

A Systems Approach to Stakeholder Engagement in Accountability of Regional Universities

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Abstract

Broadly stated, accountability for a regional university is value created versus cost. Value reflects social and economic needs of the community, state, and region. Cost of creating value is cost of implementation strategies to achieve institutional goals. The state's higher education coordinating board, a university board, and faculty senate are proxies for engaging community, state, and regional stakeholders in institutional accountability. Complex endogenous and exogenous challenges require an effective means for allocating resources within the organization, monitoring effectiveness of institutional strategies, and, as necessary, adapting strategies to ensure institutional accountability.

This paper examines these issues and recommends an organizational platform and analytical tools to administer institutional accountability. The approach originates from the quality movement proposed in the 1990's by W. Edwards Deming for reinventing government as a customer-driven service and an adaptation of the Federal Government's Office of Management and Budget, Congressional Budget Office, and Government Accounting Office. Advantages of the proposed environment are an increased emphasis on institutional accountability and quantifying institutional risk.

I. Background

Regional institutions face increasingly complex challenges affecting accountability that include technological changes, political uncertainties, financial stability, demographic shifts in student populations, and cultural issues [1]. Dynamic response of the organization to these accountability challenges requires leadership adept at establishing a well-defined institutional strategic plan, allocating resources within the organization, monitoring effectiveness of the response and, as necessary, adapting strategies to ensure the response reflects institutional accountability.

From Buhrman's discussion [2] on institutional assessment and accountability, the definition of accountability includes documented formative and summative assessment techniques to evaluate instruction. Focusing on the definition of value created (purpose) by an institution, accountability also includes:

- 1) High cost of education and lack of incentive to improve productivity.
- 2) Decreasing ability of graduates to think critically, write well, and solve problems.
- 3) Reporting on students' educational performance.
- 4) Institutional innovation and pursuit of "entrepreneurial" methods of growth.

Broadly stated, the primary measure of accountability for a regional university is value created versus cost of creating value. The value of higher education reflects social and economic needs of the community, state, and region. Very often, the state's higher education coordinating board, a separate university board, and the faculty senate are proxies for engaging community, state, and regional stakeholders in institutional accountability. To inspire sustained stakeholder support, the institution must also effectively

communicate the importance of institutional efforts on behalf of the community, state, and region.

Typically, in higher education new institutional strategies are typically superimposed onto established organizational structures. As a result, academia has produced limited examples of meaningful structural innovation. In contrast, business historian Alfred Chandler [3] concluded over fifty years ago that successful American corporations were characterized by strategies linked specifically to the organization.

II. Proposed Environment

This section proposes an organizational environment for a regional university that leverages domain knowledge of stakeholders to provide a much wider range of skills for administering institutional accountability than the traditional organizational structure.

A compelling institutional accountability issue is the role of faculty as stakeholders. Faculty possess a tremendous amount of higher education and institutional domain knowledge. Both are invaluable resources to the institution. By embracing a broader definition of accountability, faculty could expand its role in shared governance to active participation in developing and implementing strategic plans, quantifying risk of institutional decisions, and continuously improving processes. Another direct benefit is improved quality of communications between faculty and the administration.

The faculty senate, composed of representative members of the faculty, is a governing body at many universities charged with maintaining academic standards and regulations. A narrow definition of shared governance is faculty applying their competency in curriculum, tenure, and promotion in the context of prescribed rights and responsibilities.

By tradition, the university role of the faculty senate has been deliberative and advisory. In the proposed environment, the faculty senate provides a platform for leveraging faculty's role in shared governance by engaging in institutional planning and strategic effectiveness.

Organizations have used crowdsourcing [4] as a source of assistance from internet users with problem solving. In a regional university environment, crowdsourcing could be utilized as an open call to all stakeholders with domain specific knowledge on a topic for assistance with planning and strategic effectiveness. Stakeholders respond by providing insight on solutions to the problem. Contributing stakeholders are compensated by recognition and intellectual satisfaction of assisting with solving institutional problems. As shown in



Figure 1: Crowdsourcing Stakeholders

Figure 1, the domain knowledge of institutional stakeholders is the basis for soliciting relevant and fresh ideas for distributed problem solving.

Edwards Deming proposed a System of Profound Knowledge (SPK) as a means for reinventing government as a customer-driven service [5]. An SPK in Figure 1 for a regional university consists of the following four component of institutional activities [6].

- *Appreciation of systems*: Stakeholders (Board, President, and Faculty Senate) view activities as interrelated subsystems.
- *Theory of knowledge*: Test opinions, theories, hypotheses, and beliefs against data to understand activity relationships and determine process improvement strategies.
- *Knowledge of variation*: Ability to distinguish causes of measurement variation in activities, as well as predicting behavior, are essential for testing knowledge.
- *Knowledge of psychology*: Understanding that institutional stakeholders are motivated by intrinsic needs (pride in workmanship and working with others).

A balanced scorecard is a closed-loop management system supported by design methods and automation tools to facilitate the implementation of institutional strategies [7]. Scorecards focus on monitoring a limited number of process parameters derived from institutional accountability. Closed-loop implies performance data is compared to reference values and depending on the magnitude of the differences, the implementation strategy is modified.

The Pareto Distribution, commonly known as the 80% - 20% rule is applicable when balanced scorecards measure perceptions of service. For example, traffic laws cannot be enforced effectively without voluntary compliance of the majority. US Department of Transportation traffic engineering heuristics set speed limits at the 85 percentile of speed based on the principle that speed of a reasonable person should be legal [8]. Symptoms of unsustainable traffic laws are motorist frustration and criticism of police traffic services. In a similar manner, institutional processes are unsustainable when scorecard metrics are below the 80th percentile.

III. Organizational Platform

Figure 2 presents a typical and proposed regional university organizational platform that includes an *SPK*. The proposal reflects a much more proactively engaged faculty and Faculty Senate embracing the broader definition of institutional accountability. The SPK provides insight into instructional assessment, administrative and instructional effectiveness, productivity incentives, and institutional growth.



Figure 2: System of Profound Knowledge Organizational Platform

Possible variations in the proposed platform are the *SPK* box reporting directly to the University President and/or a reporting function to the University Board. The configuration is adapted from nonpartisan missions of the Federal Government's Congressional Budget Office (CBO) [9] and Government Accounting Office (GAO) [10]. Responsibilities of each are as follows:

- **Congressional Budget Office:** Provide objective, nonpartisan, and timely analysis to aid the Congress in economic and budgetary decisions on a wide array of programs covered by the federal budget.
- **Government Accounting Office:** Support Congress in meeting its constitutional responsibilities and help improve the performance and ensure the accountability of the federal government for the benefit of the American people.

Analogous to the CBO, an SPK provides an independent analysis of institutional planning and implementation strategies. In a manner similar to the GAO, SPK activities include an analysis of strategic planning as well as the assessment of implementation strategies.

Similar to the mission of the Office of Management and Budget (OMB) [11] to assist the President in overseeing the preparation of the federal budget and supervising the administration of federal agencies, the university President's Cabinet has primary responsibility for developing and implementing the President's strategic agenda.

IV. SPK Design

An SPK that includes crowdsourcing and balance scorecards is recommended for administering strategic planning and monitoring implementation strategies for a regional university. The importance of accountability to stakeholders is reinforced by applying analytical modeling tools to quantitative and qualitative analyses of university activities.

The regional university SPK is derived from generally accepted activities of university boards and faculty senates. The nature of involvement in the university activities by several university boards [12] [13] [14] [15] was examined. Institutions tend to organize board activities by assigning committees to functional areas of the institution.

Miller's [16] analysis of university engagement by faculty senate categorized activities by Functional Areas of: *Administration, Personnel, Academics, Students, Development, Investments, Facilities,* and *Intellectual Property.* These, or similar categories, depending on the institution, may be viewed as university component systems. Logical groups of activities within each system are processes. The SPK platform assists with designing, developing, and administering these complex interrelated functional areas.

Developing the balanced scorecard consists of selecting appropriate process metrics and automation tools to facilitate monitoring Functional Area strategies. Balanced scorecard reflect a well-defined organizational mission statement and enables stakeholders to understand their role within the organization. Crowdsourcing is engaging domain knowledge of stakeholders in the design and development of Functional Area processes. In this environment, the Faculty Senate, President, and Board may submit requests for assistance with validating and reporting on effectiveness of functional area strategies.



Figure 3: Shewart Cycle

Shewart's *Plan, Do, Check, and Act* (PDCA) Cycle [17] in Figure 3 is an important SPK implementation tool recommended by Deming for visionary organizations to focus on continuous improvement. A brief description is as follows:

• **PLAN:** Identify processes, resources, and develop an implementation plan to improve scorecard metrics.

- **DO:** Implement the plan, allocate resources, modify processes, and collect scorecard metrics and related process data.
- **CHECK:** Compare actual scorecard metrics and related process data with expected results. Also, identify deviations from expectations, causes of the deviations, and their effects on the implementation strategy. (Time series data may help identify trends in metrics over several PDCA cycles.)
- ACT: When an implementation results in a cost effective improvement in scorecard metrics, process modifications and resource allocations become the new standard. Otherwise, previously developed processes remain in place. When comparison results are not consistent (better or worse) with expectations, there is insufficient knowledge about the system and additional analysis and possibly PDCA cycles are needed.

In contrast, an ad hoc approach to process improvement is *managing by exception* whereby an organization reacts to exceptions in vaguely defined expectations [16].

An Ishikawa (Fishbone) Diagram [18] in Figure 4 is a cause-and-effect analysis tool for strategic planning and administering continuous process improvement. In both instances, the diagram summarizes knowledge about the system. Resource categories for a regional university are included in Figure 4. Each category directly affects scorecard metrics.

The Primary and Secondary Causes in Figure 4 are impediments to process improvements. In many instances, categories represent inter-related functional areas of the institution. A paper by Elizandro et.al. [19] analyzes the importance of a systemic approach to planning within an inter-related higher education environment. For process inter-relationships, recursive diagrams areas.



identify interactions between functional Figure 4: Fishbone Diagram for Process Improvement

An important aspect of this type of analysis is utilization of statistical methods to determine when changes in process metrics produce a significant change in a scorecard metric. In contrast to traditional descriptive statistics for institutional assessment, an SPK implementation requires a paradigm shift to inferential statistical methods for developing predictor models of processes.

Table 1 summarizes quantitative and qualitative analytical SPK tools applicable to design and development of new processes as part of strategic planning and process improvement of existing processes. Mathematical and computer models embedded in Table 1 are for testing effects of process modifications before implementing changes. Using these tools for Functional Area analysis is also the basis for an assessment of institutional risk, a critical component of fiduciary responsibility, and an integral component of institutional accountability.

V. SPK Implementation

This section prototypes an SPK to demonstrate and persuade regional university stakeholders that an SPK provides necessary tools for ensuring institutional accountability by engaging stakeholders in planning, developing initiatives, and administering institutional risk. In some instances desired metrics data are unavailable, primarily because of the current methodology for collecting and reporting institutional data. The disclaimer is for what appears to be missing and inconsistent data. The approach to an SPK implementation is the same for each Functional Area of the university. However, because *Academic Programs* are the core mission, focus of this section is on scorecard metrics for academic programs and their respective importance to the institution.

Integrated Systems – Value Stream Analysis – Facilities Layout – Production System Design – Manufacturing Process Design	 Operations Improvement – Ergonomics & Human Factors – Operating Plans – Recovery Planning – Capacity Planning 	Process Improvement Lean Production Economic Analysis Process Modeling Root Cause Analysis Statistical Methods Six Sigma Time Studies Work Sampling
Production – Production Scheduling – Theory of Constraints – Budgets & Forecasts – Crew Empowerment – Defect Analysis – Benchmarking Analysis	Project Management – Project Scheduling – Risk Management	Supply Chain – Supply Chain Alignment – Material Logistic – Inventory Control – Supplier Support – Make/Buy Process

Table 1 SPK Analytical Tools

As previously described, a scorecard metric consists of an outcome measurement and target outcome. The fishbone diagram analysis is the analysis methodology for determining target outcomes as well as causes of variations from target levels. Well defined college and department scorecard metrics facilitate the root cause analysis of problems within layers of the academic program environment.

Going Concern is an accounting concept that describes an economic entity's ability to operate for a period of time sufficient to carry out its commitments and obligations. In effect. scorecard metrics are an articulation of those commitments and obligations. In addition to monitoring instructional based revenue and resource allocation, scorecard metrics also monitor effects must of institutional strategies on graduation student retention. and rates, complementary academic activities. Within the institution. different academic program environments utilize



Figure 5: Vertical Integration of Scorecard Metrics

distinct as well as overlapping scorecard metrics.

Figure 5 represents the vertical academic program structure of a regional university. Academic departments report to colleges that report to the executive level of the university. Each level has

a context sensitive dashboard of scorecard metrics to assess Going Concern. Colleges have primary responsibility for allocating resources to ensure the Going Concern of their respective departments. The vertical integration of dashboards from academic departments to the institutional level ensures seamless institutional accountability and that everyone understands their role in the organization. A brief description of college and department dashboard follows the presentation of scorecard metrics in the university dashboard and their importance to institutional accountability.

Going Concern Metrics

Various formulae for fees, tuition, and state funding are based on number of students enrolled in the university or total credit-hours produced by student enrollment. Full-time equivalent university enrollment and credit-hours, are proxy measures of the dominant institutional revenue stream for regional universities, the benchmark for institutional viability. Because of limited revenue sources for regional universities, enrollment and credit-hours derived revenues are also the basis for target metrics for implementation strategies across all other functional areas of the institution.

Figures 6 and 7 respectively, monitor the university's instructional revenue as determined by total credit hours generated and cumulative full-time equivalent enrollments across all colleges. The limit on a university as a Going Concern, as well as the ability to grow a regional institution is entirely dependent on enrollment derived revenue. Net positive changes in students new to the university each year are the basis for growth in instructional revenue.



Figure 6: University Total Credit-Hours

Figure 7: University Full-Time Equivalent Enrollment

The following figures are examples of metrics for instructional revenue sources. Figure 8 and 9 are undergraduate enrollment for the College of Business and Engineering, respectively. For these





Figure 8: CoB Total Undergraduate Enrollment

Figure 9: CoE Total Undergraduate Enrollment

colleges, most students are full time and therefore enrollment is also a proxy measure of credithours. As in the College of Business, it is difficult to discern enrollment trends because of large fluctuations in a relatively small college enrollment. In contrast, fluctuations are much smaller because of the larger College of Engineering enrollment. In some instances variations in enrollment are easily annotated. For example, in 2014, the university experienced a 15% decrease in freshman enrollment when students could enroll in Tennessee community colleges at no cost. A significant portion of College of Engineering growth, from 2013 through 2014, was the result of a large influx of international students that ebbed during 2015-16.

In a stable (growing) environment, the number of students entering the college must equal (exceed) the number of departing students. A threat to the university as a Going Concern is consecutive years of declines in college enrollments. Because of propagation delays to graduation, each year's net change affects the revenue stream for between three and five years. Figure 10 presents fall semester incoming freshman and transfer students for the College of Engineering for years 2010 through 2017. Figure 11 presents the number of graduates and number of students departing the college without a degree (*Leakage*) since the previous fall semester. Figures 8, 9, 10, and 11 target metrics across all colleges are the basis for projecting instructional revenue streams for the university. Typical retention rates for freshman cohorts now vary around 70%. As shown in Figure 11, College of Engineering Leakage is in the range of 20% per year.







Because of the heterogeneous academic profile of regional university students, within and across colleges, developing stratified populations of students is essential to avoid masking structural problems causing Leakage. Scorecard metrics are also needed to distinguish students transitioning to another college or university because of changes in personal or professional preferences from Leakage resulting from academically unprepared students. Critically important to sustaining higher education enrollments in Tennessee are procedures to identify academically at-risk students and providing appropriate intervention in a timely manner. Resolving system stability issues is a more cost effective approach than relying exclusively on student monitoring software, which is equivalent to 100% sampling of students.

Academic Profile of Engineering Students

A method for analyzing Leakage is based on a previously described approach to monitoring student success in an academic program [19]. The population of engineering students was divided into four mutually exclusive categories based on *ACT* scores.

- Core Students with ACT scores ≥ 25 who are adequately prepared to begin engineering degree coursework.
- Mission Specific Students with ACT scores ≥ 22 and < 25 who, with mentoring, should be able to complete engineering degree requirements.
- At-Risk Students with ACT scores < 22 who may have difficulty mastering a college of engineering curriculum.
- Unknown-Risk Students who are transfer students not required to submit ACT test scores and international students without an ACT score.

These strata were analyzed for excessive number of D/W/F grades in an introductory civil engineering course, *CEE 2110*. Figure 12 presents total course enrollment for time periods indicated. Although a portion of the enrollment repeat a course, Categories 2, 3,





the enrollment. Figure 13 summarizes the results. For visualization of the distributions, grades are color coded and shown as cumulative percent. Codes are blue, green, yellow and red to represent A's, B's, C's, and all other grades (primarily W, D, and F) respectively. Frequency counts are also included in each chart.



Elizandro, et al. [20] developed a method for monitoring course stability based on the Pareto Distribution and Bloom's Taxonomy for formulating scorecard metrics for course outcomes. Course outcomes are stable when 80 % of student grades were C or above and the average grade for course outcomes and course grade was B for students who made C or above on each metric. Rationale for the B average was student eligibility for the Hope Scholarship. The dotted line of the 80th percentile in Figure 13 indicates compliance issues for category 3 and 4 students.

The results of a pair-wise chi square analysis of grade distributions for student classifications in Table 2 indicate significant differences in spatial pairing of student categories. Distributions are statistically different for category 1 and 2 students. Distributions are also statistically different for category 2 and 3 students which confirms an increase in the

Classification Comparisons	P Value
Core Students (ACT ≥ 25)	
Mission Students (22 <= ACT < 25)	7.8005E-07
Mission Students (22 <= ACT< 25)	
At Risk Students (ACT < 22)	0.001615887
At Risk Students (ACT < 22)	
Unknown Risk Students (No ACT)	0.087750273

Table 2: Chi Square Pair-wise Classification

percentage of D/W/F's and corresponding reduction in *C* or above grades. Category 3 and 4 are different for $\alpha = 0.1$ but not $\alpha = 0.05$. Almost half of the students in At-Risk Students and Unknown-Risk categories earned grades below *C*. In addition, corresponding to the rapid growth in the college of engineering, the number of students in category 4 increased from approximately 20 to 122 students between 2009 and 2014. At-Risk and Unknown-Risk students are considered as a broader category of at-risk students because of the similar profiles.

Resource Allocation Metrics

With respect to Going Concern, a commonly recommended first-pass for allocating revenue among academic programs is based on credit-hours produced by the college. The previously described randomness in small program enrollments and inelasticity of program costs are challenges to budgeting colleges on credit-hour production in small regional universities. In effect, statistical perturbations are the basis for budgeting.

Also, because of the granularity in academic degree programs, resource requirements are fairly inelastic with respect to enrollment. There are minimum resource requirements for a degree program and incremental resource requirements are fixed cost intervals for faculty and equipment. Adjunct faculty are staffing alternative. However, accessibility to adjunct faculty is problematic for regional universities. The net effect of a credit-hour approach to budgeting departments is discontinuities in program development caused by random increases and reductions in revenue. Administering SPKs for colleges and departments, based on fishbone diagrams and Going Concern metrics, is essential to ensure commitments and obligations are satisfied.

Other scorecard metrics for academic programs reflect the effects of university initiatives on academic programs. Such initiatives typically leverage undergraduate programs as a revenue source for university efforts other than instruction. A common strategy is increasing student capacity of academic program is by relying more on adjunct faculty and increasing the number of students in a class. Successfully leveraging class size as an economy of scale strategy is dependent on the academic profile of the student population. Degree programs with a heterogeneous profile are more sensitive to leveraging. Figure 14, as a proxy metric for faculty release time to support research, presents number of students enrolled in classes with class size limit of 40 and number of students enrolled in classes with class size greater than 40 for the *CEE 2110* course. The issue is ensuring the academic success of students is not adversely affected by large class enrollments.

Strategic Initiative Metrics

The following describes performance metrics for an academic program research initiative. Figure 15 indicates success of the College of Engineering in competitively funded research and Figure 16 represents yield on proposal submissions. Changes in these metrics is determined by the effectiveness of the implementation strategy and resources available to the initiative.





Figure 14: CEE 2110 Enrollment by Class Size







A common regional university trade-off is leveraging instructional revenue as *seed money* to create a research initiative platform by investing in graduate students. A successful initiative includes an increase in external funding as shown in Figure 15 and a corresponding increase in number of externally funded graduate students. An effectiveness metric for a research initiative is number of graduate students and sources of graduate student funding. As shown in Figure 17, a discernable increase in graduate enrollment is not reflected in the estimate of research funded students.





Figure 18: CoE Total Graduate Degrees Awarded

A well populated PhD program relative to the MS degree program is also an essential component of a sustainable research initiative. Figure 18 indicates there has been a recent increase in college of engineering master's degree relative to the number of PhD degrees awarded. Similar dashboard metrics to those in Figures 14 through 18 are needed for each department in the college.

Additional scorecard metrics are needed to determine the number of graduate students funded by instructional revenue and instructional workload to low enrollment graduate classes. Also needed is information on number of graduate students receiving teaching assistantships that could be allocated to undergraduates for academic scholarships. A related issue is that research funded graduate students receive a waiver of tuition and fees. Figure 6 should be modified to reflect graduate student produced credit-hours that don't contribute to instructional revenue.

VI. Conclusions

Although there are discontinuities and approximations in the data presented, a systemic approach for developing institutional dashboards and associated metrics to monitor Going Concern for a regional university has been demonstrated. Target values for these metrics are context sensitive and dependent on institutional mission. This approach must include an institutional data system to support the SPK. Institutional Functional Areas, other than Academic Programs, are similar to traditional production systems in the private sector of the economy.

Reflecting vertical integration of an Academic Functional Area, dashboards are daisy chained from the university to the college and then to academic departments. Also referenced in the paper is a prototyped SPK to administer academic degree programs based on ABET's General Criteria. In addition to college dashboard metrics, the college must have a systemic approach to a resource allocation strategy to facilitate coordination between academic departments and to detect and avoid resource starvation of programs critical to the institutional mission.

The demonstration is to persuade regional university stakeholders that an SPK provides tools for ensuring institutional accountability by engaging stakeholders in planning, developing initiatives, and administering institutional risk. Rather than optimizations strategies within Functional Areas, an SPK enables stakeholders to view the institution in the context of resource trade-offs between Functional Areas. Because the Functional Areas discussed are common to all higher education institutions, the SPK presented is a template for monitoring the Going Concern for a range of private and public institutions that includes community colleges as well as flagship institutions. However, metrics for each institutional dashboards are mission specific.

Typically, regional universities contract with consultants to provide recommendations on administering institutional Functional Areas. In contrast, an SPK assumes specific domain knowledge of the institution and a sustained commitment (ownership) in institutional processes by stakeholders. Typically, these commitments are beyond the scope of consultants. Similarly, stakeholder participation can reduce the number of administrators who typically lack breadth of institutional domain knowledge derived from stakeholder participation.

Because SPK's are integrated into a spectrum of private industries the approach is intuitive to many board members. A frequent comment in university board meetings is: *The University must be run like a business*. A more precise comment is: *As in business*, a *systemic view of the organization institution provides a platform for effectively administering a regional university*. Paraphrasing a quote attributed to Deming: *Without systems data, you're just another stakeholder with an opinion*.

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