Integrating Goal Modeling and Execution in Adaptive Complex Enterprises

Abstract

Complex Enterprises consistently struggle with successfully gaining benefits from Enterprise Architecture (EA) initiatives for a variety of reasons, one of them being an end-to-end *integration* between enterprise goals and operations that links goals to the *dynamic operations* of the organization. In this paper we describe (a) our conceptualization of the Adaptive Complex Enterprise (b) our integrative notation and semantics for goal modeling and linking for such organizations and their operations and (c) an example drawn from an embedded industry project.[1]

Categories and Subject Descriptors

K.6.1. [MANAGEMENT OF COMPUTING AND INFORMATION SYSTEMS]: project and people management – *management techniques, staffing, strategic information systems planning, services, services engineering*

General Terms

Management, Measurement, Enterprise Architecture, Sense-and-respond, Goal, Goal-modeling

Keywords

Accountability, Adaptive Complex Enterprise, Autonomic computing, Continuous Improvement, Lean, Transactions, Workflow, Services Science.

1. Introduction

The Collaborative for Enterprise Transformation and Innovation[2] is an Ohio State University initiative that develops *actionable* frameworks, tools and methods in the areas of technology application, technology management, software engineering education and information-technology-based innovation, and enterprise architecture (EA), through *direct* engagement with technology companies in the State of Ohio. These are large, multinational, "technology-consuming" companies whose primary business may be characterized as delivering services – such as banking, insurance, financial, education, health-care, telecommunication and governmental services.

Our interactions with these companies have shown that they struggle to show success in their Organizational Engineering (OE) related initiatives – primarily complex Enterprise Architecture (EA) and Service-Oriented Architecture (SOA) initiatives[3]. There are documented reasons why EA projects have limited success [Kamogawa05] with the primary ones being: (a) a lack of well-defined, measurable improvement goals that *align* the services delivered at every level of the organization, its components and its infrastructure both to and from the strategy of the organization and (b) the lack of "actionable" methodologies to guide and direct implementations that appropriately reflect these goals, in the presence of ongoing *operations and legacy components*. In today's highly-dynamic service-oriented economy, there is a critical need for *prescriptive* and *evolutionary* methods to improve the performance of services and service delivery in a manner that enables "sense-and-respond" [Haeckel99].

In our research to date we have introduced a conceptualization of an Adaptive Complex Enterprise (ACE) as a collection of Request-Execution-Delivery (RED) transactions between the customer[4] and provider roles [Ramanathan05] supported by services provided by the organizations and systems of the enterprise. In [Ramnath05] we showed how the RED transaction conceptualization at the City of Columbus allowed us to develop a sense-and-respond [Haeckel99] strategy for each of its service-providing organizations consisting of an organizational re-design, creation of an enterprise IT application portfolio, and identifying 311 as the single key, integrative, enterprise initiative. In [Ramanathan07], we presented a health-care case-study where we characterized *delivery* challenges related to *mixed-mode* (i.e. human and IT) *services* and illustrated improvements achievable through the application of Lean RED analysis, at the Ohio State University Medical Center. This method essentially extended the ACE representation scheme for mixed-mode systems with principles of Lean analysis. This analysis was based on virtual transactions supported by "eWorkcenters" that associated compositions of IT infrastructure services and physical resources to business services. We showed how the scheme was deployed in the context of existing enterprise systems and emerging technologies to reduce the time to install new PCs. The objective was essentially met by quantifying the interactions between global Lean goals and local autonomic (self-managed) goals to achieve continuous improvement.

Our contributions to the state of the research and practice to date have been the applications of the Adaptive Complex Enterprise (ACE) transaction-based representation and method for overall system improvement that integrates techniques in computer science and systems engineering to enable *a unified modeling, analysis* and *performance improvement* approach for *services*. In *this* paper, we propose the *integration* of goals - goal modeling, refinement, operational linking, measurement and management - into the ACE framework for use in continuous improvement of sense-and-respond complex enterprises. We begin (in Section 1)

[1] This work has been supported in part by a 2006 IBM Faculty Award

[2] http://www.ceti.cse.ohio-state.edu

[3] We see EA and SOA methodologies enabling OE through the integrated engineering of the business, its organizational culture and design, its processes and the supporting technology, thus operationalizing organizational efficiency and development. We see the end objective of the discipline is to produce visible, positive results of significant consequence and magnitude within a time frame that is useful to the entity being addressed.

[4] Both internal and external customers.

with an overview of related work. In Section 1 we characterize the problem. In Section 4 we provide an overview of our conceptualization of the Adaptive Complex Enterprise. In Section 1 we describe our approach to goal integration, and in Section 1 we describe its application. Section 7 has conclusions and future work.

2. Related Work

There is a wide-range of related work that applies but is currently not integrated for practice. Work in defining and operationalizing business strategy includes 5-Forces analysis [Porter79], the Balanced Scorecard [Kaplan96], and Strategy Maps [Kaplan05]. Work in aligning EA transition planning with low-level implementation planning and execution includes [Armour01], with the emphasis here being that these two activities should be treated separately. Relevant work in modelling includes [Penker00] which uses an extended UML notation for business and business-pattern modeling. Goals provide the basis for defining the priorities of an organization for the purpose of identifying activities that can accomplish these goals.

Another body of relevant work is enterprise architecture frameworks such as [Zachman], several with a focus on change management and related governance of complex IT systems. Two important examples gaining momentum especially in Europe are ISO20000 (standard, also referred to as the ITIL best practice for IT services delivery) and TOGAF [TOGAF] (based on earlier works like CIMOSA). ITIL or IT Infrastructure Library is a collection of well-document processes for the support and delivery of IT services. Much of the early work was derived from change management of engineering systems. TOGAF (The Open Group Architecture Foundation) focus is primarily on technology implementation rather than the dynamic operational behaviors to be achieved. The DOD-endorsed TOGAF represents one of the more widely accepted frameworks for service-oriented architectures. It is a consolidation of early work that began in 1983 though the European Commission's ESPIRIT initiative and Zachman's work [Zachman]. As with most standards and best practices ITIL and TOGAF are presented as process steps and requirements that determine the 'what' and do not dictate the "how" of a specific representation scheme of the enterprise that is to be improved. (This is rightly so, in order to remain widely applicable). However this also leaves much to the individual's interpretation in an enterprise-specific system improvement program and, thus, each project is done on a case by case basis, by different integrators.

The business strategy literature also contains work on goal modeling, such as the VMOST technique [Sondhi00], captured in the BRG-Model (Figure 1) from the Business Rules Group [Kolber00]. and further analyzed in [Bleistein05]. The final set of objectives typically includes a sub-set of maintenance objectives, a sub-set of improvement objectives ("increase sales conversions to 25% of initial leads" or "reduce customer retention costs to less than 10% of total sales"), and (we mention this for the sake of completeness) potentially reductions in certain objectives ("reduce new mainframes sales"). Note that objectives have related *measures* (qualitative ratings or quantitative metrics or both).

Next of relevance is work done at IBM on the Component Business Model [Cherbakov05]. This work explains how companies may make themselves more agile by architecting themselves as collections of interacting components. We see this work as providing a complementary organizational design perspective of our work.

Several goal modeling and specification techniques such as KAOS [Dardenne93], Goal-Based Requirements Analysis Method (GBRAM) [Anton96], i* [Yu93], and the NFR Framework [Chung00], have been proposed in support of requirements engineering and related activities such as elaboration, consistency and completeness checking, evaluation of alternatives, and evolution. The NFR Framework initially focused on system requirements, but has been extended [Subramanian06] to connect enterprise architecture goals to system architecture goals, and can potentially be extended to connect enterprise strategy goals.

Of special relevance are [Kavakli06] which proposes an integrated top-down and bottom-up approach to identifying misaligned goals and planning organizational change, [Jureta06] which describes a method for associating goals with justifications and [Mei07] which uses goal-models to guide the adaptation of pervasive systems to changes in the environment.

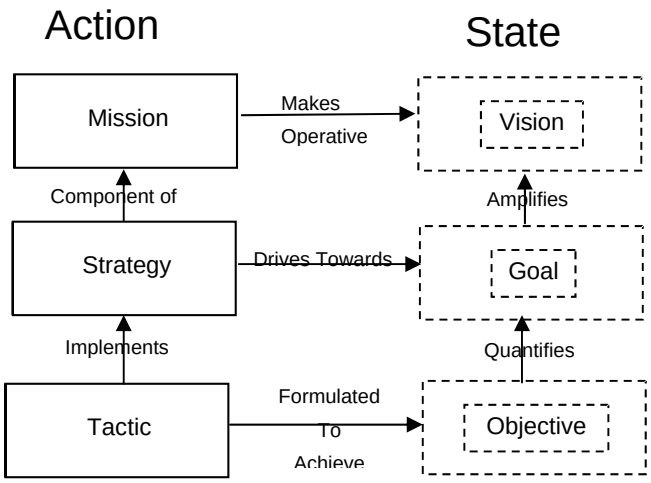

Figure 1. Elements of the BRG-Model

This considerable body of work, however, needs to be extended for use in the *dynamic, sense-and-respond* environment in which service-oriented organizations exist. This implies the linking of goals *to and from* the *dynamic behavior* of the organization, including the linking of on-going business processes, their execution by resources, and the performance of the business transactions. This is the gap that we address in the work presented here.

3. Problem Characterization

Service organizations rely heavily on enabling Information Technology (IT) and underlying components. However, such systems are getting increasingly complex and the introduction of technology does not automatically mean that services will improve. When attempting to align organizational goals with

service-delivery components in an end-to-end manner, the major challenge to be addressed is the conceptualization of the many-to-many relationships and service-based interactions between organizational goals, processes, organizations, applications, and enabling IT components (Figure 2). Note that the motivation behind this conceptualization is: (a) understanding the alignment among strategic goals and organization and infrastructure operations so as to (b) implement new services or improvements to existing services whose performance can measurably indicate the achievement (or non-achievement) of these goals.

Within an organization, there are many goals across the many dimensions (or groups of stakeholders) that have to be aligned. In Figure 3, we show the dimensions of the business with a range of strategic goals and operational goals. In a sense-and-respond organization, operational goals are achieved through business transaction execution while strategic goals must be met by *continuous improvement* cycles (i.e. not through disruptive large-scale re-organizations and so on). Note also the categorization of the goals by the elements of the Balanced Scorecard.

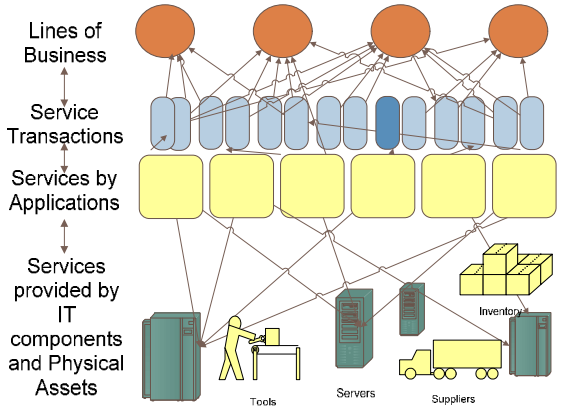

Figure 2. Many-to-Many Relationships between Enterprise Entities (Human Resources, Physical Assets, IT Systems and processes)

Characterizing the Complex Enterprise: In most service-oriented organizations (emergency rooms, engineering change, custom processing, customer help desks, IT service delivery, returns, and so on) service delivery and holistic service improvement is challenging because of complexity due to:

- Increasing variation (types and numbers) of non-routine requests whose processing needs are not completely known at request origination.
- The need to manage many-to-many service customer-provider relationships that occur between processes, organizations, agents, enterprise systems, and assets.
- Need to synchronize mixed-mode services - services provided both in the physical world and electronic world - to have performance impact. For example services can include those in the physical world (e.g. assembly, inventory management, installation); those in the electronic world (e.g. inventory management, work order management, workflow); and those provided by knowledge agents and assisting tools (e.g. requirements gathering, design, applying rules for effective triage).
- Shared services: Services today are increasingly enabled by other shared services provided by mix of human and IT "agents". These include electronic workflow, designers, suppliers, data management, knowledge sources and underlying IT infrastructure components.
- Global coordination: Often these services are remotely delivered (for example across the globe or with hand-held devices) and must be coordinated.
- Need for dynamic processing: Due to the request variation in requests, it becomes necessary to treat each non-routine request on a case-by-case basis and be able to address the discovered requirements.

We call systems with these characteristics "Complex". In large part, Information Technology (IT) itself has enabled increasingly Complex systems, and has also been a contributor to the complexity. Ae say a system is 'Adaptive' if changes can be made incrementally, locally and in short duration.

Characterizing Organizational Engineering within the Complex Enterprise As we mentioned earlier, a major issue inhibiting successful delivery of services is the lack of bi-directional *integration* with enterprise goals in a validated manner. There are 5 aspects to this integration: (a) goal identification (b) goal refinement (c) goal prioritization (d) goal implementation and (e) goal validation, all for the successful delivery and improvement of services. (a) has been reasonably well-studied in the goal-modeling literature, we finesse (c) by leaving it to future work, and, as mentioned before, we have shown how (d) may be accomplished [Ramnath05, Ramanathan07]. Thus (b) and (e) - the top-down linking of goals to the operations of the organization

Figure 3. Goal Traceability Across the Enterprise

and the bottom-up measurement and validation of goal achievement - remain, and are the focus of this paper.

4. Conceptualization of the Adaptive Complex Enterprise – The ACE Framework

We first briefly introduce our conceptualization of the Adaptive Complex Enterprise (ACE) and its representational methodology. To begin with, Figure 4 shows the basic notion of an activity, as described in ([IDEF0]). Figure 5 shows the fundamental component of ACE – the RED *transaction* [Ramanathan05] that extends the IDEF0 activity. We define the RED transaction for each type of request as an abstraction that focuses on *what* the process does and its performance (but not on the process details

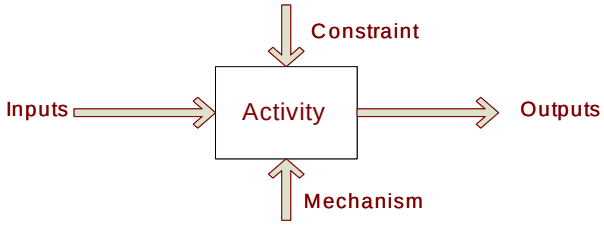

Figure 4. IDEF0 Activity Model

and variation). Each RED abstraction is defined as follows:

- Request, Execution, Delivery milestones of business processes. The Request milestone defines the 'customer' requirements that the provider commits to deliver on. Execution milestone is achieved by the agent services used and performance-level achieved while producing the deliverable. The final delivery milestone is achieved through satisfactory performance within the customers' environment.

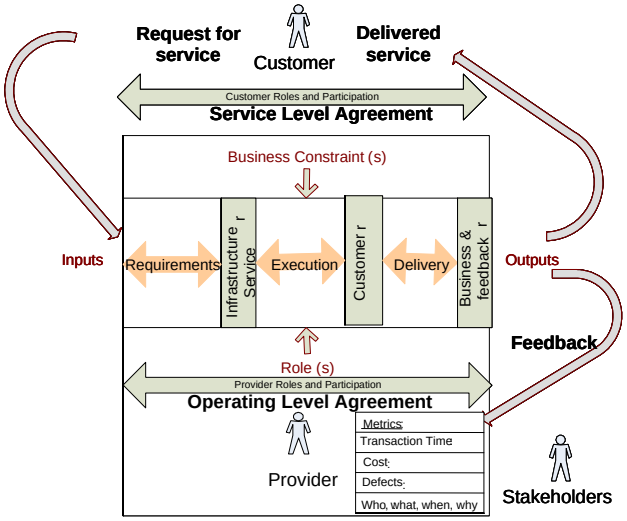

Figure 5. RED Transaction with Metrics

- The eWorkcenter roles or collection of abstract capabilities that must together provide the services (i.e. the mechanisms) that produce the RED deliverable (outputs). The roles identify underlying infrastructure services but not the "how."

Examples of primary (main) REDs in an organization include order-to-cash, procure-to-pay, engineering change, and incident-to-resolution. A RED is typically initiated by filling a Request. A request may also be known as an order, a work order, an admittance form, an incident report, ticket etc. RED type abstractions can be assembled dynamically to form a structure. That is at any point during the execution of the R, E, D steps, new Requests can initiate sub-transactions that complete *unanticipated* sub-deliverables. That is, a primary transaction is achieved by internal customers and providers, on behalf of an external customer. In the medical center example, this included unanticipated cabling, additional PCs, a non-standard image on the requested PC and so on.

A RED transaction abstracts the basic functioning of the organization that creates and delivers value-add from the perspectives of each of the dimensions of the organization. Essentially, transactions *operationalize* and are *constrained by* the goals of an organization. Note also that goals are shared by and jointly met by transactions.

In Figure 6, we show the relationship between transactions and resources, through the conceptualization of an eWorkCenter. This virtual concept is a composition of required roles that are needed

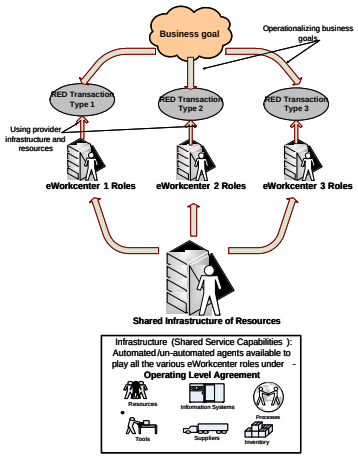

Figure 6. Business Goals, Transactions and Resources

to provide services to complete a RED transaction type. There is an eWorkCenter for each RED transaction. This concept is again quite similar to aphysical work-center with the needed tools and agents. But there are also some differences, as follows:

- These roles are dynamically bound to available agents at some point before execution. Thus a role is simply a placeholder that allows us to delay the association between a service requirement and agent with the needed capabilities.
- Since a shared infrastructure agent can fill roles in many different eWorkCenters, available capacity is more fully utilized.

Finally, we note the existence of dimensions – the Environment, Business, Business Process, Execution and Infrastructure dimensions. In each dimension, different perspectives, concerns and measures hold and different stakeholders are relevant. For more details, see [Ramanathan05].

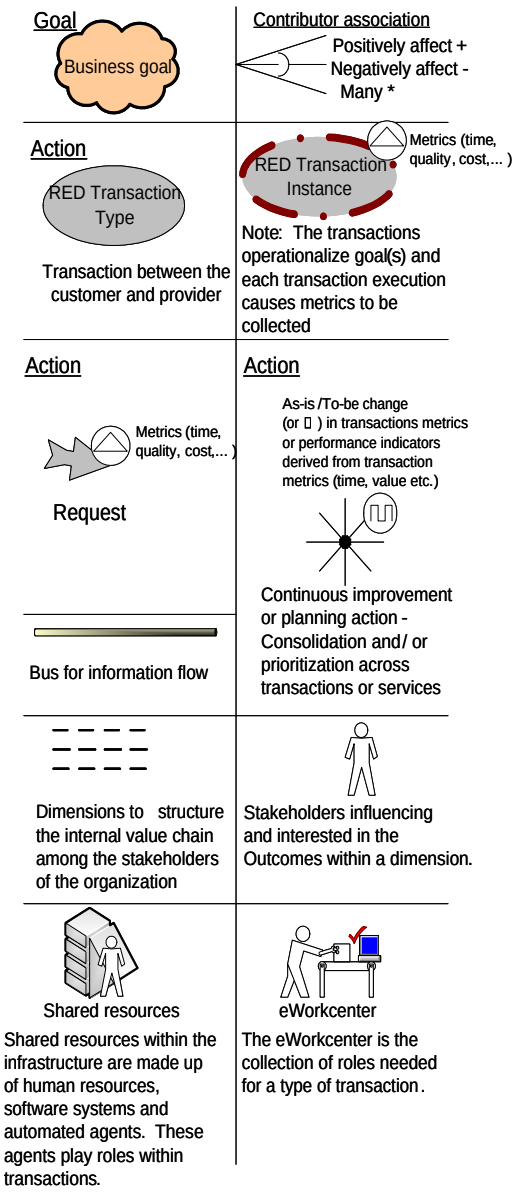

Figure 7. ACE Notation for Goal Integration

5. Incorporating Goals and Continuous Improvement

Given our focus on service delivery and continuous improvement, we now present our notation and semantics for integration of goals with services (figure 7). To begin with we have the concepts of a (soft) Goal and goal refinements (this is similar to the NFR Framework). We specialize actions into 4 classes – RED Transaction Type (an abstraction of a business process definition), a RED Transaction Instance, Request actions, and a Continuous Improvement action. We also represent Dimensions, eWorkCenters, and the Shared Resources that are dynamically bound to the roles in an eWorkCenter. Finally, note that all actions (such as Requests or Transactions) have performance indicators or quantitative metrics.

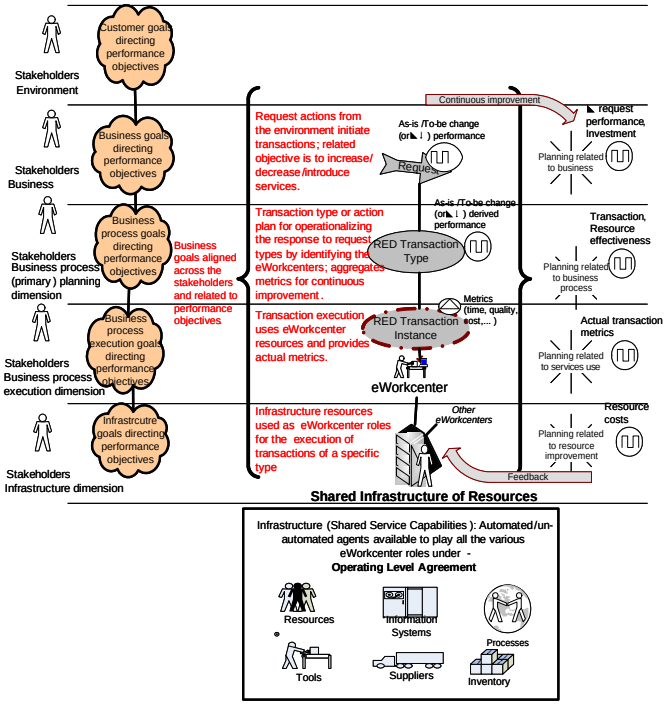

Figure 8. Goal Model Template

A generic goal model template that relates the concepts and elements of our notation is shown in Figure 8. This template refines and extends goal modelling concepts to the dynamics of the enterprise – i.e. to Business Processes, Transactions, eWorkCenters and Resources – while incorporating the goal refinement concepts extant in the literature referenced. Note also, that for readability reasons similar to those expressed in [Bleistein05] we have separated the concerns of stakeholders, goal refinement, operational actions and continuous improvement actions into their own vertical swimlanes.

6. Example Application

Figure 9 connects and elaborates the concepts described herein with a slice of a comprehensive example drawn from the City of Columbus. In a manner similar to the generic goal modeling template we split the figure into 4 vertical sections. In the first section are the *operational* goals placed in the dimension of primary stakeholder interest and linked across dimensions. Note that because this example is of a public institution where the key stakeholder is the resident and voting citizen, the effectiveness, quality and transparency goals are in the Environment dimension. Had this been a profit-making business, these goals would be in the Business dimension. In this dimension, and because of the non-profit nature of the City, the goal is one of cost-recovery, rather than profit. In the Business Process dimension process quality and effectiveness matter as aggregated over each process *type* and in the Execution dimension, goals are quality and effectives at each transaction instance. In the Infrastructure dimension what matters is the appropriate and cost-effective support provided to the dimensions above.

In the Actions column, Business dimension, the City has decided that resident satisfaction depends on the appropriate changes in the trends captured as an increase in the number of public events (known as Neighborhood Pride events), an increase in the

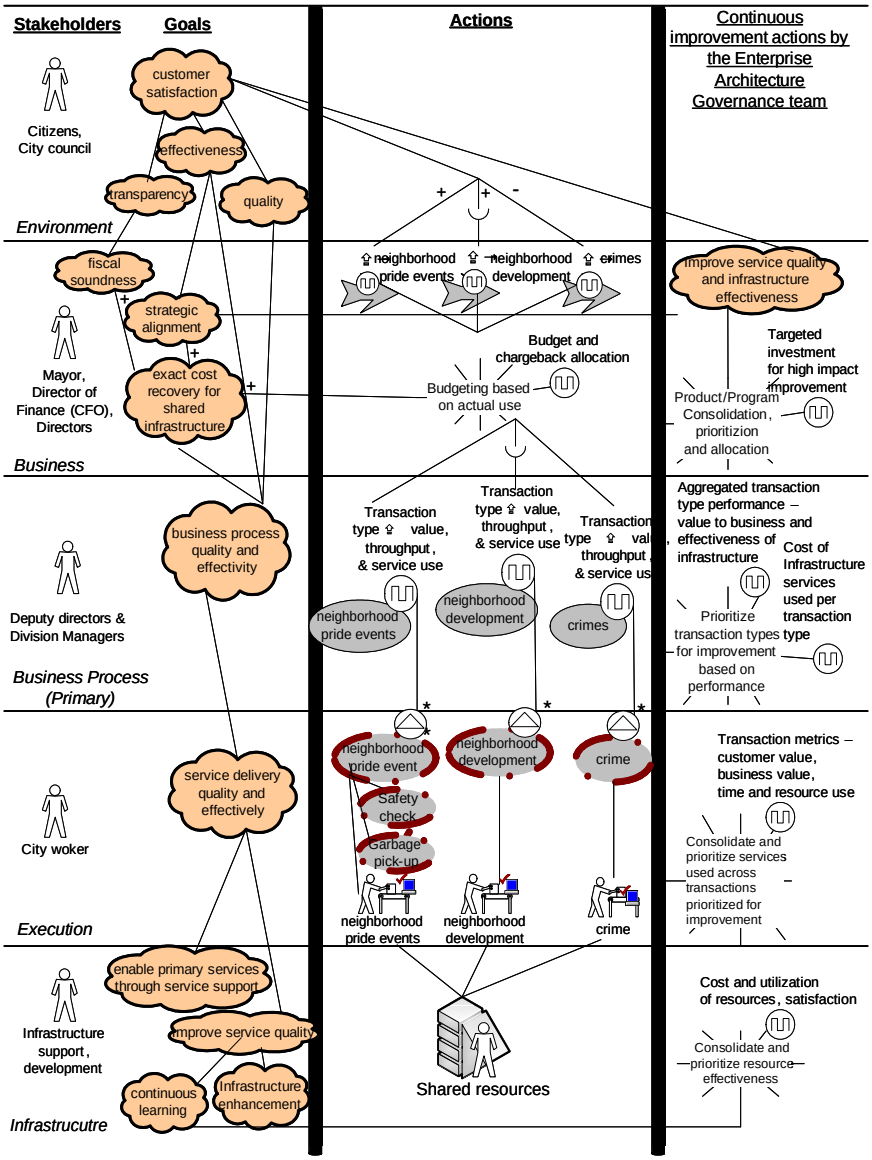

Figure 9. Sense-and-Respond Model for the City of Columbus

development investment in selected neighborhoods and a decrease in crime rates. Hence focusing on improving measures for these actions becomes, in turn, actions at enabling dimensions below.

Further, the City is allocating its operational budget across these actions, and has also instituted a "charge-back" model in order to demonstrate accountability and hence transparency. As we go down the dimensions, these high-level actions are supported by Business Processes and individual execution Transactions. A key point here is that the run-time metrics (also known as the "actuals") are collected for each individual transaction, aggregated at the Business Process dimension across each Process Type and further aggregated and/or synthesized across all processes to impact the Customer Satisfaction goal. Note also that going down the dimensions, the individual transactions are supported by eWorkCenters corresponding to each transaction and bound as needed to the Shared Resources of the City. These shared resources could be IT resources or human resources.

Finally, we move to the last, Continuous Improvement column. Note how the Continuous Improvement actions vary by dimension; in the Business dimension the focus is on the service mix and quality delivered to the resident, in the Business Process dimension it is on *process* quality and cost of the underlying infrastructure, for the Execution dimension it is the prioritization of the infrastructure services used, and in the Infrastructure dimension it is cost and resource utilization. Note that here also, metrics flow up the dimensions to be aggregated or synthesized at each level.

Some high-level consequences of the model are:

- An articulation of the goals and actions that can be shared among the business and IT stakeholders for improved communications.
- Performance information gathered for more subjective prioritization and actions, thus contributing to alignment with goals.
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More precise identification of all the aspects of the transaction (e.g. eWorkcenter roles and competencies) that have to be improved in the shared infrastructure dimension before goals can be met.

7. Conclusions and Future Work

The ACE concepts may be applied to several areas of EA concern. These include identifying components – both IT and organizational – to outsource and identifying areas of business innovation by examining the different perspectives in each dimension. Once linkages among the components in each dimension are modeled, the dynamics of the organization may be simulated. With appropriate tool and data support, this model can also become the functional representation of the organization's management dashboard. Through modeling the binding between the transactions, eWorkCenters and resources, the engineering of service-level-agreements (SLA) and the operating level

agreements (OLA) on the shared resources may be better accomplished. The end-to-end and bi-directional linkages also allow the analysis of the benefits and costs of goals for use in goal prioritization. Finally, we are also working on formally defining ACE composition semantics.

8. Acknowledgements

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