

Using the NFR Framework in the context of the Balanced Scorecard: The Strategic Engineering of Public IT

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Abstract

We examine the unique application of the Non-Functional-Requirements (NFR) Framework within the context of a Balanced Scorecard used to measure, manage and identify gaps in the strategic plan for the Department of Technology (DoT) in the City of Columbus, Ohio. Specifically, the NFR Framework enables the examination of tradeoffs and relationships in the organizational engineering of DoT. This comprehensive framework provides measures and procedures in direct support of key requirements in public sector technology departments - continuous improvement, transparency, traceability, accountability, and alignment with other city government departments in the delivery of public value.

Keywords

Accountability, Adaptive Organizations, Balanced Scorecard, Continuous Improvement, Management, Measurement, NFR Framework, Organizational Design, Organizational Engineering, Public Sector, Sense and Respond, Strategic Planning, Transparency.

1. Introduction

In [4] we showed how a “Sense and Respond”[1] IT Strategic Plan for the Department of Technology (DoT) at the City of Columbus, Ohio, was developed from (a) business requirements and (b) Request-Execution-Delivery transaction analysis. The latter served to identify a unified applications portfolio that in turn drove, and subsequently, leveraged the technology architecture for the enterprise. We also recognized the “killer application” of the portfolio, namely the 3-1-1 “single-point-of-citizen-entry” system that has begun to serve as an *enterprise applications integration* framework, as well as a driver for organizational integration.

As DoT proceeded with the implementation of the Strategic Plan, however, we have learned that the plan missed certain elements². In order to remedy these gaps, while also putting in a framework to measure and manage impact and progress towards the implementation of the plan, we have begun implementing a Balanced Scorecard [2] for DoT that addressed the interlinked perspectives of Financial Control, Customer Satisfaction, Internal Business Processes and organizational Learning and Growth.

The step that logically follows in this process is the implementation of the Balanced Scorecard as a continuous improvement practice. Standard practice in such contexts is to analyze the organizational value-streams and business-processes that support these value-streams to find measures and metrics for the scorecard. However we were unable to find systematic approaches for doing the *organizational engineering* that is needed as DoT is morphed (a) in support of the Strategic Plan; (b) in support of the desired scorecard measures; and (c) in

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² In fact, one of the elements – the charge-back model for DoT services – an existing key strategic initiative in DoT, was not captured in the Strategic Plan or identified by the planning process.

support of performance improvement as the scorecard results were populated. This paper focuses on an exploration of the Non-Functional-Requirements (NFR) Framework [5] as an approach to conduct this organizational analysis and design.

We begin (in Section 2) with an overview of the Balanced Scorecard, the NFR Framework and other related work, and then proceed to a case study in the application of these frameworks in Section 3. Section 4 has conclusions and future work.

2. Related Work

2.1 *Linking Strategy and Performance: The Balanced Scorecard*

The Balanced Scorecard [2] is “a comprehensive framework that translates a company’s strategic objectives into a coherent set of performance measures.” It consists of forward- and backward-looking, external and internal measures drawn from four perspectives (1) Financial (2) Customer (3) Internal Business Process and (4) Learning and Growth. “Strategy maps” link these perspectives to business strategy [19].

In addition to the 5-forces (Customer, Supplier, Substitutes, Entrants and the Competition) Porter, in his influential work [3], introduces the concept of the “value-stream” that may be analyzed to identify where a company might create a competitive advantage. The value-stream notion exists in the Balanced Scorecard as well – as a model that can be analyzed to identify performance measures in each of the four perspectives.

Balanced scorecard in the public sector: Performance evaluation, particularly in the public sector, which does not face the same competitive pressures as the private sector, has often been viewed as a threat in spite of it being seen as an important aspect of successful service organizations [16, 17]. However, as local governments face constrained budgets and increasing demands for accountability and efficiency, public administrators have begun to focus on performance measurement and management [26]. Cities such as Phoenix and Seattle in the US implemented Service Efforts and Accomplishments Reporting (SEA) when the Governmental Accounting Standards Board (GASB) [18] began to encourage state and local governments to report on financial and non-financial performance.

However, the link between effort and outcome remains unclear, as Kaplan and Norton [2] point out, “outcome measures without performance drivers do not communicate how the outcomes are to be achieved.” The Balanced Scorecard has thus emerged as a popular decision support tool for strategic management in the private sector [19] and studies have begun to emerge on its successful implementation in the public sector [15, 20, 21, 24]. Case studies suggest that the Balanced Scorecard can also serve as a foundation for designing performance measurement systems using systems concepts [22, 23] for information systems management [25].

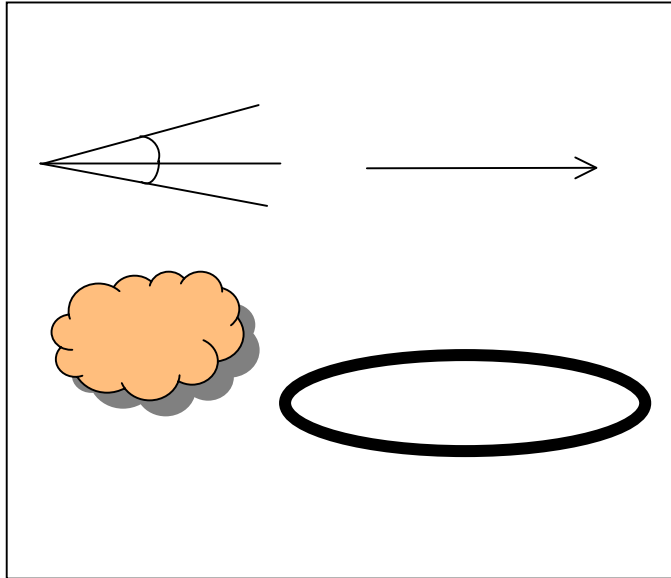
2.2 *The NFR Framework*

The NFR Framework [5] is a systematic, comprehensive and pragmatic notation and approach to building quality into software systems. In this framework, non-functional requirements (design requirements such as scalability, security) that describe *how* a system should deliver its function are captured in *soft-goals* that may be decomposed or *refined* and then *operationalized* by design elements typically drawn from a catalogue. The framework identifies and makes explicit interdependencies between soft-goals, as well as helps analyze tradeoffs where one operationalization may positively affect, that is, help implement (marked with a +) a soft-goal, while at the same time negatively affect, that is, detract from (marked with a -) another soft-goal. A subset of the Framework notation is shown in Figure 1.³

³ We have made a small change to the notation by choosing – for reasons of clarity - to use an oval with solid edges as an operationalization, rather than a cloud with solid edges as in the original notation.

2.3 Related Work on Public Enterprises and E-Government

Di Maio [14] states, “By year-end 2005, more than 80 percent of e-Government benchmarks that are based on traditional operational measures or developed for private e-business sectors will provide no (or limited) value to e-Government programs”. He also points out that “Through 2005, only governments that focus on enterprise architecture and back-office re-engineering will achieve their original e-Government objectives earlier than 2010.” Di Maio and Kost [13] explain that successful e-government strategies, going forward, will increasingly focus on other key elements, including interoperability, enterprise architecture, a multi-channel strategy, back-office re-engineering, performance metrics and integrated data management. “Data needs to flow across agency



boundaries as well as across tiers of government, but legacy systems and solutions, as well as turf issues, have made that level of integration difficult, if not impossible”.

Gartner’s strategic planning assumption is that “Through 2005, “e-government” for most agencies will consist of little more than a re-designed website with little or no business process transformation.”

Gartner’s Public Value of Information Technology (PVIT) framework for assessing the progress of an e-Government program complements the NFR Framework for the implementation of the IT strategic plan at the City of Columbus. Gartner advises, “Governments need to prepare for when e-government will simply be government.”

Thus the need for a comprehensive strategic plan and a systematic alignment and organization of technology departments like DoT to meet the challenge of these business/technology trends.

2.4 Other Related Work

There are other hierarchical analysis methodologies, most notably the Architectural Tradeoff Analysis Method [10]. In [11] this work is extended with remedial patterns that may be applied if the architecture of a system is found to be faulty.

3. Case Study: Applying the NFR Framework in the Organizational Design of DoT

Figure 2 is a graphical elucidation of the application of our comprehensive approach to DoT. This picture has been divided into four sections, mirroring the perspectives of the Balanced Scorecard. Each of these four perspectives generates soft-goals and their operationalizations, which are shown below in boldface.

The Financial Perspective: DoT’s primary customers are the other departments within city government⁴ to whom DoT provides a shared-service [7]. In common with other departments, DoT has to operate in a fiscally sound manner, and as a shared-service department, is required to work on a full cost-recovery model. Thus, **Fiscal Soundness** refines to **Full Cost Recovery**, which is operationalized by a **Charge-back Model** where the charges for each delivered service are determined, accumulated and charged against the budget of the customer

⁴ Such as the Mayor’s Office, Recreation and Parks, Public Utilities etc. For a complete list, see [6].

department (the charge-back process also *validates* **Strategic Alignment** – i.e. the alignment of IT services to meet the strategic objectives of city departments).

The Customer Perspective: DoT provides infrastructure provisioning and support for various city departments. This support includes desktop support, desktop and server application support and network support. For these departments, customer satisfaction implies responsive incident-management, comprehensive problem-management, supported by complete change and configuration-management. The industry best-practice standard for infrastructure management is ITIL [12], with the key ITIL processes subsuming those corresponding to the under-lined-requirements above. Thus we show **ITIL** as operationalizing the **Responsive Infrastructure Support** refinement of the **Customer Satisfaction** soft-goal.

Another refinement of Customer Satisfaction is **Transparency** - a key requirement for public organizations. In order to implement transparency from the outside, there must be, by definition, transparency within departments. But there is another reason for transparency. *Internal* shared-service organizations such as DoT have to be transparent to the other departments i.e. their customers. This transparency is essential because (typically) a portion of each department's budget is allocated internally to the shared-service, and because the allocation is internal there is constant pressure to reallocate the money back to the customer department. In the absence of such transparency, it would be difficult to explicitly indicate the shared service that is "bought" by this internally allocated budget. Thus we show **Cost Allocation** as operationalizing the **Transparency** soft-goal. Also note that **Cost Allocation** is a component of the **Charge-back Model**. Note that while it is **Cost Allocation** that delivers transparency, and may be used independently of charge-back, cities have often blindly implemented a full charge-back model when their real need for Transparency would have been sufficiently operationalized with **Cost Allocation**. In fact, **Charge-back** negatively impacts **Customer Satisfaction** because it positions DoT more as a vendor than as a partner Department. The fact that it contributes both positively and negatively to soft-goals means that the **Charge-back Model** is a *tradeoff* (that DoT has chosen to make).

Finally, Customer Satisfaction refines to **Strategic Alignment**, which is operationalized by the Business, Information, Operations and Strategy (**BIOS**) template ([4]) that is maintained (and hence operationalized) by the **Account Managers** to document, model, and analyze their customer departments and to derive their IT requirements.

The Internal Business Process Perspective: The soft-goal here is termed **Continuous Improvement**. This soft-goal is operationalized by **Request-Execution-Delivery (R-E-D) Analysis** [27] and by **Enterprise Architecture**. It also refines to **Improved Infrastructure Processes**, which is operationalized by **ITIL**.

The Learning and Growth Perspective: DoT personnel need to understand technology, understand the customer and learn best practices. We operationalize the **Technology** soft-goal with **Technology Training** and the **Customer Awareness** soft-goal with the **BIOS** document. We also show that **Enterprise Architecture** operationalizes both these soft-goals. Note that **Technology** could negatively impact **Fiscal Soundness** because of the inclination of the IT personnel to implement the newest and oftentimes expensive and risky technology.

Finally, we show **University Partnerships** as operationalizing the soft-goal of **Best Practices**.

4. Concluding Remarks

We believe that using the NFR Framework within the context of a Balanced Scorecard will serve us very well in modeling, analyzing and engineering DoT. The Framework has made explicit the linkages and trade-offs between the various soft-goals and their operationalizations and enabled us to clearly visualize, and therefore systematically analyze, design and engineer the DoT organization. Its combined use along with the Balanced Scorecard has already been helpful in finding gaps in the Strategic Plan. Thus, we believe it will expedite the transition from performance measurement to performance management and continuous performance improvement.

Our next step is to use this approach to fully implement the performance scorecard for DoT. We plan to report on the questions raised by this implementation. There are other elements and extensions of the Framework that we expect to find of value – such as the extension by Yu of the NFR Framework with an “actor dependency” model for use in Business Process Reengineering (BPR)[28] that captures intentional dependencies between stakeholders. The potential use of a catalogue of operationalization methods found by mining organizational *patterns* [8] is also of interest. Finally, note that an intent of the NFR Framework was to create an automated knowledge-based system for automated goal-driven organizational design. Other systems [9] have also attempted such design.

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