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Method for Continuous Generation of Component Business Model Heat Map using Execution Data for a Complex Service Enterprise

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Abstract

Component Business Models (CBM) and manually synthesized heat maps have been used successfully by IBM Global Business Solutions to develop logical models that assist strategic decision-making. A key aspect of CBM is the layered intra-enterprise approach that identifies Execution, Control and Direction. However, the performance relationships between these layers can be a challenging to compute algorithmically, because of the typical 'impedance' mismatch between the underlying models and metrics used at these layers. In this paper, we introduce a meta-model related to microeconomics and Activity Based Costing – which we call the Interaction model. We show how this algorithmically relates operational execution data; to CBM heat maps for large scaled service-oriented systems. We use production data from the city of Columbus' 311 system (a one-stop request handling system for city services) to illustrate the value of this algorithm in generating the heat map to help service investments and other dashboard type applications.

Keywords - *Component Business Model, service-oriented systems, Interaction, decision-making rd*

1. INTRODUCTION

Motivation for Integrating Component Business and Adaptive Complex Enterprise Frameworks: Generating a heat map is the most important capability of IBM's Component Business Model © from an organizational decision-making perspective. A heat map highlights those components that need immediate attention [1] with respect to a variety of issues ranging from strategic decisions, resource allocations, technological architecture, performance after mergers and acquisitions, prioritizing transformation initiatives and unlocking value through identification and creation of new solutions. However, the process for generating a heat map is often manual, subjective and top down, which makes it difficult to use as a tool for continuous improvement.

Here, we integrate CBM with the Adaptive Complex Enterprise (ACE) Interaction Method to generate a heat map algorithmically from operational data. We show the benefits of our approach by applying it to a highly complex services organization – a major city. An *Interaction meta-model* establishes traceability between operational level interactions and its effect on the generated heat. The model captures the shared nature of resources used across components. Finally, it enables the heat map to serve as a dynamically updating dashboard, tracking the health of business components.

Benefits and Application of Methodology to 311 and a Complex Services Enterprise: A key factor in the success of public institutions today is the implementation of e-governance: the application of communication and information technologies to the organization and its operations [2]. Incorporating such technologies is definitely desirable, but little is known about how this can be done systematically to achieve desired results. This is a challenge because of the sheer size of public institutions and the large variation in services needed by the citizens. Complications also arise because there is no single institution (e.g. city, state, etc.) responsible for functioning of the entire enterprise. Suggestions for achieving this include: deployment of large-scale sensor networks across cities, converging various public agencies through a high-speed information network [3] and so on.

Answering this need are leading players - like IBM [4] with their "Smarter Cities", Cisco's "Smart + Connected Communities" [3], Siemens [5] and their "Green Cities" initiative, the Federal Broadband initiatives, and National Science Foundation's Cyber-Infrastructure initiatives. Thus, there is a growing interest in contributing to this field, from academia as well as the corporate sector. The overall goal is delivering citizen services through an interconnected government enterprise.

An important aspect of an e-governance strategy, that generates important operational data, is the call-center. Considerable time and effort has been expended [6] in analysing emergency service calls like the 911 service. A lot of call center research also focuses on trying to maximise the number of calls that can be serviced. However, little work has been done on developing insights about the operational

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efficiency of an organization using this data. Not only does our work introduce this perspective in general, but it also highlights the use of such analysis as a part of the e-governance strategy.

Outline: The remainder of the paper is organized as follows. We introduce basics about the CBM, followed by a discussion on heat map analysis in the first section. The second section talks about Activity Based Costing and other methods used for accounting services. We discuss our approach to achieve traceability while generating a heat map in the third section, and follow it with a description of the 311 service in the city of Columbus. The fourth section describes a case study and illustrates our approach.

1.1. Component Business Model

The Component Business Model from IBM [1] is a structured representation of different components in an organization along the dimensions of competencies and accountability. Flaxer et al. [7] state that CBM is an aggregation of models, methods and techniques that are designed to organize, understand, evaluate, and ultimately, transform an enterprise. It offers a simplified view of large-scale enterprises and is a foundation for discovering both inefficiencies and strengths towards strategic growth.

Definition of CBM: A component is a part of an enterprise functioning independently and having its own business purpose. A component can provide services to other components in the organization as well as to external entities. These components are arranged in a grid in which columns and rows have an associated meaning. The columns of the grid are competencies of the organization that characterize the different areas in which services are provided by the enterprise. The rows are the accountability levels, which characterize the abstraction and impact of decision-making associated with the components. There are three pre-defined accountability levels.

1. **Direct**: These components of the topmost layer govern the strategies for the organization and define policies for other components.
2. **Control**: These components monitor performance and manage unexpected events.
3. **Execute**: These "worker" components leverage infrastructure and provide value to the customer.

1.2. Heat Map Analysis

Different approaches have been implemented by organizations to accomplish this task. In a case study of Queenstown Lake District by IBM, workshops and interviews were conducted to assess the current state and identify the pain points [8]. IBM in collaboration with Department of Defence (DoD) worked on the Business Management Modernization Program aimed at identifying transformation opportunities within DoD [7]. They applied various evaluation criteria like return on investments (ROI), cost effectiveness, system and application use and technical maturity level, to business components in order to develop an understanding of the strengths and weaknesses of the business. It is also possible that senior executives in the enterprise follow best practices to develop benchmarks within and across components [1]. There have been cases where the approach was as subjective as taking a vote on the effectiveness and strategic value of each business component [9]. Fisher et al. proposed a method [10] to calculate the business importance of entities in a service-oriented enterprise using dependency diagrams and probabilistic analysis. To the best of our knowledge, there has not been much research in developing a systematic approach towards the generation of heat map and its analysis.

1.3. Some challenges in generating the heat map

Not all capabilities have well defined components in each of the three accountability levels – i.e. Direct, Control and Execute defined in the CBM. This is one of the challenges faced while translating an organization into such a model. It often happens in large organizations, especially in government enterprises where a hierarchical organization is followed, that the CBM becomes narrow in the Direct layer. There exist fewer decision-making components that are shared across a number of capabilities and the components that build these capabilities. This observation holds true at the component level, as it does at the organization level. There are a number of shared resources used by organizations, which cannot be mapped precisely to one component in the CBM. The role of these shared resources towards a particular event of interest in the organization is hence not captured by the CBM.

This observation was also made by Fisher et al. in [10] where they state that, although it is possible to assign business importance to entities using key performance indicators, it is unclear how such importance should be delegated across business components. As we will describe further in this paper, it is the *contention over these shared resources* that may be the cause of business concern for some components. The main idea behind generating a heat map is to identify the components that require immediate attention [1]. If resource contention is responsible for a component being of concern to the organization, it should be represented correctly in the CBM. However, use of subjectively derived evaluation criteria like ROI, throughput, cost-effectiveness, etc. across individual components might produce a heat map that is far from reality. The analysis of such a heat map may result in identification of the wrong component or the wrong capability or even the wrong accountability level.

Another observed limitation of the heat map is its static nature. The heat map generated using the CBM of an organization is generally analysed in the context of an immediate transformation opportunity. The heat map highlights the components that need attention in a single colour, say red and a single shade of the same. Hence, the heat map is used as a mechanism for *reactive* analysis. However we believe that the CBM methodology can also be used as a proactive system. It can be used as a monitoring dashboard that updates itself dynamically with interactions taking place across business components. The result of these interactions will change the degree of concern associated with each of the business components. This change therefore needs to be captured in the heat map with changing shades of the highlighting colour in the CBM, indicative of the varying degrees of heat across components.

This problem is closely related to what is widely referred as the impedance mismatch problem [11]. It highlights the difficulties faced while translating real world data into a model. The impedance mismatch problem has been discussed in depth in the context of mapping relational data into an object-oriented model. An enterprise model is the computational representation of the structure, activities, processes, information, resources, people, behaviour, goals and constraints of a business, government or other enterprise [12]. Therefore, the scope of enterprise modelling in representing data is extremely large and complex. We believe that the impedance mismatch problem does exist in enterprise modelling as well. Loss of traceability is an undesirable consequence of impedance mismatch, where we define traceability as the intelligence to map an event and the entire set of components (including their underlying activities) responsible for its cause. Traceability and heat map analysis are thus two sides of the same coin. Traceability may be horizontal across capabilities, or vertical across accountability levels in a CBM. It is the loss of traceability, in the process of shaping an enterprise into an enterprise model like the CBM that we address in this paper.

2. RELATED WORK

2.1 Activity Based Costing

Large public enterprises offer different types of services to their customers. Over the last few decades, there has been a substantial growth in the number of service-oriented companies. The cost analysis of such enterprises requires special attention. Traditional costing models have been useful for many years in the past and will continue to be useful even today, for mundane tasks like inventory analysis, etc. However in today's competitive era, costing models are expected to do more. They must provide insights on profitability analysis, process improvement and evaluation of overall company performance. Activity Based Costing (ABC) introduced by Johnson and Kaplan in 1988 [13] has changed the way cost of services is calculated and is considered one of the top management tools today. ABC has a process centric view of an enterprise that accounts for variable costs of activities conducted by different business components. According to [14] the ABC methodology of accounting is a three-step process. Firstly, the cost of resources is assigned to various activities performed by a component.

A cost driver models the rate at which different activities of a component consume resources. A cost object represents a service offered by the component. In the second step, ABC assigns activity cost to these objects. An activity driver measures the rate at which an activity contributes to the cost object. The final result is a service; the cost of which is based on the activities that ultimately produce the cost object.

The consumption of a shared resource in any organization is always unequal. It is therefore necessary that impact on business components due to the skewed nature of this consumption should trace back accordingly. This is precisely the advantage of ABC. ABC makes the use of cost drivers and activity drivers (which can be percentage values) that model the nature of a shared service. ABC is a fine-grained analysis of an organization that contributes to traceability analysis. It also analyses the contribution of various components in delivering a service. In the sections that follow, we present an approach that leverages the capabilities of ABC to achieve traceability in CBM and enterprise models in general.

2.2. Other work

There has been a lot of work related to the use of component business models in developing a transformation strategy for enterprises [7] [8] [9]. The idea of applying CBM for identifying transformation opportunities in the public sector is not new [15].

Cherbakov et al. have stated [16] the need to explore methodologies for strengthening the linkage between the business KPIs (Key Performance Indicators) and their reflection in the services provided by the organization. They also point out the need for tightening the coupling between business and operational considerations in IBM's Service Oriented Modelling and Architecture. In order to address this issue, an automated heat map analysis was suggested by Lee and Ivan, using their value centric model – VIOLA [17]. VIOLA uses a semantic engine powered by ontologies for intelligent inferences. This work is closest to what we are trying to achieve. However, our methodology is different from VIOLA in a number of ways. While it uses a value centric approach, the investigation is specific to dependency analysis and shortfall assessment along the IT domain. Our approach uses call center data to identify the components that need immediate attention. This is a much more objective way of analysing the heat map. It is closer to linking the relationship between the value delivered by an enterprise to the customer using the available infrastructure.

The IT Infrastructure Library (ITIL) version 3 [18] proposes the concept of service based costing that is very similar to ABC. The goal of service based costing is to account for all direct and indirect costs associated with the services offered by an organization. The use of service based costing then enables an organization to climb up the levels of full-cost maturity model.

Portfolio management is also an important proposition in ITIL. It focuses on the ability of an organization to adjust investments based upon a feedback mechanism built into the organization. Closely related is the concept of Balanced Score Card relating infrastructure-to-operations-to-customer satisfaction [19] and provide traceability. It enables monitoring of relationships at a fine grained level and makes use of this analysis for continuous improvement. Our model is very much in coherence with the ideas of portfolio management and the balanced scorecard.

3. INTERACTION META MODEL

3.1 ACE and RED Interactions

The Adaptive Complex Enterprise (ACE) [20] is based on a fundamental concept of microeconomic transaction that we call an Interaction. ACE models a service request-driven enterprise and associated transactions that provide these services. We describe the ACE interaction meta-model in context of a complex services organization, made up of multiple business capabilities, each handling many types of service requests. Starting with the organization's customer service or call center (e.g. 311) that accepts service requests, we model each of these service requests as a RED Interaction type and instance. Every incoming request is categorized into one of many Interaction types. Each business component has a defined set of Roles, which make use of certain resources and is responsible for handling a subset of Interaction types. Based on this Interaction type to business component mapping, an incoming service request is triaged as a RED Interaction towards the right business component for closure. We next describe the CBM enhanced with the ACE model.

Requests and Interactions: When a customer service Request comes in, each Interaction brings together resources to complete its Requirements-Execution-Delivery (RED). The Requirements milestone is governed by the customer's needs that the organization agrees to deliver. This is typically gathered at the 311 call-center. Resources within the responsible components achieve the Execution milestone by collaborating within the organization for production of deliverables. The final Delivery milestone is accomplished by ensuring satisfactory performance in the customer's environment.

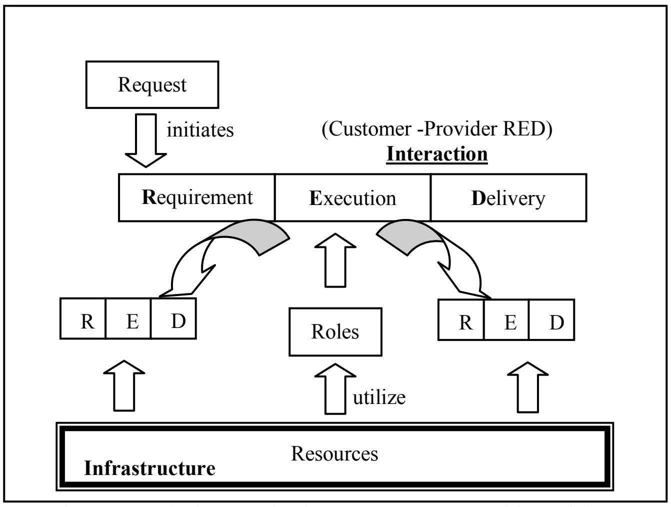

Figure 1: Typical Interaction between customer-provider and the RED millstones that are points of measurement of resource use.

Each of these Interactions can evolve dynamically, such that every Interaction during its execution in either of its R, E and D steps can spawn another sub-Interaction to ensure completion of the parent. A RED Interaction (Figure 1) thus abstracts every communication milestone that takes place for the closure of a service request.

Roles and Resources: ACE defines Roles as a collection of competencies that collaborate together to achieve desired results during the Execution phase. The association of Roles and resources can take place on the fly. Therefore, Roles are placeholders using which organizations achieve mapping between infrastructure competencies and service requirements. Finally, a resource is a physical (human, equipment, etc.) or virtual (software, document, etc.) asset that is assigned for some duration of the Interaction.

Therefore, when we talk about Interaction and its Resources, we are talking about a workflow abstraction that produces value by 'consuming' resource time and cost. Next we show how to relate this to business components in a traceable way.

3.2. Integrated CBM and ACE

An ACE organization is a set of capabilities containing components that own and execute Interactions that are resourced by assets in an infrastructure as shown in Figure 2Figure 2. This achieves traceability between an Interaction, the cost and capacity of its resources, the component and capability that it contributes to. An Interaction (type and its instances) is thus horizontally traceable to the capability that owns it at the Direct layer, manages it at the Control layer and processes it at the Execute layer. We can also trace from the accountability layer to the specific component and finally to specific resources used from the infrastructure. Note that the cost of an Interaction is dependent upon the availability of resources (management, administrative, operational; as well as physical and virtual) across all the three accountability layers. We define the cost and heat (value) contributions of an Interaction type in the next subsection that follows.

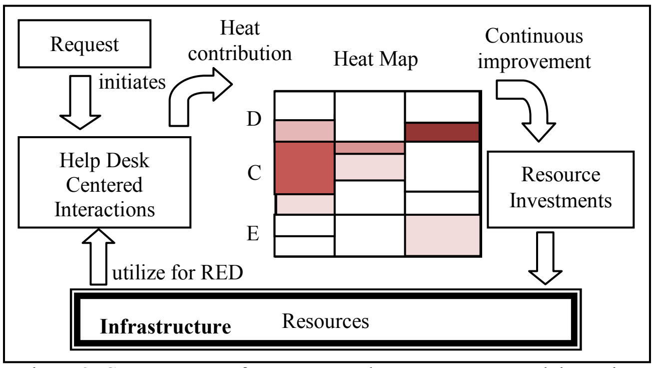

Figure 2: Components, Infrastructure and Resource usage and dynamic update in heat map.

Heat contribution of Interactions: The amount of heat contributed by an Interaction type is dependent on 1) the average response time of its instances, 2) the number of instances and 3) the cost of resources that contribute towards the closure of those instances. The time required for the closure of a particular type of request, the number of requests received and the average cost required to close a request is dependent upon the nature of the Interaction type and its complexity. Hence, associated with every Interaction type there are thresholds for each of these parameters. For a period of time under observation, we define $C_{threshold}$ as the maximum resource cost that is acceptable for the closure of a service request corresponding to an Interaction type. Similarly we define thresholds for maximum response time $T_{threshold}$, maximum number of requests processed $N_{threshold}$. Using these thresholds and actual values associated with costs, time and number of request we calculate the deviation of actual values from these thresholds as

$$\Delta C = C_{actual} - C_{threshold}$$

Similarly we calculate deviation corresponding to response time ΔT and number of requests ΔN. Interestingly however, it is not always that an organization would like to reduce the number of requests. It may happen that certain Interaction types are encouraged by the enterprise. For example consider the case of a city government, which is a public enterprise. The city would like to reduce the number of calls associated with clearing potholes on roads. However, it would encourage calls that request reservation of city owned halls for private functions since it contributes to revenue. Therefore, we introduce a parameter Ψ, which accounts for this desired increase or decrease in the calls associated with an Interaction type.

Traceability of an Interaction: An Interaction type is said to contribute positive heat, if it either incurs more cost than expected (a concern of the Control Component); or consumes more time than an acceptable threshold (a concern of the Execute Component); or receives more (or less) requests than expected (a concern of the Direct Component). Heat associated with the CBM can therefore be modelled as:

$$heat_{InteractionType} = f(\Delta C, \Delta T, \Delta N, \Psi)$$

Component Cost due to its: Interaction Types: We can now describe the cost of a component considering all its contributing Interactions. The cost *rcost* of any (virtual or physical) resource type used by a component is accounted for, by a factor *f*. This resource type may or may not be a shared within and across components. Let there be *p* types of resources in the infrastructure (Figure 2) that are available across all components. The value of *f* may be any non-negative real value that reflects the units of capacity used by that component. It would be zero if a resource type is not used by the component. Hence the total cost of a component is:

$$C_{component} = \sum_{i=1}^{p} r\cos t_i * f_i$$

Using the above equation, we can define the cost of a capability in the CBM. Each of the components resides in one of the three accountability layers – Direct, Control or Execute. Let the sum of costs of components at the Direct layer for the k^{th} capability be C_D. Similarly let C_C and C_E be the costs at the Control and Execute layers respectively. The Cost of the k^{th} capability is then defined as:

$$C_k = C_D + C_C + C_E$$

Constructing the Cost of the Organization: As the last step, we assume that there are *m* capabilities defined, in the organization's CBM. Hence, the total cost of all resources to the organization can be computed by summing across all the capabilities.

$$C_{total} = \sum_{i=1}^{m} C_i$$

Note that we have used a bottom up approach to defining C_{total} using the cost contributions of each Interaction. Often this data might not be initially available in a city, since the activity-based accounting has a related data collection overhead that most organizations might not wish to embark upon. Nevertheless, there is time accurate response-time based data collected at 311 to which costs can be related as follows. Let there be *n* service requests or instances of Interactions processed by the call center of the enterprise in a time period of observation. Average cost of an Interaction is then defined as:

$$C_{Interaction} = C_{total} / n$$

3.3. Model driven decision support

Note that our heat function has the parameters of cost, time, number of requests, and desired increase or decrease. At an extreme we can achieve the goal of minimum time through unlimited resources that contribute towards the completion of an Interaction. However the *optimal* decision for investment in infrastructure resources is not trivial. Consider the realistic scenario where a decision is made to invest in a single instance (e.g. an employee) of a single resource type (human resource). An organization seeks decision support to identify the right capability business component in the appropriate accountability layer to invest in this resource, so that *heat* is minimized.

More generally, infrastructure investment decisions for multiple resource instances of more than one type make the investment choice even more complex. Therefore our proposed methodology is useful along two directions: Firstly, it can be used as a continuous monitoring mechanism that tracks the health of business components. Secondly, it also acts as a predictive system, which can provide insights about the impact of an investment on different components.

Consider an illustrative scenario where an organization performs a comprehensive analysis of received service requests and the time required to close them. After this analysis, a decision *d* is to be made for investment towards some resources, in order to reduce the response time of a certain service request type. Let there be a set *D* of possible decisions because of the options described in the end of the preceding section. The investment will have a result of increased cost ΔC and also a possible expected change in time Δt required for closure. Using these changes it is possible to calculate the change in heat Δ*heat* for that request type and hence an overall change in efficiency of the call center. Each decision *d* in the set *D* will result in a different Δ*heat.*

<table>
<tr><th></th><th>Development</th><th>Administration</th><th>Health</th><th>Public Safety</th><th colspan="2">Public Services</th><th>Public Utilities</th><th>Recreation</th></tr>
<tr><td rowspan="2">Direct</td><td>Planning and Zoning</td><td>Mayor’s Office</td><td rowspan="2">Environmental Health</td><td>Fire</td><td rowspan="2">Transportation</td><td rowspan="2">Refuse Collection</td><td>Power and Water</td><td>Forestry</td></tr>
<tr><td>Housing</td><td>Finance Director's Office</td><td>Police</td><td>Sewage and Drains</td><td>Parks</td></tr>
<tr><td>Control</td><td>Building Services</td><td>Finance and Management</td><td>Health Support Services</td><td>Fire Administration</td><td>Planning & programming</td><td>Refuse Management</td><td>Energy and Water Management</td><td>Facility Management</td></tr>
<tr><td rowspan="4">Execute</td><td rowspan="2">Code Enforcement</td><td rowspan="4">Mayors Action Center</td><td>Disease Prevention</td><td>Investigation</td><td colspan="2">311 Call Center</td><td>Electricity</td><td>Park Maintenance</td></tr>
<tr><td rowspan="2">Environmental Hazards</td><td rowspan="2">Patrol</td><td>Traffic Maintenance</td><td>Refuse Operations</td><td rowspan="2">Billing Services</td><td rowspan="3">Sports Facilities and Events</td></tr>
<tr><td rowspan="2">Customer Support</td><td>Inspection</td><td>Rumpke</td></tr>
<tr><td>Food Safety</td><td>Support</td><td>Parking Violations</td><td>Keep Columbus beautiful</td><td>Water</td></tr>
</table>

Figure 3: Component Business Model for the 311 service at city of Columbus.

We can model the optimal decision of investment that minimizes heat as:

$$d_{opt} = \arg\min_{d \in D} heat_D(d)$$

Hence, the optimal decision d_{opt} would be a member d of the possible set of decisions D, such that it minimizes the heat (and hence maximizes efficiency) generated in the CBM.

Application Considerations: From the set of equations stated above, we summarize the following: The optimal decision of investment in resources is the one that minimizes the heat for handling Interactions in the organization. This efficiency is a function of the cost of Interactions, the time required for their closure and number of requests received. These Interactions may take place across different capabilities in the CBM. The cost of an Interaction calculated for a single capability is the sum of costs of resources, factored by its amount of shared usage at the Direct, Control and Execute layers. Therefore, a variation in the availability of a resource(s) will result in the variation of cost, which in turn will affect the heat of handling Interactions.

This variation in availability of resources and its effect on the contributed heat largely depends on the type of resource in which the organization decides to invest. We define three types of resources: 1) existing shared resources 2) existing dedicated resources and 3) missing resources. It would be easy to imagine that an investment would have the most desirable impact on efficiency, if it were made towards a missing resource having maximum impact. If we consider the variation in availability of a shared resource it will have an effect on all of the components that share the resource. The amount of change in this heat would depend upon the distribution that governs the sharing of that resource. This is exactly what our model tries to achieve using the factor f defined in the first equation.

By establishing such traceability of *heat* towards investments at the granularity of an Interaction, the organization can observe its effect in a dynamic fashion. Considering these observations, it is possible to adapt to these changes and modify the resource availability, such that desired efficiency is achieved. Thus, using this model an organization will be able to have a dynamic heat map in place that updates in real time with every service request received and closed by the call center.

4. Methodology Applied to the 311 Service

As a part of the Mayoral 2012 Vision, the government of the city of Columbus decided to shift from being an “order taker” organization to a “sense-and-respond” organization. In order to achieve this goal, the Department of Technology (DoT) along with researchers from Center for Enterprise Transformation and Innovation (CETI) [21] at The Ohio State University have been studying the implementation of the Adaptive Complex Enterprise (ACE) [20] framework. An earlier study concluded that the public services of the city would benefit greatly from a networking approach around 311 [22]. This conclusion is very similar to what IBM suggests [4] independently in their Smarter Cities vision. 311 is a one-stop call center for various non-emergency needs of the citizens of Columbus. It is neither an emergency response system like 911 nor is it a 411 general enquiry helpline. Rather, 311 is a networking service that coordinates the 19 departments, 20 divisions and more than 40 sections that contribute towards the welfare of the city. 311 caters to more than 550 types of services.

4.1. Case Study Background

We have a log of the helpdesk requests received by 311 from January 28, 2005 to May 16, 2011. These are a total of 1,088,866 records. Each record is a service request which has information along the dimensions of request ID, date request ticket was opened, name of the agent who opened the ticket, current status of the request, the date of status, incident date, name of department to which request belongs, division name, section name, name of the role to which request has been referred/assigned to, the type of service request, comments, location of requests and related comments and its property type and customer name.

4.2. ACE CBM Application for Decision Support

First to obtain a conceptual architecture, we modelled the various departments, divisions and section at the city of Columbus using the CBM. (It should be noted that the intent of this activity was purely academic research with some guidance from IBM as well. No profit was involved whatsoever.) The generated model with the most prominent capabilities and important components is shown in Figure 3. In addition, extensive interviews were conducted with leading personnel of each component [22]. These were primarily aimed at assessing the current the infrastructure of each department and identifying missing resources. Information was gathered along four dimensions of business, infrastructure, operations and strategy.

Figure 4 shows a summary of the capabilities comparing employed FTEs, request types and associated call statistics. Figure 5 summarizes the missing services, their impact on business components and number FTEs considering the shared nature of these services. It should be noted that the above table is a summary of the data that we have collected for every business component.

Capability	FTEs	Request Types	Incoming requests (calls/day)	Average Response Time (days/call)
Development	291	78	72	16
Administration	266	39	1	6
Health	400	32	1	12
Public Safety	3892	26	19	10
Public Service	783	43	503	6
Public Utilities	1290	33	23	9
Recreation	269	13	31	16

Figure 4: Capabilities, their Infrastructure resources, workload and performance.

There is no trivial relationship between any of the columns. Although Public Services receive the largest number of calls on a given day and of a various types, their response time is one of the lowest. Public Safety, although has the largest number of FTEs does not have the lowest response time. Development handles the largest number of request types with a mid-size FTE strength, but has a fairly high response time. These observations reiterate the need for a sophisticated analysis of the service requests at the call center. Based on the data collected through interviews, we identified the missing or desired services in each business component. We also calculated the number of FTEs and business components that are affected if a *missing* service was installed.

The model in section 3.3 refers to the decision-making problem involving the choice of the right investment. The above missing services are a subset of the different infrastructure investment options available for improvement in the organization. As discussed earlier, there could be possible investments in existing shared or dedicated resources.

Missing Service	**FTE impact**	**Component Impact**	**Shared?**
Mobility	4208	17	Shared
Security	4208	17	Dedicated
IT	4288	23	Dedicated
Communication	4033	15	Dedicated
Online support	3845	19	Shared
Budgeting	2353	9	Dedicated
Report Generation	3182	12	Dedicated
Procurement Management	2935	17	Dedicated
GIS	2205	12	Shared
Document Management	2353	10	Shared
Integration	3182	6	Dedicated
Extended 311	1418	7	Shared
Inventory Management	2473	6	Shared
Monitoring	1980	3	Dedicated
Document imaging	1965	3	Shared
Tools/software	1244	11	Both
Business Process Improvement	1359	7	Dedicated
Work order Management	1166	4	Shared
Outage Downtime	1666	2	Dedicated
Documentation	832	5	Dedicated
Automation	775	3	Dedicated
Encryption	416	2	Shared
Change Management	63	3	Dedicated
Marketing	27	2	Dedicated
Infrastructure	41	2	Dedicated

Figure 5: Missing services and their impact

Unfortunately, as is the case with most organizations, we do not have any details regarding the use of these shared resources. Therefore, the cost contributions to each of the components could not be determined. The data associated with ΔT and the resultant increase in resources was also not available. Hence we could not perform extensive calculations.

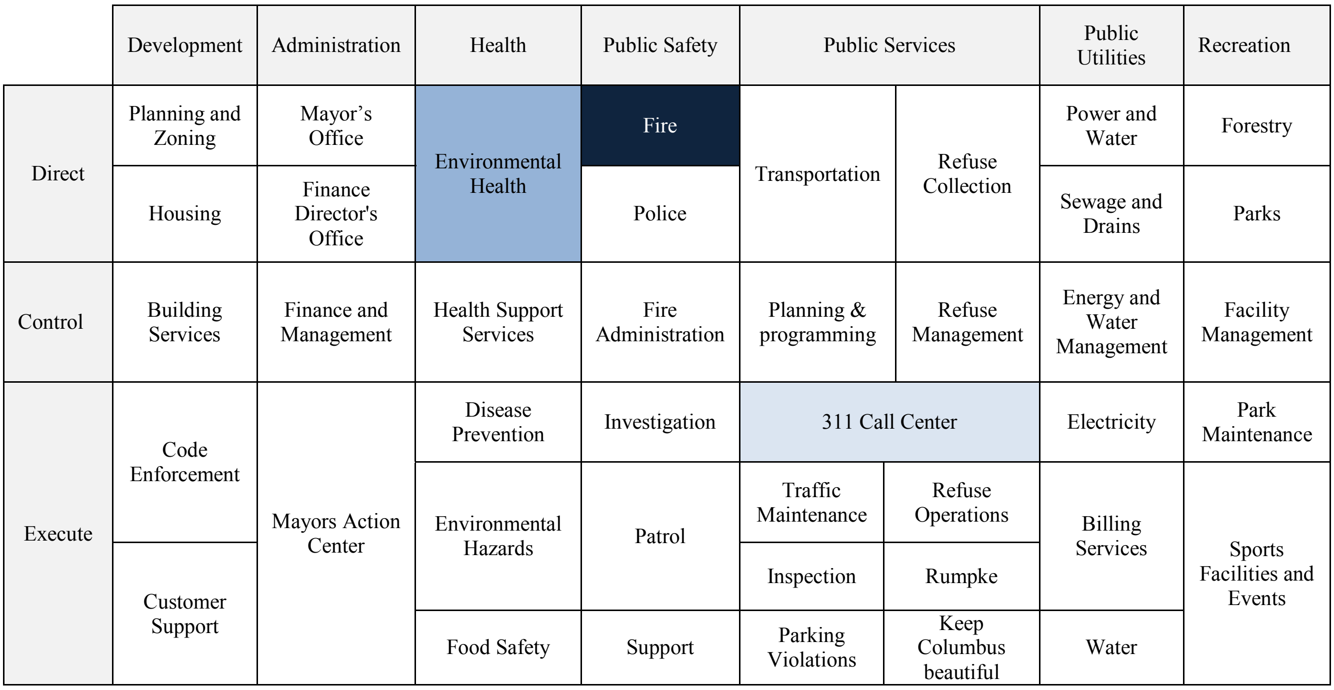

Figure 6: Impact of providing "Monitoring as a service".

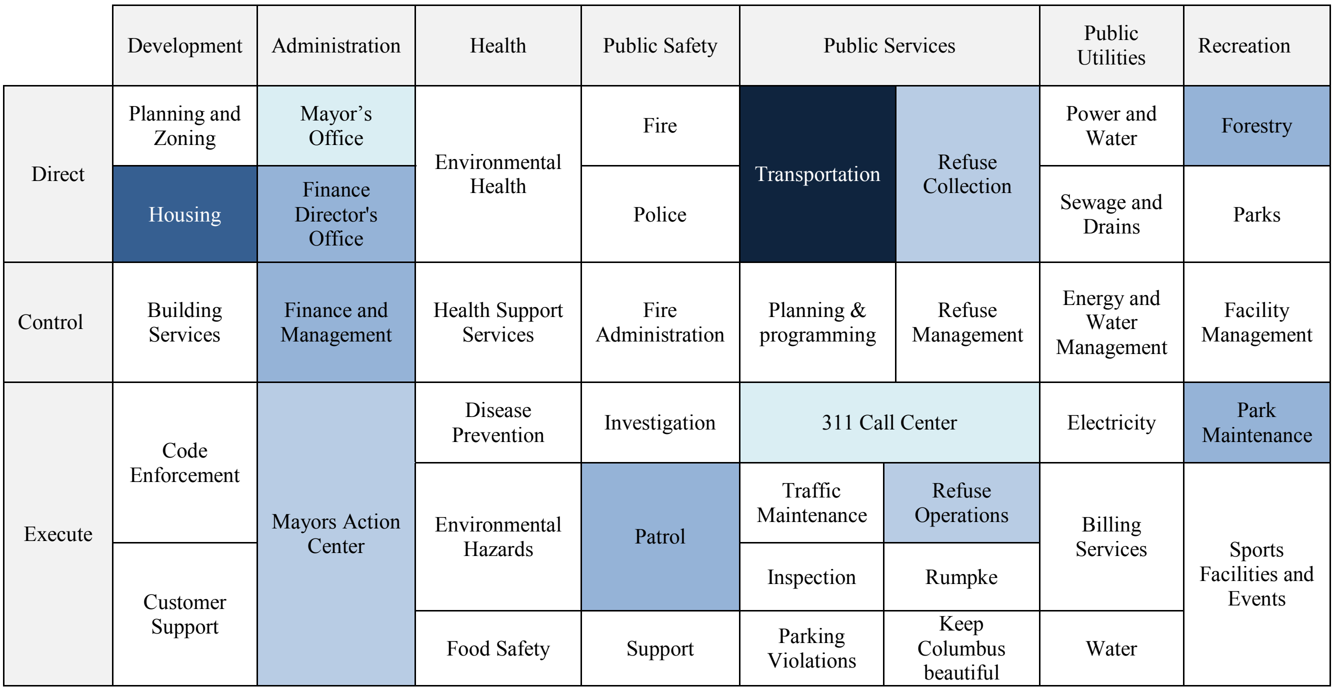

Figure 7: Impact of providing GIS services

However, we noted that the change in heat is dependent on the change in interaction cost ΔC and change in response time ΔT. Recall that the change in cost is the sum of products of *rcost* and factor *f* across all resources. Cost would therefore increase with an increase in number of resources. Similarly, the change in response time is the sum of times consumed by all the resources. Hence, time would also increase with an increase in the number of resources involved for co-ordination. It is important to note that both of these parameters influencing the change in heat, are dependent on the number of resources involved in the Interactions.

In this case of the 311 call-center, we did have data about the human resources (FTEs in Figure 5). Using this data, we could make a rough estimate of the needed investment in missing services required to effect maximum change in heat Δ*heat*. Another factor involved in heat is cost. If an investment is chosen such that it affects maximum FTEs and incurs minimum cost, we have a fair judgement of the investment that can result in minimum heat. Also to reiterate, as discussed earlier, our model provides decision support along two dimensions. Firstly, for estimating current heat in the CBM and secondly, for analysing the impact of investments in resources, across all *components* in the organization. We can now illustrate the second part of decision support through two examples. Figure 6 shows the impact of installing monitoring services in the 311 service. As stated in Figure Figure 5, there would be three components impacted by this missing service. The impact within each component is dependent upon the number of employees associated with that component. Based on the data available through interviews, the impact is shown in varying shades of colour, where darker shades signify larger impact and lighter shades imply lesser impact. Similarly, Figure 7 illustrates the impact of installing GIS services in 311 networking. We observe that GIS services have a larger impact on the organization. It is also seen that these services have an impact that is considerably uniform in the different CBM capabilities. For example, almost all components in Public Services (Transportation being largest) and Administration are impacted. On the other hand, the impact of Monitoring services is quite scattered, across different capabilities.

CONCLUSION

We have shown that the integrated CBM-ACE model presented here allows an organization to assess the value of provided services and gauge their performance in a dynamic fashion. Our work proposes the use of the CBM heat map analysis technique as a continuous monitoring mechanism. It makes use of customer-facing help desk data which is commonly available in large enterprises today. This is a paradigm shift from CBM's traditional use as a reactive methodology for identifying transformational opportunities. We use ideas from the ABC technique to introduce a model that can achieve traceability into the various business components in an organization and resources used by them. The efficiency of an Interaction is modelled as being dependent upon different resources at the Direct, Control and Execute layers. The optimal choice of investment in these resources in order to maximize efficiency is framed as a decision theoretic problem. We illustrated the possibility of applying our methodology at the city of Columbus for the 311 service.

FUTURE WORK

In this paper we presented evidence for applying our proposed methodology for the 311 service. By inserting select points of measurement within the organization, we wish to gather the missing data and implement the complete methodology which results in a decision support system. The effect of cost and time are currently the main factors considered for analysing Interaction efficiency. It would be worthwhile to observe and compare the effect of investments in shared and dedicated resources. This would be particularly interesting when a large number of components need a dedicated service as compared to large number demanding a shared service.

The use of call center data for developing insights into the operations of an organization is a way of internal analysis. It is also necessary to find out how the external world feels about the provided services. A popular topic of research among the research community is sentiment analysis. Most of the work research aims at inferring the type of sentiment – positive, negative or neutral, associated with an organization, its product or service in terms [23]. There is a wide range of research in developing different types of techniques to achieve this goal. However, the action to be taken in view of this sentiment is still a manual decision-making process. We wish to develop a system by which public sentiment about the government of a city can be inferred by mining social network data, news articles and blogs. Further, a framework would be established that can co-relate this external view of the services along with the insights about the internal view described in this paper. This framework would serve as a sophisticated mechanism for measuring the health of services offered by the government of a city.

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