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Development of a System to Measure Performance of a Supply Chain Services Program

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Development of a System to Measure Performance of Procurement, Logistics, Inventory, and Fleet Management

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Abstract: This is to describe the methods and outcomes of an initiative to develop a system and Key Performance Indicators (KPIs) for an organization's internal supply chain programs. The "system" was a set of IT architectures, reporting processes, and data models as well as the human skills and procedures that enabled the reporting workflows.

The initiative was completed in about six months and involved substantial effort and significant accomplishments. This paper only attempts to provide the highlights that the author believes are most useful to inform similar efforts by others. To that end, there's emphasis on the incredibly valuable practice of following a project management methodology, the project's explicit recognition and treatment of systemic risks to data quality, and respect for the opportunity to strategically shape the decision process through system design.

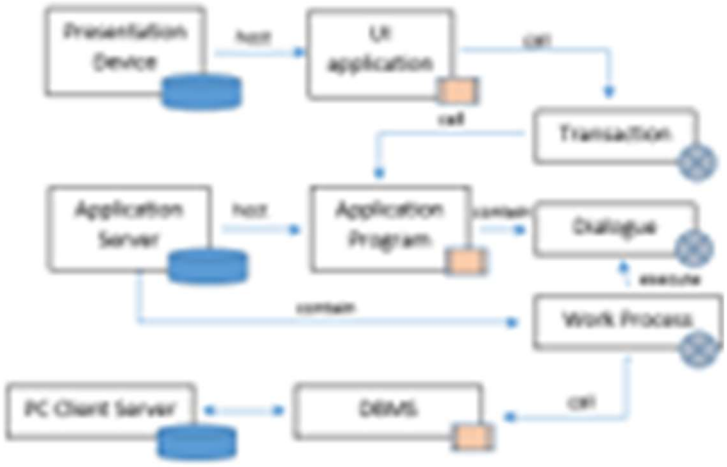
Some details have been anonymized or pseudonymized to protect client privilege and confidentiality of information.

Context

This system was developed for a division of a North American company that owns and operates electric utility infrastructure. The company's annual revenue was approximately $13B, and annual procurement of MRO, equipment, professional and technical services, Information Technology, and construction and maintenance of facilities, electrical substations, and electrical transmission lines totaled approximately $1.5B. Internal warehouse inventory was valued at approximately $45M. The company's service territory was sited across a five-state region. The company operates in a heavily regulated industry, with data and information subject to financial controls, ratepayer scrutiny, regulatory reporting requirements, and cyber security monitoring. The Division for which this system was developed is responsible for internal "supply chain" activities, including the management of procurement, logistics, inventory, the management of vehicle and mobile equipment fleet. The Division and (to some extent) the Executive management generally recognizes unique program performance benchmarks for programs in procurement and logistics (by the Utility Purchasing Management Group, UPMG) fleet management (by Utilimarc), and contingent labor services (by Staffing Industry Analysts). The data models for each of these accepted benchmarks are based on features that differ from variables commonly available in the organization's legacy systems. For example, Utilimarc benchmarks fleet management by equipment type, but there's no such metadata tracked by the organization's fleet management program.

A partial map developed of the organization's enterprise architecture related to this program performance is shown in Figure 1. ERP architecture runs on a Client Server platform; the server hosts a central database and an ERP application, through which most of the division's transactions pass. The data is stored in the Client Server database layer, which includes data marts for limited sets of data.
A Power BI application and server has been integrated.

Figure 1 – Some Enterprise Architecture



The division's contingent labor performs its transactions through a vendor-facing platform and transfers a limited set of procurement data.
Fleet management transactions and information are cloud-based. The data managed by the application suite for catalog, inventory, and procurement is not comprehensive of the organization's related business data such as PO spend, acquisition cost estimates, emergency inventory stock, asset condition scores, rogue site inventory, stranded inventory, requestor specifications and standards, bundled freight costs, and a substantial amount of unstructured procurement action documentation. The division relies on an existing set of reports that lack any traced data lineage and have uncertain value to management teams or external stakeholders.

Objectives:
This initiative addressed an expressed desire by the division leadership to consolidate the existing reporting system, centralize information, streamline ETL activities, and provide management with meaningful indicators of the organization's performance. The goal was to "…make this a more data-driven management system." The division Chief also sought the ability to easily report performance up to the COO Executive in a monthly cadence while also integrating the metrics with the quarterly strategic planning activities of the division and performance reports to internal customers and stakeholders.

Constraints:
Challenges included a general illiteracy of the division's management team in consuming data and data reports, an existing set of reports that was overwhelming to allotted meeting slots and manager attention, and a general lack of meaning and actionable insight in existing KPIs and reports. In some sense the target was moving, with initiatives in progress to improve processes for inventory targets, management of stranded inventory, and adoption of a telematics system for fleet. The division's analysts possessed skills focused only on administering existing reports, with no apparent skills with ETL tools or data mining, few skills in DAX or Power BI, and limited ability in data visualization, communication, or presentation design.

Risks

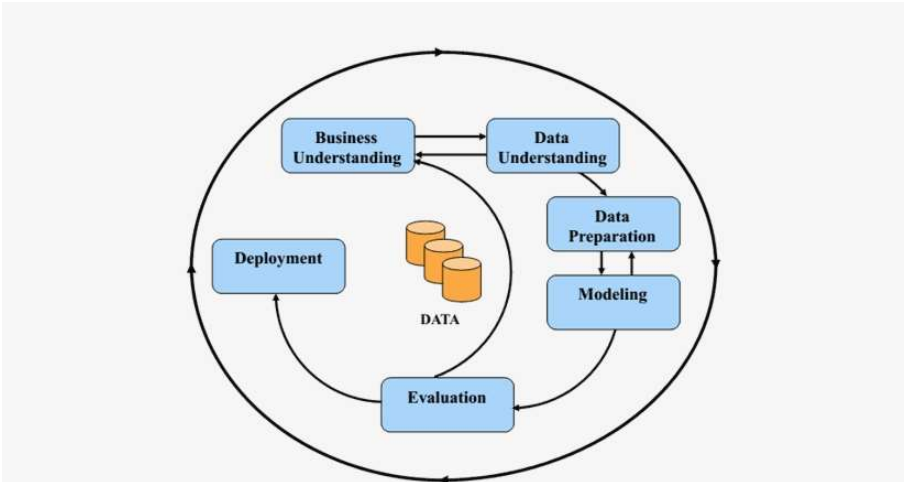
This strategic development was undertaken with respect and attention to the following risks:

- Source data for the KPI isn't representative of the sample populations
- Source data isn't coherent – data points aren't same/similar
- Source data isn't easily accessible, perhaps because of an unstructured or qualitative sources
- Data quality is compromised in the processes of elicitation, extraction, transformation, or loading; data quality is compromised by bias or errors
- A KPI is too complex or the ratio data is too intractable to be assembled in a timely manner by analysts or system reporting functionality
- Metric fails to communicate the actual performance concerns of information consumers
- Metric fails to suggest prescriptive opportunities to decision-makers
- Metric suggests a misleading prescription to decision-makers
- The body of KPIs doesn't fit – visually or handily – within convenient dashboards, meeting times, or existing communication formats
- Total computational efficiency – time for extraction to consumption, as well as overhead resources for analysis and reporting – is an unreasonable cost
- Analytics staff are unable to administer and maintain the system, produce reports and prune and shape reporting content, and develop and present trenchant visualizations
- Consumers of the information fail to understand the visualizations or glean useful actionable information (even if prescriptions are explicitly given)
- Metric is not credible to customers and upstream consumers of the information
- Reporting process becomes distorted or confounded by future state changes to enterprise architecture, applications, and analytics capabilities

Design Methodology

This metric system was developed through a consulting engagement by Emkhos, LLC. The consultant led a team of the organization's SMEs through the following process that applied project

Figure 2 – The Analytics Process



management rigor to the standard analytics discovery process (Figure 2). Application of this method ensured successful project delivery (against scope, schedule, and budget), minimization of bias, error, and confounding in the data models, and structure to support the organization's management of the contracted consultant engagement.

Development Process Milestones

1. Charter the initiative with sponsor and team; establish objectives, timelines, and communication plan.
2. Assess current state context and risks; map processes and value streams; interview information consumers and system analysts.
3. Market research of industry best practices and benchmarks, regulatory framework for data
4. Strategize categorization of metrics and reporting workflows
5. Iterative strategic development of KPIs
    a. Strategize candidate KPIs
    b. Map lineage; estimate ETL costs and risks
    c. Model KPI, mine sample data;; perform validation
    d. Design visualization alternatives; mock up dashboard and present to focus group
    e. Evaluate cost and benefit in relation to all candidate KPIs
6. Presentation of findings and recommended system; approval by sponsor
7. Reproduction of selected reports by lineage tracing and star schema mapping; build Power BI reports
8. Develop new KPIs, ETL process, dashboards, reporting templates, and Power BI functionality
9. Perform SIPOC analysis and Develop Change Management Plan
10. Design and deliver training for analysts and for data literacy for information consumers
11. Develop Implementation Plan
12. Sponsor decision to implement
13. Ongoing implementation support and change management

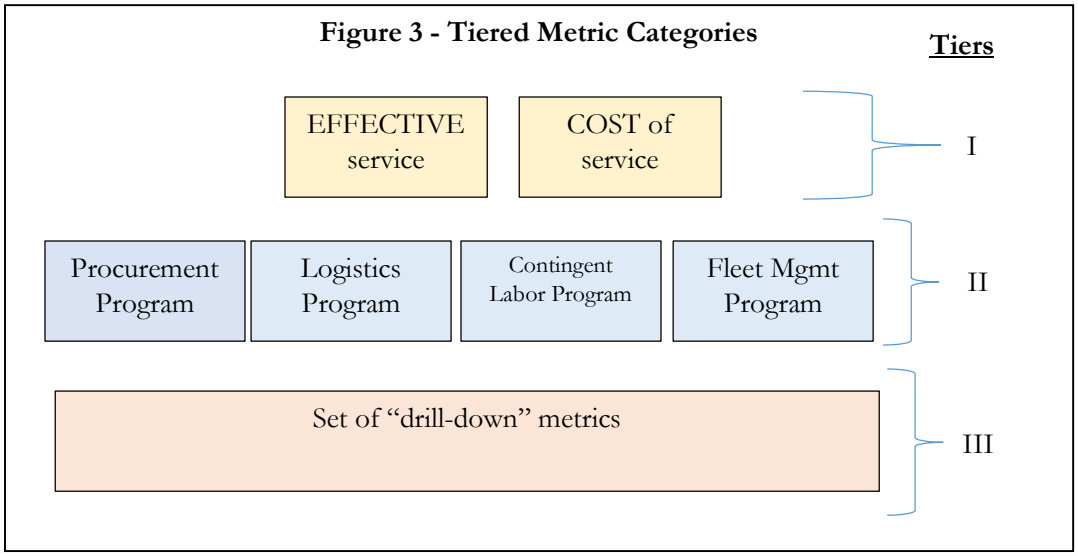
Outcomes and description of select KPIs

This initiative established a set of KPIs based on two categories:

1) Effectiveness at meeting internal customer needs, and

2) Cost efficiency of performing this service.

The workflow for reporting from the Division Chief to the Chief Operating Officer Executive is based on average performance of the Division programs within these two major categories. Each major category is composed of metrics specific to each program – these are used for reporting by Division Program Managers to the Division Chief and to internal customers. And for each program there is a suite of "drill down" metrics that are used for performance discussions and strategic planning within the Division. This hierarchy is summarized in Figure 3 below, followed by an explanation of some select KPIs.



Description of select KPIs

Procurement Program Cost is a second-tier metric that describes the cost-effectiveness of the procurement program's service. The KPI ratio is total spend value per buyer. Target range is $13M - $20M, based on industry benchmarks; target trend is upward.

Drill Down metrics associated with this KPI focus on objectives that support the trend goal, including:

- Bundled Transactions, given as the number of purchase transactions per $ of spend. More bundles are better, but bundling creates risk to the diversity of the vendor/supplier pool. (And pool diversity is a quiet driver of competitive pricing, among other benefits.) Because diversity risk should be managed in lock step with any strategic bundling, this metric is visualized and reported concurrently with the monthly and cumulative annual awards to small/disadvantaged business opportunities.
- Category Management, given as the percentage of total spend to managed spend. Managed spend is defined by pre-award review containing the stamped authorization by a designated Category Manager AND citation of the award in the registered Category Management Plan. Target is 80% or greater.

Procurement Action Time, a second-tier metric that describes the timeliness of Procurement's action to award internal customer requests. This is shown as an differential between request dates and award dates, by category and by requesting organization.

Drill Down metrics associated with this KPI are categorized by each of the customer Divisions within the organization AND by category of spend. A drill-down metric that's extremely useful to the customer is Wait Time, which provides a real-time expectation of the customer's experience "standing in line" while waiting for

award. Wait Time is based on current number of pending requests, current number of servers, and an approximation of arrival times - factors given by Queuing Theory. Another drill-down metric – Intake Reset – is intended to help manage the chronic practice by buyers of manually resetting the request date, which artificially improves the buyer's individual performance report. (This practice is being addressed by a change to use of this PAT metric in individual performance monitoring.)

Material Issue, a second-tier metric that describes the timeliness of processing an inventory material request to issue of the material to a project site. This metric risks being confounded by the questionable "need date" established by requestors as well as the artificial manipulation of inventory target levels by buyers. Initiatives to address these problems are underway and are being tracked by drill-down metrics.

Drill Down metrics associated with this KPI include measures of the entire cycle – from buyer requests, inventory pick, and internal freight delivery. To some extent, this performance can be constrained by Stock Out events, a risk that has led buyers to overstock inventory by artificially manipulating target levels. To help manage the relationship between these metrics, the data visualization for Material Issue also shows the running aggregate of Deadstock as well as explicit flagging of Material Issue events that were constrained by Stock Out.

Cost Savings, a second-tier metric in the category of cost effectiveness. The KPI ratio is total year to date savings, a roll-up from tracking tools of individual programs. The classification of these savings is given by the UPMG standard, which credits initiative such as a buyer's negotiation of prices requestor's independent cost estimate. Target is 2% of annual spend. The denominator of this target ratio is drawn from the more credible set of data from financial actuals, and therefore the prior year spend is used (instead of the running total of award dollars, which analysis has determined to vary by more than 25% over actuals!)

Drill Down metrics associated with this KPI include the important indication of competition in procurement. This is shown by the number of responsive and responsible bids received for each award, with a target of three determined by a principle of Game Theory in contracts. Another important drill down metric focuses on an initiative to disaggregate hidden costs of freight spend that's "bundled" into material and equipment orders by suppliers (enabling alternative logistics for such bundled freight represents an opportunity for substantial cost savings in material procurement prices paid). This drill-down metric is given as a percentage of material POs and alliance contract awards with an INCO EXW distinguished in the data record.

Other Performance Addressed by Metrics

Aside from the examples described above, other metrics were established at the second-tier and drill-down levels to provide meaningful measurement and management of important performance elements. Some of the noteworthy metrics address the following:

- Ability to manage scope creep, cross-sell, and up-sell in contracted project costs
- Vehicle fleet monthly out of service delays of prioritized equipment as a function of established maintenance down-time
- Cost to manage contingent labor (administration, system fees, and onboarding), visualized against the Staffing Industry Analysts (SIA) benchmark
- Fleet management total cost per mile; some aggregated historical data needed to be crosswalked and a cloud subscription needed to be purchased in order to form these metrics; those costs were considered in the cost/benefit analysis in design
- Warehouse cost per issue of material; this metrics was managed against the UPMG benchmark

Integration and implementation of this system

This system was deployed along with redesign of some selectively targeted legacy reports using data lineage tracing and translation to a Power BI star schema. The entire set of metrics was translated to a dashboard prioritized by business risk and equal relevance to division programs. The supporting roles of analysts were defined and incorporated into individual performance plans and position descriptions, and training was designed and delivered for analysts (in data modeling, report building, and data visualization) and for managers (in data literacy and data-driven decision making).

(the end)