describes the systematic detection and recovery of revenue that a firm is owed but fails to collect (Priezkalns, 2011). Data quality is a recurring root cause: poor data impose operational costs and lost revenue on the typical enterprise (Redman, 1998), data quality has several dimensions beyond accuracy, including completeness, timeliness, and accessibility (Wang & Strong, 1996), and weak master data governance is a persistent barrier to reliable records (Haug & Arlbjørn, 2011). From a quality perspective, rejected or under-supported claims are a cost of poor quality, made up of failure, appraisal, and prevention costs (Schiffauerova & Thomson, 2006). Accounting research adds that complex, resource-constrained processes are especially prone to internal control weaknesses (Doyle *et al*., 2007), and that such weaknesses degrade the quality of financial information (Ashbaugh-Skaife *et al*., 2008).

Finance research explains why delay matters even when refunds are eventually received. Shorter cash conversion cycles are associated with higher profitability (Deloof, 2003; García-Teruel & Martínez-Solano, 2007), and the cost of cash tied up in receivables is greatest for firms facing financing constraints (Baños-Caballero *et al*., 2014). Pending drawback refunds behave like a receivable that the firm itself controls the speed of collecting. Studies in financial analytics and planning show how such cash flows can be brought into capital allocation, strategic planning, and executive decision systems (Lawal & Oduleye, 2019b; Lawal & Oduleye, 2021a; Lawal & Oduleye, 2021b; Isiekwu *et al*., 2021; Nwangwu *et al*., 2021), and work on measurement in regulated services shows the difficulty of attributing returns to process investments (Sanni *et al*., 2020; Sanni & Atima, 2021a).

A further body of work on risk, audit, and financial controls supplies methods for detecting leakage before external parties do. Data-driven risk evaluation and capital adequacy frameworks illustrate how quantitative monitoring supports control in financial institutions (Akomolafe & Agu, 2019b; Mensah *et al*., 2019), predictive analytics and governance frameworks for anti-money laundering show how rule-based screening can flag anomalies in high volumes of transactions (Atakpa, 2021; Fadayomi *et al*., 2021; Ominyi & Anichukwueze, 2021), and risk-based business intelligence architectures connect such controls to management reporting (Mbonu *et al*., 2021). Security audit, data protection, and records confidentiality research addresses the integrity and availability of the records on which any claim depends (Dosunmu & Ogundele, 2019; Fadayomi *et al*., 2019; Mbonu *et al*., 2019; Onche *et al*., 2020; Oshoba *et al*., 2019), and governance frameworks for data in other sectors reach similar conclusions (Ilodigwe & Adesemoye, 2021; Okoli *et al*., 2020).

Compliance research outside customs offers further parallels. Frameworks for post-merger compliance integration, cross-border regulatory clearance, and high-value statutory compliance show how firms translate multi-jurisdictional rules into operating controls (Ominyi, 2020; Ominyi & Anichukwueze, 2020; Ominyi *et al*., 2020), while studies of contract liability and force majeure illustrate the cost of documentation gaps in global supply chains (Uchechi & Ominyi, 2019; Uchechi *et al*., 2020). Risk-based decision-making in regulated manufacturing (Aneke & Adesemoye, 2020), ethics and compliance training that changes behavior (Anichukwueze *et al*., 2020), and ESG-integrated procurement (Okojie *et al*., 2020) all point to the same design principle used in this paper: compliance is most reliable when it is built into the workflow rather than checked at the end. Work on operational integrity in high-risk drilling makes a similar argument in a very different setting, treating productivity and safety compliance as interdependent outcomes of shared capabilities rather than as priorities to be

traded against each other (Nwangwu *et al*., 2018); in drawback, faster filing and complete evidence are likewise produced by the same redesigned workflow.

1.6. Design Implications for Drawback Recovery

1.6.1. Lean in Rule-Bound Administrative Workflows

Applications of Lean and Lean Six Sigma to document-centered work show which tools survive the move from the shop floor to a claim file. Ghosh and Lever (2020) developed a value stream map for L'Oréal's artwork process, a multi-reviewer approval workflow whose cycle of drafts, sign-offs and resubmissions resembles drawback claim preparation and internal review (Stage 4 in Table 2). Hess and Benjamin (2015) applied Lean Six Sigma within a university, where process improvement depended on cultural change as much as on tools, and Barton (2013) examined Lean approaches across the UK police service, a rule-bound public setting in which, as in drawback, legal requirements cannot be removed as waste. Ray and John (2011) studied Lean Six Sigma in a business process outsourced organization, which matters here because the broker handoff places part of the drawback workflow with an external provider. Roth and Franchetti (2010) used a full DMAIC cycle to improve printing operations, while Ambali *et al*. (2021) propose a Lite-DMAIC adaptation for organizations with limited staff time and analytical resources. The LDR model takes from this stream the mapping of information flows rather than material flows and a proportionate improvement cycle suited to a small trade compliance team, rather than a full Six Sigma infrastructure.

1.6.2. Selecting and Combining Improvement Methods

A second group of studies asks how Lean, Six Sigma and process management should be combined, and under what conditions they deliver results. The question of whether Lean, Six Sigma and Lean Sigma are fads or real process improvement methods (Näslund, 2008) is answered in part by comparisons of business process management and Lean management that identify where the two approaches overlap and where they diverge (Uriona Maldonado *et al*., 2020). Måren *et al*. (2020) evaluate a Lean business process improvement methodology, and the link between Lean process improvement and customer-focused performance has been examined with perceived organizational context as a moderator (van Assen, 2018). Möldner *et al*. (2020) relate Lean manufacturing practices to process innovation performance, and Balocco *et al*. (2019) trace Lean change processes in the business models of digital ventures. For drawback, these studies support two design choices: the LDR model pairs Lean diagnostics with re-engineering of the data flow in Phase 3 instead of relying on either alone, and it judges success by recovered value rather than by internal activity counts. Ashore-Onisemo *et al*. (2021) reconceptualize the cost of poor quality as a governance metric, which justifies reporting rejected and under-supported claims as quality costs alongside elapsed time on the Phase 5 dashboard.

1.6.3. Encoding Compliance Rules in The Workflow

Drawback eligibility rules cannot be relaxed to speed up processing, so the redesign must carry them inside the workflow. Berente *et al*. (2010) study process gatekeepers and their role in securing compliance with enterprise processes; the LDR model gives this gatekeeping role to the analyst who releases matched lines into a claim. De Nicola *et al*. (2011) propose a method for checking business processes against informal business rules, a problem that appears in drawback when substitution judgments reside in individual staff knowledge and produce the conservative substitution losses shown in Figure 1. Elgammal *et al*. (2014) formalize compliance patterns for business process compliance, which corresponds to the error-proofing checks on duplicate designations and units of measure in Phase 3 and to the five-year window alerts in Phase 4. Hadasch *et al*. (2016) examine how directive explanations influence users' process compliance performance, which supports standard work documents that state why a line is excluded as well as that it is excluded. Eyetsemitan *et al*. (2021) translate tax and regulatory requirements into explicit workflow steps for small firms, and research on business-class taxpayers in Ethiopian revenue administration examines their behavior toward tax compliance (S M & Tsega Zemen, 2020), a reminder that claimant behavior, including a tendency to under-claim when rules are unclear, shapes what a regime actually returns.

1.6.4. Customs Revenue and The Recovery Ledger

Customs research frames the administration's side of the drawback relationship. Grigoriou (2019) examines how automated risk management helps customs administrations reconcile revenue maximization with trade facilitation, which implies that claims are increasingly selected for verification by risk rules; a complete audit trail retained from the point of shipment (Phase 5) is the claimant's response to that selection. Morini *et al*. (2017) ask whether trade facilitation and customs revenue collection form a paradox, a tension that drawback makes concrete because every refund returns revenue the state has already collected. Ianchovichina (2007) asks whether duty drawbacks on exports are worth the hassle, which places the cost of running the claim process at the center of the case for using the program at all. These studies shape the financial design of the model: the leakage dashboard keeps potential eligible drawback, claimed drawback and recovered drawback as separate amounts, and the reported saving in Section 3.3 is kept apart from the representative cycle-time projection so that expected entitlement is never presented as realized cash.

1.7. Research Gap, Aims and Contribution

Taken together, these literatures explain why delay and leakage arise in compliance-heavy processes and offer tools to address them, but little published work treats drawback recovery itself as an operational process to be designed and measured. Economic studies ask whether drawback schemes justify their administrative cost (Ianchovichina, 2007), and trade facilitation research prices the time spent in border procedures (Hummels & Schaur, 2013), yet neither examines the claimant's internal workflow, in which eligible value is either captured or lost before a claim ever reaches the customs authority. The present study addresses that gap.

This paper examines where cycle time and revenue leakage originate in the drawback application workflow, which Lean and re-engineering interventions reduce both within the regulatory constraints of the drawback regime, and how the resulting gains can be measured in terms that link process flow to recovered revenue. The analysis is grounded in practitioner improvement work on the drawback workflow at Cummins Inc., in which the first author took part and in

which the drawback procedures were mapped, analyzed and streamlined. The practitioner account of that work reports an annual saving of $143,000; the figure has not been independently reconciled and is treated separately from the representative cycle-time calculations (Section 2.2). From that work the paper develops a five-phase Lean Drawback Re-engineering (LDR) model. Its contribution lies in treating drawback recovery as a revenue-generating operational process rather than a compliance formality, in overlaying a leakage map on the conventional value-stream map so that lost value becomes as visible as lost time, and in a taxonomy of leakage sources that other claimants can apply to their own programs. Section 2 sets out the research method, Section 3 presents the current-state diagnosis, the LDR model, the projected outcomes and the discussion, and Section 4 concludes.

2. Research Method

2.1. Research Design and Process Boundary

The study follows a single-case, action-oriented design in which the first author participated directly in the improvement work (Yin, 2018; Coughlan & Coghlan, 2002). Case and field research is well established as a route to building operations management theory (Meredith, 1998; Voss *et al*., 2002), and action research, in which the researcher participates in the change being studied, has been advocated as a distinct paradigm for operations management (Westbrook, 1995). The unit of analysis is the duty drawback application workflow, from the close of the export period that creates potential eligibility to the point at which a claim is filed in ACE. CBP processing after filing is treated as external to the internal value stream, although its outcomes, refunds received and rejections, serve as quality measures.

The legal boundary of the workflow is defined by Drawback and Refunds, 19 U.S.C. § 1313 (2018), Modernized Drawback, 19 C.F.R. Part 190 (2021), and the Trade Facilitation and Trade Enforcement Act of 2015 (2016). These provisions fix the claim types summarized in Table 1, the five-year filing window, the eight-digit substitution standard and the electronic filing requirement. The process model treats them as fixed constraints: redesign may change how evidence is captured, matched and reviewed, but eligibility and filing decisions rest on the applicable provision rather than on inference from the process model.

2.2. Evidence Base and Status of The Reported Values

The case provides a practitioner account of a drawback workflow and its redesign. Process walk-throughs, discussions with stage owners and review of transaction documents defined the diagnostic procedure, following the case research practice of drawing several sources of evidence on the same process (Yin, 2018; Voss *et al*., 2002). Participant counts, a sampling frame and dated record extracts are not part of the evidence reported here, so these activities are not treated as a reproducible empirical sample. The stage durations in Table 2 and the leakage shares in Figure 1 are therefore representative reconstructions, presented in that form to protect confidential company information, and every result derived from them is illustrative.

The $143,000 annual saving is reported in the practitioner account of the case. No independent financial reconciliation is presented, and the saving is not used to validate the projected cycle-time effect. The two forms of evidence answer different questions: the representative values show how the redesign is expected to change flow, whereas the reported saving describes a financial outcome whose components (recovered drawback, reduced preparation effort and earlier receipt) cannot be separated with the information available. Prospective evaluation should retain dated claim batches, inclusion rules, interview protocols and a reconciliation from eligible duties to amounts recovered.

2.3. Analytical Procedure and Performance Measures

The analysis proceeds in four steps. It defines the process boundary and maps the handoffs between the functions that hold entry, export, bill-of-materials and duty payment records; classifies each activity as value-adding, compliance-required or non-value-adding, extending the value-stream conventions of Rother and Shook (1999) with a category for work the law requires; computes representative cycle measures; and identifies candidate leakage mechanisms before designing a future state. Future-state durations are projections. Evaluation of implemented changes requires separate before-and-after transaction records and a stated measurement window.

Four measures anchor the analysis. *Internal cycle time* is the elapsed time from the end of the export period that a claim batch covers to submission of the claim in ACE. *Process cycle efficiency* (PCE) is value-adding (VA) time divided by internal cycle time (George, 2002). *Revenue leakage* is the value of drawback for which the firm was eligible during a period but which was not recovered, comprising amounts not claimed, under-claimed, and claimed but rejected. *Capture rate* is recovered drawback divided by potential eligible drawback, a ratio adapted from revenue assurance practice (Priezkalns, 2011).

Recovery must be reconciled to eligible, filed and paid claims as separate amounts. One-off refunds, recurring processing savings and working-capital benefits require separate ledgers and stated time horizons. A recovered refund must not also be counted as a second revenue benefit; only the financing cost of earlier receipt belongs in a separate timing benefit. The representative process map does not establish the distribution of observed queue times or the frequency of each leakage mechanism.

3. Results and Discussion

3.1. Current-State Diagnosis

The current-state value stream comprised six internal stages, summarized in Table 2. Claims were prepared in periodic batches. Work at each stage waited for the previous stage to finish an entire batch, and several stages depended on information requested by email from other functions or the broker.

Table 2: Current-state value stream for the drawback application workflow (representative values)

Stage	Description	Elapsed days	VA days	Main waste
1. Export evidence collection	Gather commercial invoices, bills of lading, and electronic export records for the period	21	1.5	Waiting, motion, missing documents
2. Import entry matching	Identify eligible import entries and link them to exports by part and HTS code	28	2.0	Over-processing, defects, rework
3. BOM and substitution analysis	Determine imported content per exported unit and substitution eligibility	18	1.5	Waiting for engineering, inconsistent rules
4. Claim preparation and review	Assemble claim lines, compute refunds, internal review	24	1.0	Inventory (queued batches), rework loops
5. Broker handoff	Transfer data package to broker, answer queries	16	0.25	Waiting, transport of information
6. ACE filing	Broker transmits claim electronically	3	0.25	Minor
Total		110	6.5	PCE = 5.9%

In the representative map, process cycle efficiency is approximately 5.9 percent (6.5 of 110 days), consistent with benchmarks for administrative processes that have not been redesigned (George, 2002). Queueing theory explains why: by Little's law, average cycle time equals work in process divided by throughput (Little, 1961), so large batches of claims waiting between stages lengthen elapsed time even when the work content is small, and variability and high utilization at shared resources such as the broker magnify queues further (Hopp & Spearman, 2008). The constraint is Stage 2, import entry matching, which carries the longest elapsed time (28 days) and the main rework loops. In the case workflow, matching was performed manually in spreadsheets, using part numbers that did not always map cleanly to HTS classifications, and import records had to be requested from the broker for each batch.

Applying the eight categories of waste to the representative map identifies candidate delays, repeated handling, defects and fragmented records. The 6.5 value-adding days within 110 elapsed days imply approximately 94 percent non-value-adding time, but this remainder includes both required administrative work and waiting; it does not establish that more than 90 percent of elapsed time was spent in queues. Document requests, repeated data entry, part-number mismatches, batch accumulation and email handoffs are proposed mechanisms to test against event logs and transaction records.

The practitioner review of past claim periods identified eligible drawback that had not been recovered, and root-cause tracing grouped the unrecovered value into five categories. Figure 1 presents their representative shares as a Pareto chart; the shares indicate the relative priority of each category for redesign and are not a measured frequency distribution.

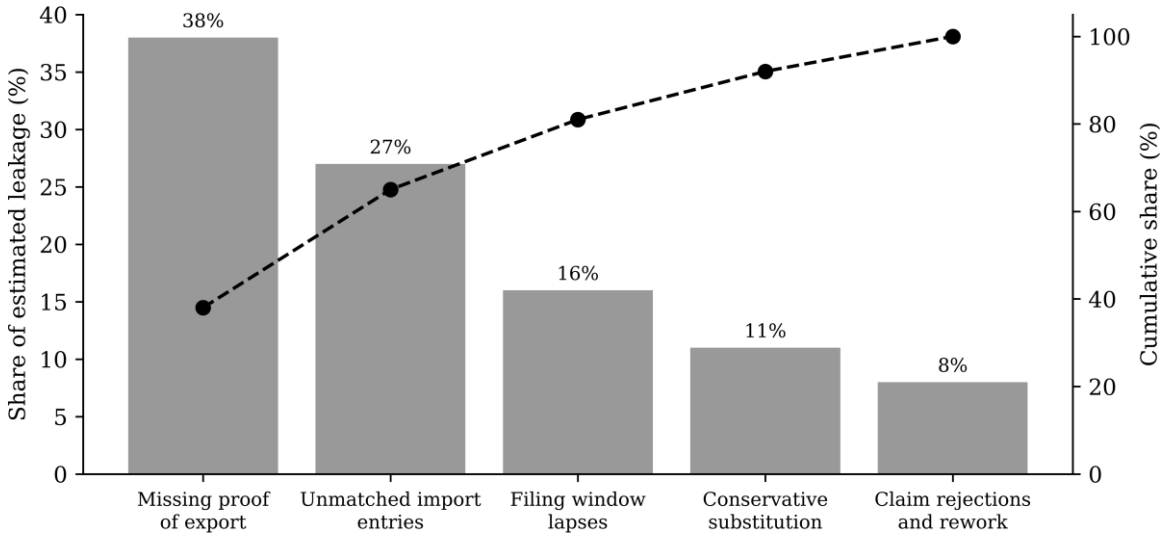


Fig 1: Pareto analysis of drawback leakage by root cause (representative shares)

Missing proof of export (38 percent) arose when export documentation was not retained in a retrievable form, so exports that qualified could not be supported. Unmatched import entries (27 percent) reflected imports that were eligible but never linked to an export because of part-number and HTS inconsistencies. Filing window lapses (16 percent) occurred when import entries passed the five-year limit before being designated, often because they were deprioritized during slow batch cycles. Conservative substitution (11 percent) reflected under-claiming where staff, unsure of substitution rules, excluded lines that would have qualified under the eight-digit HTS standard. Claim rejections and rework (8 percent) covered lines rejected or reduced after filing. The first two categories together account for nearly two thirds of the leakage, which made data capture and matching the priority for redesign. Tracing losses back to their originating step in this way parallels near-miss and hazard analysis in safety management, where systematically captured data on small failures are used to prevent larger ones (Arumosoye & Obriki, 2019; Obriki & Arumosoye, 2018),

and internal audit systems that test controls at the point where errors arise rather than at the end of a process (Obogo *et al*., 2020).

Long batch cycles provide a plausible mechanism linking delay to lost documentation, expired filing opportunities and conservative matching decisions. This account does not identify a causal relationship from transaction-level data. The proposed controls address the mechanism, which must be tested independently. Related distribution research connects traceability weaknesses with downstream verification problems (Aneke & Adesemoye, 2019; Anene, 2021).

3.2. The Lean Drawback Re-Engineering Model

The proposed model, referred to here as the Lean Drawback Re-engineering (LDR) model, has five phases. It combines the diagnostic discipline of VSM with targeted re-engineering of data flows and is bounded by the requirements of 19 CFR Part 190. Table 3 summarizes the phases.

Table 3: Phases of the Lean Drawback Re-engineering (LDR) model

Phase	Purpose	Principal tools	Primary target
1. Define value and scope	Specify recovered refund per period as the value; set stream boundaries; quantify potential	SIPOC, eligibility screening, baseline capture rate	Shared goal across functions
2. Map and measure	Make the current state visible with time, quality, and leakage data	Swim-lane map, VSM, PCE, first-pass yield, leakage Pareto	Constraint and leakage sources
3. Re-engineer data flow	Eliminate re-keying and manual matching at the source	Single drawback repository, automated data feeds, rule-based matching, poka-yoke	Cycle time, unmatched entries, missing proof
4. Establish flow and pull	Replace large batches with a steady filing cadence	Smaller monthly batches, standard work, FIFO lanes, aging alerts	Queue time, window lapses
5. Control and sustain	Hold gains and drive continuous improvement	Leakage dashboard, visual controls, audit trail, kaizen reviews	Capture rate, rejection rate

Phase 1: Define value and scope. Value is defined from the perspective of the firm as the end customer of the process: the timely receipt of the maximum lawful refund with a complete audit trail. Defining value this way puts revenue recovered, not claims filed, at the center of measurement. Scope is set by screening which product families, trade lanes, and claim types carry material drawback potential, so that effort concentrates where returns are highest.

Phase 2: Map and measure. The mapping step described in Section 3.1 is formalized. Each step is recorded with process time, wait time, first-pass yield, and owner. A distinctive feature of the LDR model is that the value-stream map is overlaid with a leakage map: every point at which eligible value can drop out of the stream is marked, so that the team sees not only where time accumulates but also where money is lost.

Phase 3: Re-engineer the data flow. This phase draws most directly on re-engineering. Rather than speeding up manual matching, it removes the need for it. A single drawback repository consolidates import entry data from ACE reports and the broker, export records from logistics systems, and bills of materials from engineering. A maintained cross-reference table maps internal part numbers to eight-digit HTS codes, which enables rule-based matching of imports to exports and automatic flagging of substitution-eligible lines. Error-proofing checks validate quantities, units of measure, and duplicate designations before a line enters a claim. Export proof is captured at the time of shipment rather than retrieved months later. These design choices follow the principle that a shared, traceable record across functions is what makes compliance verifiable (Nnabueze *et al*., 2021). Once the repository exists, predictive models of the kind used in supply chain demand forecasting can be layered on it to anticipate drawback volumes by period and to plan staffing for each filing cycle (Aifuwa *et al*., 2020). Machine learning approaches to demand and revenue forecasting offer the same capability for projecting expected refunds (Tonoyan *et al*., 2021a; Dada *et al*., 2021b; Basnet *et al*., 2021).

Phase 4: Establish flow and pull. Large periodic batches are replaced by a steady, smaller monthly cadence, so that work flows continuously instead of accumulating. Standard work documents define each task, its inputs, its decision rules, and its completion criteria, which reduces variation and dependence on individual knowledge; documented procedures of this kind act as the infrastructure that keeps improvements from decaying after a project ends (Agboada *et al*., 2019), and that allow the process to be assessed against a maturity scale as it is extended to other sites (Anyanwu, 2019). First-in, first-out processing with an aging alert ensures that import entries approaching the five-year window are pulled forward and designated before they expire. The broker handoff is redesigned as a standardized data package with an agreed turnaround, eliminating ad hoc query cycles, in line with vendor governance practices that link service expectations to cost outcomes (Ike *et al*., 2021; Okonkwo *et al*., 2019). Setting a first-time resolution target for broker queries borrows from service operations, where first-contact resolution is a primary driver of cycle time and cost (Wikiri, 2021; Anyanwu, 2020), and the cadence is protected by continuity planning so that filing does not stop when key staff or systems are unavailable (Fadero *et al*., 2020). Aging alerts turn the five-year window from a reactive deadline into a monitored condition, in the same way that predictive maintenance replaces breakdown repairs with planned intervention (Sunday *et al*., 2020; Adaramola *et al*., 2018) and inventory models protect availability before shortages occur (Okonkwo *et al*., 2018b).

Phase 5: Control and sustain. A leakage dashboard reports potential eligible drawback, claimed drawback, recovered drawback, capture rate, internal cycle time, entries approaching the filing window, and rejection rate. Dashboards of this kind close the visibility gap between operating staff and executives and support continuous performance monitoring (Ogbole *et al*., 2021; Sanni & Atima, 2021b). Visual performance management systems have been shown to change how organizations review and act on performance (Bititci *et al*., 2016), and the selection of measures follows established principles of performance measurement system design and periodic updating (Neely *et al*., 1995; Bourne *et al*., 2000). Kaizen events are most effective, and their results most durable, when they involve cross-functional teams and are followed by structured support

in the work area (Farris *et al*., 2009; Glover *et al*., 2011). Maturity models offer a way to track the progression from initial improvement to institutionalized practice (Arumosoye & Obriki, 2021). Visual controls make the status of each batch visible to all functions. Regular kaizen reviews examine new leakage causes and update matching rules. A complete audit trail, retained for the regulatory record-keeping period, supports CBP verification and reduces rejection risk, mirroring compliance-by-design approaches developed for other high-scrutiny procurement settings (Okonkwo, Ogunwole, *et al*., 2021) and audit trail models designed for tamper-proof regulatory recordkeeping and real-time audit readiness (Anichukwueze *et al*., 2021; Oshoba *et al*., 2020).

3.3. Process and Financial Outcomes

The representative future-state design projects an internal cycle of 33 elapsed days compared with the 110-day current-state illustration, a projected reduction of 70 percent. Figure 2 compares the two states stage by stage. The largest projected reductions occur at import entry matching (28 to 9 days), claim preparation and review (24 to 8 days) and the broker handoff (16 to 2 days), the stages at which the redesign replaces manual matching, queued batches and ad hoc query cycles. Value-adding time remains about 6.5 days, giving projected process cycle efficiency of 19.7 percent compared with 5.9 percent. Table 4 summarizes these measures together with the expected reduction in manual re-keying points and the change in filing cadence. All of these values are design calculations rather than measured before-and-after outcomes.

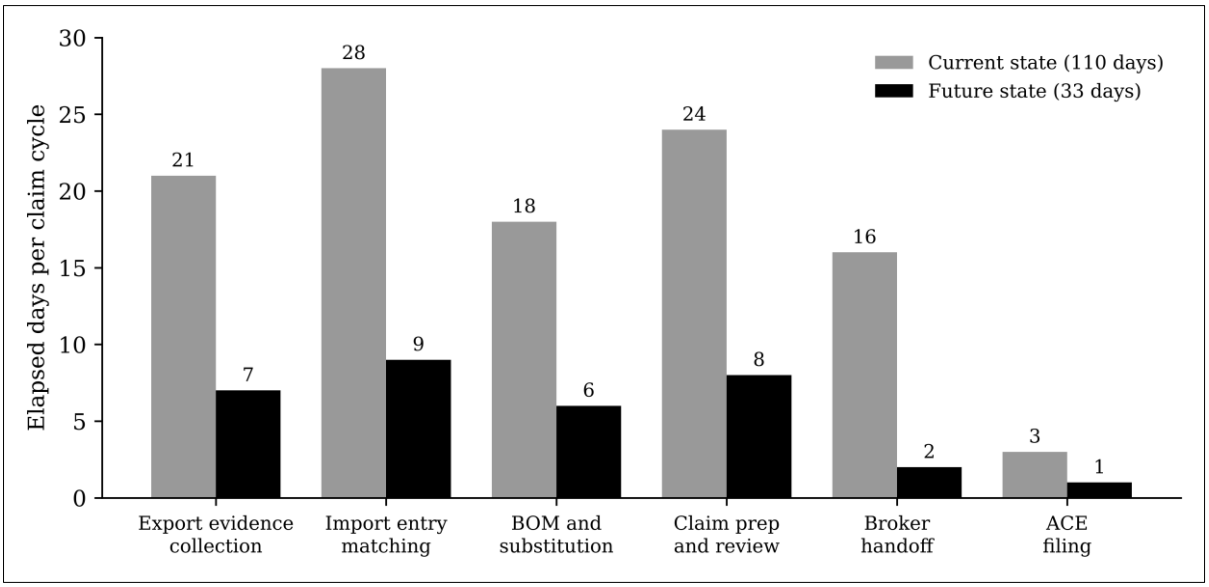


Fig 2: Internal cycle time by stage, current state versus future state (representative values)

Table 4: Summary of process performance, current versus future state (representative values)

Measure	Current state	Future state	Change
Internal cycle time (days)	110	33	-70%
Value-adding time (days)	6.5	6.5	No change
Process cycle efficiency	5.9%	19.7%	+13.8 points
Manual data re-keying points	3 or more	0 to 1	Largely eliminated
Filing cadence	Large periodic batches	Monthly	Smaller, steadier flow

The practitioner account reports annual savings of $143,000. Candidate mechanisms include recovered drawback, lower preparation and rework effort, fewer broker queries and earlier refunds. Their separate contributions and recurring value require financial reconciliation; savings should not be assumed to scale automatically with export volume. Cost-management research supports comparing such benefits with implementation costs (Oduleye & Medon, 2021). Faster recovery can affect the cash conversion cycle (Deloof, 2003; Baños-Caballero *et al*., 2014), while digital recovery and transaction platforms provide related liquidity mechanisms (Osuji *et al*., 2021; Okafor *et al*., 2021; Agyei *et al*., 2019).

The interventions map directly to the leakage categories. The single repository and capture of export proof at shipment address the largest category; rule-based HTS matching addresses unmatched entries and conservative substitution; aging alerts address window lapses; and error-proofing with a complete audit trail reduces rejections. Shorter cycles also reduce the exposure window during which documents can be lost and entries can expire, reinforcing the link between flow and revenue identified in Section 3.1.

3.4. Discussion

The study extends the Lean administrative literature into trade compliance, where it has received little attention. It argues that the classic VSM measure of process cycle efficiency is necessary but not sufficient for revenue-generating administrative processes: a leakage overlay is needed to connect flow to financial value. The analysis is also consistent with the view that Lean and re-engineering are complementary (Hines *et al*., 2004). Lean diagnostics locate the constraint and the leakage points in the representative map, but the largest projected gains in Figure 2 come from re-engineering the data flow rather than from incremental speed-ups of manual tasks, in line with Hammer's (1990) warning against automating broken processes. The model

follows the Lean-first sequence recommended for service firms (Bortolotti & Romano, 2012) and responds to the critique that administrative Lean focuses too narrowly on internal efficiency (Radnor & Johnston, 2013; Radnor & Osborne, 2013), since the leakage overlay ties every improvement to value recovered. By linking flow measures to recovered cash, the model also connects operational improvement to the broader literature on financial analytics and enterprise value creation (Lawal & Oduleye, 2018a). Whether the projected gains materialize is an empirical question that the measures defined in Section 2.3 are designed to answer.

Several practical lessons follow. Drawback is best managed as a revenue process rather than a paperwork task: measuring capture rate alongside cycle time changes priorities and secures cross-functional support, which matters when a process spans several functions with different incentives (Eyetsemitan *et al*., 2020). Most leakage originates in how export proof and part classifications are captured, long before a claim is prepared, so data should be fixed at the source. Smaller, regular batches shorten cycles and directly reduce filing window lapses, and a defined data package with an agreed turnaround removes one of the largest sources of queue time at the broker interface. Capability needs to be built alongside procedures, since training analysts in trade rules and data tools, backed by clear governance and compliance oversight, keeps improvements from depending on a few individuals (Akomolafe & Agu, 2019c; Falemi *et al*., 2020). Finally, a dashboard of eligible versus recovered drawback keeps management attention on the gap that matters.

The study is based on a single case in one firm and one regulatory jurisdiction, which limits generalizability. Success factors for Lean implementation, including leadership, skills, and organizational context, vary across firms (Achanga *et al*., 2006; Netland, 2016), and process improvements are notoriously hard to sustain once project attention moves elsewhere (Bateman, 2005), so the durability of the gains should be tested over a longer period. Stage durations and leakage shares are presented as representative values to protect confidential information, and the future-state cycle time is a design projection that should be verified over several filing periods. The work was conducted shortly after the TFTEA rules became mandatory, when practices across industry were still settling. Future research could test the LDR model across firms of different sizes and drawback volumes, examine other duty remission regimes such as inward processing in the European Union, and study the effect of robotic process automation and machine learning on import-export matching accuracy.

4. Conclusion

The proposed Lean drawback model links administrative flow to evidence retention, matching accuracy and recovery control. Representative durations project a reduction from 110 to 33 days, while the $143,000 annual saving remains a practitioner-reported outcome. These two forms of evidence should be assessed separately. The practical contribution is a filing process with shared records, explicit aging controls and accountable exception review. Transaction-level validation is needed to establish realized cycle-time changes, net savings and the contribution of each intervention.

Implementation should begin with a defined claim population, a shared transaction identifier and a clear distinction between eligible duty, filed claims and amounts received. Each stage needs an owner, an entry condition and an aging threshold. Exception review should resolve missing export evidence and inconsistent classifications before a filing deadline becomes an unrecoverable loss. A shared record supports this control only when staff maintain source documents, record corrections and preserve the history of decisions. Faster processing must retain the evidence necessary for compliant recovery.

The projected cycle reduction depends on representative stage durations rather than independently observed before-and-after distributions. The proportion of time outside value-adding work does not establish the proportion spent waiting, because required administration also consumes time. Financial evaluation must separate refunds, recurring processing savings and the financing benefit of earlier receipt. Implementation expenses, broker costs and unresolved claims belong in the same reconciliation. These distinctions prevent the model from overstating recovery or counting the same benefit more than once when estimating an operational business case.

A prospective study should follow comparable claim cohorts through completion, including unsuccessful claims and late exceptions. Researchers should retain filing timestamps, document requests, approval events, paid amounts and staffing changes. Analysis should compare median and upper-tail cycle times, recovery rates and net costs under stable eligibility rules. Differences in claim complexity require explicit adjustment or stratification. The resulting evidence would identify which controls improve flow, which transfer work to another stage and which require redesign before broader deployment across manufacturing drawback operations.

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