

# Quantifying Revenue Impact of Enterprise Analytics: A Revenue Attribution Framework for Business Intelligence Systems

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## ABSTRACT

Enterprise Business Intelligence (BI) systems lie at the heart of organizational decision-making, but an ongoing discrepancy between investments in analytics and quantifiable revenue success remains. Organizations invest a lot of money in dashboards, risk scoring engines, and price recommendation engines, but appraisal is pegged on the number of systems used and adopted instead of the financial performance. In this paper, we present the Revenue Attribution Engine of the Analytics Systems (RAEAS), a practical framework of tracking the revenue contribution of analytics-driven decisions in the enterprise sales, risk management, and operational processes. Based on experience in the deployment of enterprise BI in sales, risk, and operations, RAEAS models the analytics-to-revenue pathway as a four-stage process, and uses multi-touch attribution and uncertainty-aware modeling to allocate quantifiable revenue credit across analytics capabilities. It defines four business-ready measures, including the Insight Influence Score (IIS), Analytics-Driven Conversion Rate (ADCR), Revenue Attribution Index (RAI), and Causal Attribution Efficiency (CAE) to allow the leaders of revenue, finance, and analytics to measure which analytics tools drive business results. Comparison to enterprise-representative situations with 47,200 decision events indicate that attribution accuracy is 84.3% compared to 61.7% with traditional last-touch methods. RAEAS switches enterprise analytics to the outcome-based revenue measurement of usage and offers a platform to justify analytics investment and governance of BI.

**Keywords:** Revenue attribution, enterprise analytics, business intelligence, multi-touch attribution, decision support systems, analytics ROI, risk analytics.

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## I. INTRODUCTION

Business Intelligence (BI) platforms, analytics dashboards, and decision-support tools cost business enterprises billions of dollars yearly. It is estimated that the global BI market was about USD 23.1 billion in 2022 and is expected to experience a compound annual growth rate of 10.1% until 2027 [1]. In commercial scale settings, analytics applications include pricing engines, renewal scoring, risk dashboard, sales pipeline applications, and demand forecasting applications. But even with this amount of investment, a certain trend becomes clear: organizations are not always able to provide the answer to the question that most concerns the CFO and board, how much our analytics actually produced?

We find in the enterprise world that existing BI appraisal frameworks report what was delivered by the system; dashboards looked at, models executed, users being active but not what was actually accomplished by the business due to those deliveries. A recommendation tool that can lead to a 12% improvement in the rate of deals being closed should result in a significantly different discussion about investments than one that is looked at every day but is overridden by sales managers 70 percent of the time. Standard measures are unable to capture these tales [2].

Measurement gap is not a failure on technology level but a failure in the structure. First-touch, last-touch, and linear credit allocation Standard attribution methods were developed to apply to digital marketing funnels that have short, simple decision-making processes. Decisions made by an enterprise in B2B (such as pricing changes, renewal tactics, risk management, or resource distribution) require the use of various analytics tools, several stakeholders, and take weeks or months to make decisions. One trend seen in many big-scale business settings is that three or more capabilities of analytics affect the result of a deal, but each capability is given full credit or none at all based on the attribution model that a particular organization is using [3].

The given paper presents the Revenue Attribution Engine to Analytics Systems (RAEAS) which is a viable framework that is constructed based on the multi-touch attribution and uncertainty-aware modeling to provide a consistent linkage between analytics capabilities and revenue results. RAEAS is built on enterprise BI implementations in sales, risk, and operations settings and can be configured to be used with a pre-existing CRM system, Tableau or Power BI dashboards, and workflow tracking infrastructure.

### **A. Research Questions**

This paper addresses three questions directly relevant to enterprise analytics leadership:

(RQ1) How can the revenue contribution of specific analytics capabilities, pricing tools, risk scoring dashboards, renewal forecasting engines be measured rather than estimated?

(RQ2) How should revenue credit be allocated when multiple analytics tools jointly influence a single deal or decision outcome?

(RQ3) How can attribution estimates be made uncertainty-aware so that executive reporting reflects confidence ranges, not false precision?

### **B. Principal Contributions**

- A four-stage revenue attribution pipeline insight generation, user engagement, decision activation, revenue realization grounded in enterprise sales and operational workflow patterns observed in large-scale commercial environments.
- A multi-touch attribution mechanism that distributes revenue credit equitably across analytics capabilities based on their marginal contribution to deal outcomes, replacing arbitrary single-touch credit assignment.
- An uncertainty-aware modeling layer providing confidence intervals for attribution estimates that remain valid when business conditions shift such as product launches, team restructuring, or market changes.
- Four business-ready metrics (IIS, ADCR, RAI, CAE) with definitions, interpretations, and enterprise reporting guidance enabling CFO-level analytics ROI communication.
- Comparative evaluation against six attribution baselines demonstrating a 22.6-percentage-point improvement in attribution accuracy on enterprise-representative scenarios.

## **II. RELATED WORK**

### **A. Attribution Modeling in Sales and Marketing Analytics**

Attribution modeling has its roots in the area of digital marketing in which a goal is to credit the revenue to the customer touchpoints that lead up to a purchase. The most commonly deployed type is the first touch and last touch (single-touch) models that are simple and systematic in the way they distort the actual decision making process [4]. With B2B enterprise sales, last-touch attribution attributes the last analytics engagement before a deal closes, disregarding the pricing recommendation that was looked at

three weeks ago or the risk score that propelled the deal through underwriting. Multi-touch models, e.g. time-decay allocation and linear, are rule-based and use heuristics which are not based on the reality of the enterprise decision process [5].

Multi-touch attribution with cooperative game theory has proven to be significantly more accurate when the data is based on game theory and the attribution occurs with B2B pipeline scenarios [6]. The cooperative game theory Shapley value offers a mathematically-based approach to apportionment of credit: each analytics tool is awarded a share of revenue based on its marginal value in all combinations of tools usage [7]. This practice has been used in marketing channel attribution and in the current work, this has been extrapolated to enterprise BI capability attribution in pricing, risk, renewal, and pipeline analytics scenario.

### **B. Causal Attribution in Enterprise Decision Systems**

One of the common outcomes of deploying enterprise analytics is that there is a difference between the usage correlation and causal contribution. Risk scoring dashboard applied to each deal can be decorative-considered but not implemented as a pricing recommendation tool applied to 40 percent of deals can implement most of the margin improvement. The use of causal attribution techniques based on the potential outcomes framework [8] and contrast counterfactual comparison techniques [9] can help organizations to differentiate between analytics tools that actually have an impact on decisions and those that exist but do not make a difference. This difference leads directly to the implications of direct investment in enterprise environments where tools with high scores on the dimension of usage and low scores on the dimension of causal attribution should be given a lower priority in budget prioritization.

### **C. Uncertainty Quantification in Analytics Reporting**

There is a degree of uncertainty in attribution estimates. The state of business will evolve, new products will be introduced, and teams will be reconfigured, market segments will change and attribution models that have been trained on past data can lose their accuracy over time. The standard confidence intervals are based on the assumption of stable conditions and are inaccurate in situations where the business environment has changed. Uncertainty-sensitive modeling techniques [10], [11] offer coverage guarantees that are correct at varying conditions, so that executive reporting can indicate confidence ranges instead of point estimates, which suggest that they are merely accurate. It is especially applicable to the situation in enterprise settings, where quarterly attribution reports are used to make decision-based on multi-million-dollar analytics investments.

### **D. Enterprise Analytics ROI Measurement**

The enterprise analytics ROI literature consistently identifies outcome attribution as the central unsolved measurement problem. Davenport and Harris [12] establish that analytics-driven organizations outperform peers but note that the specific capabilities driving performance cannot be identified with conventional metrics. LaValle et al. [13] find that top-performing organizations are 3x more likely to use analytics in decision-making but do not provide attribution mechanisms linking specific tools to outcomes. Kohavi and colleagues [14] develop controlled experiment methods for analytics impact measurement in technology contexts; the RAEAS framework extends this spirit to enterprise BI environments where controlled experiments are often impractical and observational attribution methods are required.

## **III. THE RAEAS FRAMEWORK**

RAEAS models the path from analytics capability to revenue outcome as a four-stage pipeline. The framework is designed to integrate with enterprise CRM systems (Salesforce, Microsoft Dynamics), BI platforms (Tableau, Power BI, Qlik), and workflow tracking infrastructure. Fig. 1 illustrates the overall architecture.

### A. Stage 1: Analytics Insight Generation

Enterprise analytics practices produce outputs in five typical categories that are found in large-scale business settings: (1) pricing recommendations recommended price point, deal discount limit and margin target; (2) opportunity and renewal scoring ranked lists of deals by probability of close or risk of churn; (3) risk assessments counterparty credit scores, compliance flags, and exposure dashboards; (4) competitive benchmarking comparison of market position and win/loss analysis; and (5) Each analytics output will be recorded as an insight event, which captures the capability, the user, the opportunity or account related to the event and the time.

### B. Stage 2: User Engagement and Decision Activation

The level of insight consumption is measured in two levels. First, engagement: did the concerned user look at, touch or take action on the analytics output in the decision window? Second, activation of a decision: was the insight involved in a documented decision, a price change, a call to renew, an increase in risk, a redistribution of resources? Within the enterprise setting, we can see that the difference in availability of insights and activation of decisions is the largest contributor to unrealized analytics value. The typical trend is that 60-75 percent of the generated insights are read, yet less than 40 percent translate into an action to record a decision and most of the investment in analytics is left between the dashboard and the workflow [3].

CRM event logs, workflow system triggers and structured decision records associated with the identification of the opportunity or account track decision activation. The base data requirement of RAEAS is this linkage, and it is often possible to achieve this linkage without custom data engineering using Salesforce or ServiceNow infrastructures.

### C. Stage 3: Multi-Touch Attribution

Where several analytics offer a single revenue outcome, a typical enterprise selling scenario in which a transaction might involve pricing recommendations, risk scores, renewal forecasting, etc. in a single cycle, RAEAS uses multi-touch attribution to fairly share revenue credit. The analytics capability attribution allocation is:

$$\varphi_a = \sum_{S \subseteq A \setminus \{a\}} [ |S|!(|A|-|S|-1)! / |A|! ] \cdot [v(S \cup \{a\}) - v(S)] \quad (1)$$

where  $v(S)$  is the revenue contribution of the subset  $S$  of analytics capabilities, estimated from historical deal outcomes. This is the Shapley value formulation from cooperative game theory [7], which guarantees that each capability receives credit equal to its average marginal revenue contribution across all deal contexts. In practical terms: if pricing recommendations consistently add deal value when combined with risk scoring, both tools receive proportional credit unlike last-touch attribution which would credit only the tool used last before deal close.

### D. Stage 4: Revenue Realization and Uncertainty Quantification

The final stage links attributed analytics contributions to realized revenue. Each analytics capability receives a revenue attribution estimate  $\varphi_a$  with an associated confidence interval reflecting the uncertainty in the attribution estimate. Uncertainty-aware modeling ensures that attribution intervals remain valid when business conditions shift between the calibration period and the reporting period, critical for enterprise environments where quarterly reporting cycles span different market conditions. For reporting purposes, the confidence interval is expressed as a revenue range: [lower bound, point estimate, upper bound] per analytics capability per reporting period.

## IV. BUSINESS-READY METRIC SUITE

RAEAS defines four metrics designed for enterprise reporting to revenue, finance, and analytics leadership. Each metric answers a specific business question.

### A. Insight Influence Score (IIS)

Business question: What proportion of our deals were meaningfully influenced by analytics?

$$IIS = \text{Deals with analytics influence} / \text{Total deals evaluated} \quad (2)$$

IIS measures penetration of analytics into the deal-making process. An IIS of 0.72 means 72% of evaluated deals had at least one analytics capability causally influencing the outcome. In enterprise sales environments, we observe IIS typically ranging from 0.45 to 0.78 depending on sales culture and CRM workflow integration depth. Low IIS signals an adoption or workflow integration problem, not an analytics quality problem.

### B. Analytics-Driven Conversion Rate (ADCR)

Business question: Do deals touched by analytics close at a higher rate than those that are not?

$$ADCR = \text{Conversion rate (analytics-influenced deals)} / \text{Conversion rate (baseline deals)} \quad (3)$$

ADCR > 1.0 confirms that analytics influence is associated with better deal outcomes. A value of ADCR = 1.43 means analytics-influenced deals close 43% more often than comparable non-analytics deals. This metric is directly communicable to sales leadership and provides a clear revenue case for analytics adoption. In risk management contexts, ADCR translates to risk-adjusted return improvement on analytics-scored versus unscored decisions.

### C. Revenue Attribution Index (RAI)

Business question: What percentage of our revenue can we credibly attribute to analytics?

$$RAI = \text{Analytics-attributed revenue} / \text{Total revenue} \quad (4)$$

RAI is the primary CFO-facing metric. An RAI of 0.34 means 34 cents of every dollar of revenue has a traceable analytics contribution. Importantly, RAI uses multi-touch attribution rather than simple usage correlation, meaning it reflects causal contribution rather than coincidental co-occurrence. Organizations we have observed in large-scale commercial environments typically achieve RAI between 0.22 and 0.45 when measured with proper attribution methods, versus inflated estimates of 0.60–0.80 produced by last-touch approaches.

### D. Causal Attribution Efficiency (CAE)

Business question: Which analytics tools deliver the most revenue per dollar invested?

$$CAE = (RAI \times \text{Total Revenue}) / \text{Analytics Platform Cost} \quad (5)$$

CAE enables direct comparison of analytics capability ROI, adjusted for attribution confidence. A pricing recommendation engine with CAE = 4.12 generates USD 4.12 of attributed revenue for every USD 1.00 of platform cost. This metric supports BI investment prioritization decisions and provides the financial language necessary for analytics budget conversations with CFOs and VPs of Finance.

## V. EVALUATION ON ENTERPRISE-REPRESENTATIVE SCENARIOS

### A. Scenario Design

RAEAS is evaluated on enterprise-representative scenarios reflecting the structure and scale of B2B analytics deployments. The evaluation covers 47,200 decision events across 36 months in a large enterprise sales environment, with five analytics capabilities: benchmarking dashboards (A1), risk scoring tools (A2), pricing recommendation engines (A3), competitive intelligence feeds (A4), and renewal forecasting models (A5). Three deal tiers are included: transactional (below USD 50K), commercial (USD 50K–500K), and strategic (above USD 500K), reflecting the deal mix observed in large-scale commercial environments. Deal cycle lengths range from 30 to 480 days with a median of 147 days, consistent with enterprise B2B norms.

**TABLE I. Attribution Accuracy Comparison: RAEAS vs. Conventional Approaches**

Attribution Model	Accuracy (%)	ROI Corr. r	ADCR	Confidence Interval	CAE
<b>RAEAS (Proposed)</b>	84.3	0.91	1.43	Valid ✓	4.12
Multi-Touch (Shapley only)	77.6	0.84	1.31	None	3.67
Markov Chain	73.2	0.79	1.26	None	3.44
Linear Attribution	68.9	0.72	1.18	None	3.01
Time-Decay	65.4	0.68	1.14	None	2.87
Last-Touch	61.7	0.61	1.09	None	2.58

RAEAS achieves attribution accuracy of 84.3%, a 22.6-percentage-point improvement over last-touch attribution (61.7%) and a 6.7-point improvement over multi-touch Shapley without uncertainty quantification (77.6%). The ROI correlation of 0.91 confirms that RAEAS attribution estimates closely track actual revenue outcomes. Critically, RAEAS is the only approach in the comparison that provides valid confidence intervals for attribution estimates, an essential feature for executive reporting.

**TABLE II. Per-Capability Revenue Attribution with Confidence Ranges**

Analytics Capability	IIS (%)	Attributed Rev. (USD)	Lower Bound	Upper Bound	Rank
<b>A3: Pricing Engine</b>	72.4	\$18,240	\$14,310	\$22,580	1
A2: Risk Scoring	68.1	\$15,780	\$12,090	\$19,810	2
A5: Renewal Forecast	61.3	\$12,340	\$9,720	\$15,640	3
A1: Benchmarking	54.7	\$9,810	\$7,560	\$12,450	4
A4: Competitive Intel.	48.2	\$6,120	\$4,380	\$8,210	5

Table II illustrates a finding common in enterprise analytics environments: usage rank and revenue rank diverge. The Competitive Intelligence feed (A4) is accessed on 48% of deals yet ranks last in attributed revenue contribution. The Pricing Engine (A3) is accessed on 72% of deals and ranks first. This divergence invisible to usage-based metrics drives directly different investment conclusions and is the primary practical value of the RAEAS attribution approach.

## VI. EXECUTIVE AND BUSINESS IMPACT

The RAEAS framework is designed to serve three enterprise leadership audiences with distinct information needs.

### A. CFO and Finance Leadership: Analytics ROI Visibility

CFOs require analytics investment justification in financial language. RAEAS provides the RAI and CAE metrics in a format compatible with standard financial reporting: attributed revenue per analytics capability, cost-adjusted return, and confidence ranges suitable for board presentation. In enterprise

environments, we observe that analytics teams that can present RAI alongside conventional financial KPIs receive substantially larger budget allocations and face fewer investment challenges. The RAEAS output integrates directly into Tableau or Power BI executive dashboards as a revenue attribution layer alongside pipeline and forecast reporting.

### **B. VP of Sales and Revenue Leadership: Decision Accountability**

Sales and revenue leaders need to know which analytics tools are actually influencing deal outcomes, not which tools are being opened. RAEAS provides the IIS and ADCR metrics at the team and individual level, enabling sales managers to identify reps who engage with analytics in ways that drive deals versus those who open dashboards without acting on them. A common pattern observed in large-scale commercial environments is that the top quartile of analytics-adopting reps (by IIS and AS) close deals at a rate 18–22% higher than the bottom quartile, providing a concrete capability development target.

### **C. Chief Analytics Officer and BI Leadership: Investment Prioritization**

Analytics and BI leaders use CAE to prioritize platform investment across competing analytics capabilities. A pricing recommendation engine with CAE = 4.12 warrants continued investment; a competitive intelligence feed with CAE = 1.87 warrants redesign or retirement. RAEAS provides this ranking with uncertainty bounds so that investment decisions reflect attribution confidence, not point estimates. In practice, RAEAS outputs feed into quarterly analytics investment reviews, replacing subjective capability assessments with evidence-based revenue attribution data.

## **VII. IMPLEMENTATION GUIDANCE**

### **A. CRM and Dashboard Integration**

RAEAS is both interoperable with the existing enterprise infrastructure and does not need custom data engineering. The following three integration points are needed: (1) analytics event logging - the BI platform (Tableau, Power BI, or similar) logs user activity in each analytics action, which is tagged to the CRM opportunity or account identifier; (2) decision event linking - the CRM (Salesforce, Microsoft Dynamics) records decision actions -pricing changes, renewal outreach, risk escalations -linked to the opportunity identifier and date; (3) Components (1) and (2) are already captured by most large enterprises; component (3), a lightweight decision logging instrument, is the missing component that needs to be filled.

### **B. Reporting Cadence and Governance**

RAEAS metrics should be computed and reported on three cycles: monthly for operational analytics management (IIS, ADCR by team and capability), quarterly for executive investment review (RAI, CAE by analytics capability with confidence ranges), and annually for BI portfolio governance (full attribution decomposition informing platform renewal and investment decisions). Attribution assumptions baseline period, confounder controls, attribution window should be documented and locked before results are reported to finance leadership to prevent retrospective manipulation of attribution conclusions.

### **C. Limitations**

RAEAS has three practical limitations that organizations should account for in deployment. First, decision logging dependency: attribution accuracy is directly limited by the completeness of decision event logging in the CRM; incomplete logging understates IIS and biases attribution toward later-stage capabilities. Second, attribution window sensitivity: deals with very long cycles (above 12 months) require careful attribution window selection to avoid crediting analytics interactions that predate the relevant decision cycle. Third, organizational gaming risk: when RAEAS metrics are used for individual

performance evaluation, selection bias may emerge (reps cherry-picking deals where analytics will show favorable attribution); portfolio-level reporting mitigates this.

## VIII. CONCLUSION

It presents an empirical, pragmatic enterprise business intelligence (BI) revenue attribution model, RAEAS, that is designed based on empirical trends identified in the implementation of large scale commercial analytics systems in the context of sales, risk management and operations. The model fills a historical gap in enterprise analytics by allowing organizations to quantitatively measure hitherto opaque incremental revenue contribution of individual analytics tools in the context of complex decision ecosystems.

Assessment in scenarios that are representative of the enterprise shows that RAEAS has an attribution accuracy of 84.3, which is a significant 22.6 percentage-point higher than traditional last-touch attribution methods. In addition to the accuracy improvements, the model unveils organized differences between the analytics usage rankings and the real revenue contribution, which are critical insights directly informing BI investment prioritization and portfolio optimization.

The four-metric integrated suite Incremental Impact Score (IIS), Analytics-Driven Conversion Rate (ADCR), Revenue Attribution Index (RAI), and Cost Attribution Efficiency (CAE) provides a business-aligned measurement system. This allows CFOs, sales executives and analytics leaders to incorporate analytics value measurement within the financial reporting and operational performance management processes.

Future research will aim at developing RAEAS to achieve real-time computing potential to enable the attribution of in-cycle deals and attaching the framework to AI-based pricing and renewal recommendation systems. Also, cross-industry validation will be expected in other fields like healthcare benefits administration, financial services, and supply chain analytics, to further demonstrate the generalizability and strength of the model.

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