Using Dance of Change Concepts to Apply Critical Cultural Success Factors to Data Quality Initiatives

(Research in Progress)

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ABSTRACT

Data Quality (DQ) is an important determiner of success for any organization to conduct its mission and meet its objectives. Organizations undertake initiatives to improve the quality of the data that drives value for the organization. Two studies led by the University of Arkansas at Little Rock (UALR) have identified a list of 6 clearly defined cultural factors for data quality initiatives that are considered critical to their success. A DQ initiative can be considered an organizational change initiative. Senge's Dance of Change system dynamics model can be considered a framework for evaluating organizational change. This study explores how the Dance of Change model can be used as a framework for understanding the critical cultural success factors (CCSFs) generated by UALR's previous Student Project and Delphi studies.

1   Introduction

This paper explores the role of culture and social issues in organizational initiatives involving data quality (DQ) or information quality (IQ), used interchangeably here. The paper poses two primary questions:

- Why do some DQ initiatives succeed while others fail to meet their cost, schedule, scope, or value delivery objectives?
- Do social and cultural issues pose formidable challenges to information and DQ programs?

To answer these questions, the study brings together several different concepts: data, data quality, data quality initiatives, organizational change management, system dynamics, the Dance of Change, organizational culture, and critical cultural success factors.

The "Data Quality, It's Cultural" (DQIC) Project – This study is being conducted as part of the "Data Quality, It's Cultural (DQIC)" project. Several years ago, a small group of DQ industry practitioners and academics established the DQIC project to explore the role of culture and social issues in data quality initiatives and to evaluate potential strategies to help address

them. While the group is widely distributed, the locus of the project's activity is centered at the University of Arkansas at Little Rock (UALR). The DQIC project believes that improved knowledge of sociocultural impacts would permit the crafting of better DQ initiative implementation strategies.

Organization – The paper is organized as follows:

- Background Concepts
- Dance of Change – the systems framework for representing the structure of DQ initiatives
- Critical Cultural Success Factors (CCSFs) for DQ Initiatives – targeted studies to identify critical cultural success factors for DQ initiatives
- Where do CCSFs fit into the Dance of Change? – mapping of DQ initiative CCSFs to various parameters and variables in the Dance of Change model
- Conclusions and Future Work

2   Background Concepts

Data and Data Quality – In today's world, "data" is crucial in driving almost all organizational activity: from the analysis of the organization's operating environment, through the decision making made by the organization's managers and employees, to the processing of the organization's transactions. Consequently, for an organization to operate efficiently and effectively, it requires data, and for the organization to optimally meet its objectives, that data should be of high "quality".

Quality is frequently defined as "Fit for purpose". Thus, good quality data can be defined as "Data that is fit for its use". [Redman, 2001]   Good quality data typically exhibits a number the following characteristics: accurate, precise, complete, consistent, timely and authoritative.

Data of unknown quality is inherently untrustworthy. If you don't know the quality of your data, how can you trust it? Poor data quality (DQ) is a generally pervasive and universal problem. Industry experts have estimated the cost of poor data or information quality at from 15% to 25% of the operating profits (however defined) of a typical organization. The social and economic impact of poor quality data costs billions of dollars. A recent report estimated that poor quality customer data alone costs U.S. businesses a staggering $611 billion a year in postage, printing, staff overhead, missed opportunities, frustrated customers, etc. And poor data quality is a problem that applies just as harshly to governmental organizations as to industry. For example, it has been disclosed that 50% to 80% of computerized criminal records in the U.S. were found to be inaccurate, incomplete or ambiguous.

Furthermore, if left unattended, the quality of data will naturally degrade over time as the systems and technology that produce it change, as the processes that are used to manipulate it are modified, and as environmental conditions where it is used evolve. Data quality is a pervasive and persistent problem throughout the modern world.

Data Quality Initiatives – Good data quality doesn't just happen. An organization achieves high levels of data quality by implementing initiatives that consciously attempt either to directly improve the data, or to correct issues in the systems, technology, processes and usage environments that cause data quality problems to arise in the first place. These data quality initiatives are typically implemented as "projects" in the traditional sense of the word: an organized collection of activities intended to meet a specific time-boxed objective. Just like any other project in an organization, a data quality project must be proposed, justified, funded, staffed, and managed.

Organizational Change – A data quality initiative is an improvement project. Any improvement project can be thought of as an expression of change within an organization. Organizations are always attempting to change their current structure or operations to achieve higher levels of performance, or to better adapt to their evolving operating environment. TechTarget defines "organizational change management (OCM)" as "a framework for managing the effect of new business processes, changes in organizational structure or cultural changes within an enterprise." [TechTarget 2009]

System Dynamics and the Dance of Change – The management literature is full of references on organizational change that attempt to categorize it, explain how it operates, and supply suggestions on how best to be successful at achieving it. However, as McFarland states: "… the track record of change efforts [is] dismal [and] it may not be improving. Experts have reported similar results for organizational change efforts since the 1980s. … For many years, the training field has viewed organizational change as a process that is both linear and sequential. Instead, change has revealed itself to be non-linear and chaotic. It's time to find a new model - one that … takes into account 21st century workplace dynamics and realities" [McFarland 2012]. The field of study which provides the mechanisms to represent and describe nonsequential, nonlinear relationships that interact over time, complete with delays and mental models is called "system dynamics" (SD).

One such non-linear change management modeling approach is called the "Dance of Change". Proposed and explained by Senge [Senge 1999]. The Dance of Change model provides a holistic "systems thinking" way of looking at organizational structures. Organizational structure used here is concerned with the key interrelationships that influence organizational behavior over time. These are not interrelationships between people, but among key variables, such as between an organization's investment in a change initiative and an increase in overall learning capabilities of individuals, teams and communities within the organization. The Dance of Change is a framework for exploring nonlinear, cause-and-effect, positive and negative feedback loops which are manifested in the dynamic behaviors of the organization over time.

Culture & Quality – Early work by Zuckerman on cultural archetypes (based on prior work by Rapaille) was used to develop an American archetype of quality (as opposed to say a Japanese or German cultural archetype of quality) to understand the basic characteristics of American culture that lead to successful quality improvement efforts [Zuckerman 1992]. Robinson has written on how these archetypal models should be used by an organization that wants to improve the quality

of their products [Robinson 2010]. While these ideas were originally researched for and implemented in the specific quality arena of manufacturing, it stands to reason that an archetype of quality in any arena could potentially carry over to data and information quality.

The Role of Culture and Social Issues in Organizational Change – TechTarget's definition of OCM also states that "simply put, OCM addresses the people side of change management." So, an important dimension in any change initiative is "organizational culture".

Organizational Culture can be defined as the pattern of behavior encompassing the shared vision, values, norms, systems, symbols, language, assumptions, beliefs, commitments, and habits that shape the overall environment of the organization. This pattern of behavior impacts the organization's strategies, policies and overall approach to problem solving. [Williams 2015]

Critical Cultural Success Factors in Data Quality Initiatives – The project management literature is huge. Significant intellectual effort has been expended on exploring and describing best practices in project management. One of these best practices involves identifying and utilizing what are called "critical success factors (CSFs)". Morrison defines CSFs as "the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department, or organization" [Morrison 2012]. Because CSFs vary from one type of situation to another, an organization should focus on identifying those CSFs that are central to and unchanging for the type of situation which the organization is interested in addressing. To keep things simple, the organization should limit the number of CSFs to an easily manageable amount, between five and seven. The area of interest to this project is the identification of CSFs related to organizational culture as they apply to DQ initiatives, thus producing "critical cultural success factors (CCSFs)".

3   The Dance of Change

Many different models of organizational change exist in the management literature, from Lewin's Change Management Model, to the McKinsey 7-S Model, to Kotter's 8-Step Change Model, and many more. While any of these models will provide a plan based on experience and observation that can be followed, for the most part these approaches are static and descriptive and don't consider the dynamics of modern organizations as they change over time [Belyh 2015]. As stated in the Background Concepts section, system dynamics is a field of study that "does" consider the dynamic nature of modern organizations. SD permits a much deeper understanding of the way these organizations adapt and evolve. The Dance of Change by Senge is one such SD approach to change management.

System Dynamics (SD) – SD employs a diagramming language using systems diagrams that provide a way to sketch out systemic interrelationships in a system or organization. A systems diagram presents a series of elements that are connected to one another with directional cause and effect links. As the value of an element goes up or down, the element(s) it points to will also go up or down either in the same direction or the opposite direction depending on whether the causal element has a positive or negative impact on the effected element. These graphical

interrelationships among several elements can eventually lead back to the original causal element thus creating a feedback loop. These feedback loops can be positive reinforcing feedback loops if there are an even number of cause and effect links, or negative balancing feedback loops if there are an odd number of cause and effect links. As these feedback loops proceed over time, they can cause the system to exhibit nonlinear behavior, such as exponential growth or collapse, oscillation, goal seeking, or erratic movements.

A cause and effect link can sometimes have a delay which slows down the system and can lead to unexpected consequences. Some elements can represent constraints which influence a balancing loop by providing hidden limits that the system will adhere to, but which can also provide significant leverage points for a change initiative.

Limits to Growth – At its core the Dance of Change model uses an archetypical pattern of behavior called "Limits to Growth" (see Figure 1).

Balancing Loop
Target
(limiit or constraint)

Delay

Growing
Action

Growth
Process

Actual
Performance
(that can be measured
or observed to grow)

Limiting
Process

Corrective
Action
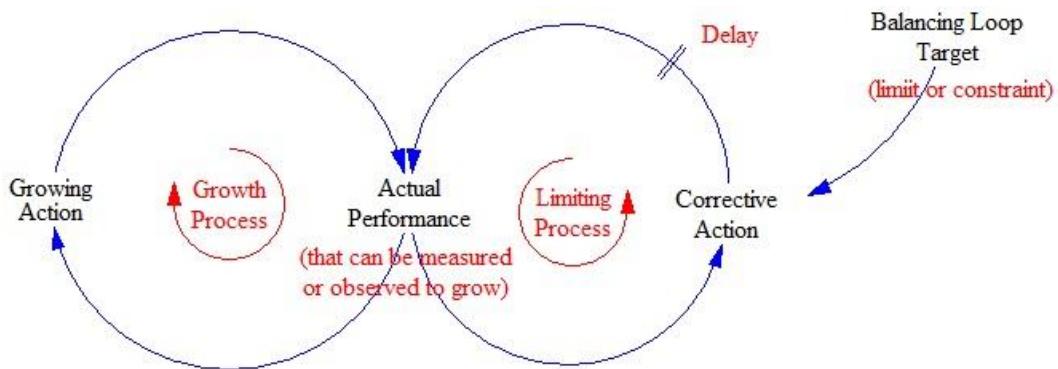
Figure 1 – Limits to Growth Archetype

The limits to growth archetype systems diagram depicted in Figure 1 shows a growth process positive reinforcing loop interacting with a limiting process negative balancing loop. The growth process incorporates a growing action element, increases in which will lead to increases in the actual performance element. Increases in the actual performance element then lead back to increasing the growing action element which will complete and continue to feed the positive feedback loop. The limiting process includes a corrective action element which increases as increases in the actual performance element approach a balancing loop target element. However, increases in the corrective action element leads back to decreases the actual performance element increases, sometimes with a delay, which will complete and continue to feed the negative feedback loop. Systems that have this type of archetype structure exhibit performance behavior over time characterized by growth and then plateauing, or, if the delay is extended, growth which peaks followed by collapse. [Senge 1994]

Several general strategies have been suggested for dealing with limits to growth situations. If a plateauing or peaking is observed, then:

- The practitioner should resist the temptation to just continue to do more of what worked in the past, and instead should try to better understand the limiting process.
- The practitioner should explore the limits or constraints that are causing the behavior to plateau or to peak and decline.
- The practitioner should look at any delays in the balancing loop that might be causing the system to push beyond its real capacity.
- In the early phases of the project, the practitioner should try to anticipate the limits, and, while the limits cannot be eliminated, the practitioner's can develop the organization's capacity to better handle them.
- Finally, the practitioner can look for and develop other growth processes that can bolster and sustain the desired growth.

As a Limits to Growth archetypical model, the Dance of Change model is composed of a series of positive reinforcing feedback loops or Growth Processes, and a series of negative reinforcing feedback loops or Challenges.

Growth Processes of Profound Change – The Dance of Change model consists of three positive reinforcing feedback loops that together are called the "Growth Processes of Profound Change". These loops are depicted in Figure 2.

All three of the Growth Processes of Profound Change begin with an Enthusiasm and Willingness to Commit element, increases of which drive an increase in an Investment in Change Initiatives element. These are the core elements needed to get any change initiative off the ground. [Senge 1994]

- Personal Results – The first reinforcing feedback loop is labelled "R1 - Personal Results". This loop is first because it represents the importance of the growth of each individual's commitment to the change initiative. An increase in the Investment in Change Initiatives element will in turn drive an increase in the Learning Capabilities element, possibly after some delay. Learning Capabilities are the skills and proficiencies that enable individuals, teams and larger communities to enhance their capacity to produce meaningful results. As people's Learning Capabilities increase, they will also begin to see an increase in their Personal Results. Senge notes that direct personal benefits constitute the first source of reinforcing energy for sustaining deep change. Increases in Personal Result then naturally lead to an increase in Enthusiasm and Willingness to Commit, thus completing the positive reinforcing loop.

- Networks of Committed People – The second reinforcing feedback loop is labelled "R2 - Networks of Committed People". This loop focuses on the importance of engaging the motivating factors of having colleagues who also think the change initiative is important, who can provide support, and with whom ideas and insights can be shared. An increase in the Investment in Change Initiatives will naturally lead to an increase in the number of People Involved. An increase in the number of People Involved can then lead to an increase in the amount of Networking and Diffusion as people share their experiences

and seek out help and advice, which will in turn lead to an increase in Enthusiasm and Willingness to Commit, thus completing the positive reinforcing loop. Senge states that "they know of no company that has generated significant momentum in profound change efforts without evolving" networks of committed people.
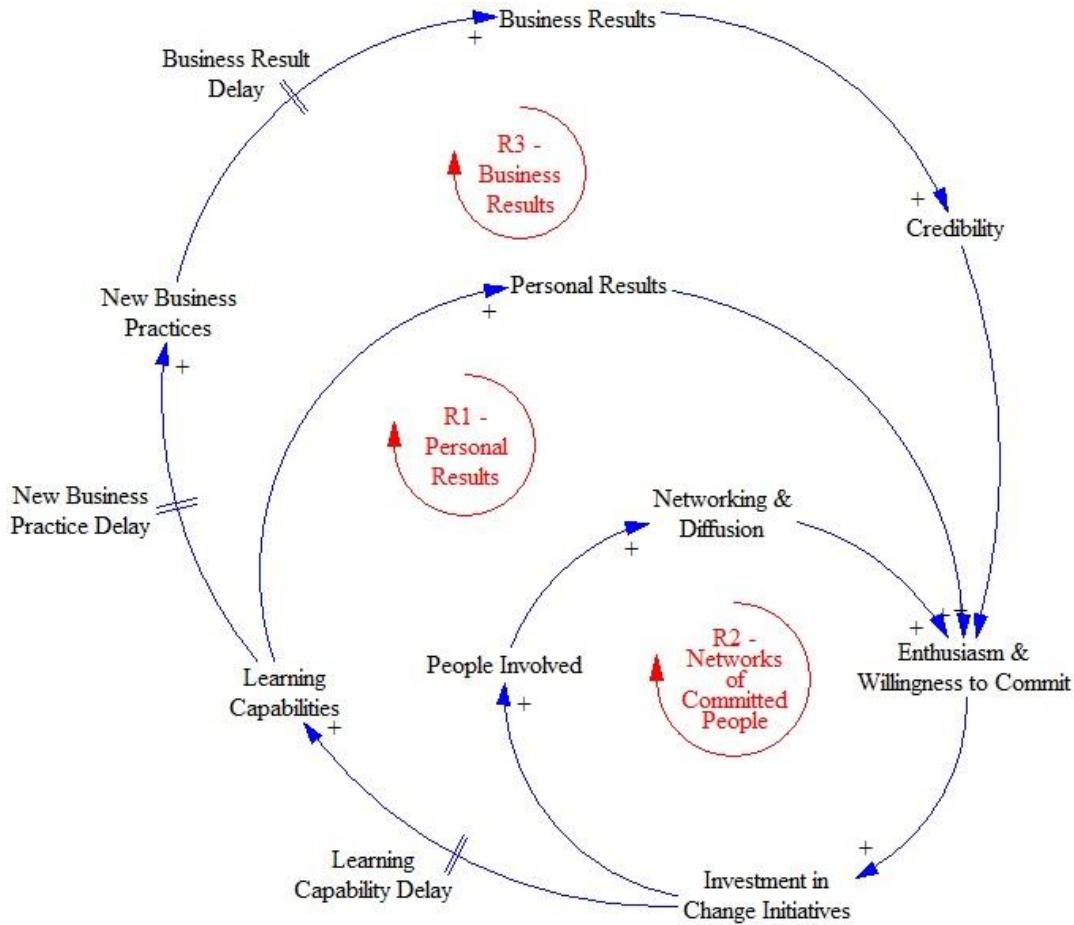

Figure 2 – Growth Processes of Profound Change

- Business Results – The last reinforcing feedback loop is labelled "R3 - Business Results". The same increase in Investment in Change Initiatives that drove an increase in the Learning Capabilities for the Personal Results loop will also drive an increase in New Business Practices, possibly after some delay, for the Business Results loop. New Business Practices will eventually lead to improved Business Results, after a delay. Improvements in Business Results are often very difficult to measure, but must be tracked because of their importance. Once Business Results begin to improve because of the New Business Practices, again after some delay, the change initiative will begin to achieve much greater Credibility. Increased Credibility will of course result in an increase in Enthusiasm and Willingness to Commit, thus completing the positive reinforcing loop.

Challenges to Profound Change – The Dance of Change model also consists of several negative balancing feedback loops that together are called the "Challenges to Profound Change". Balancing loops are not necessarily bad. In general, they are the sources of stability in a system. They provide resistance to changes when outside forces intrude. However, when the objective is to actually change the system, the balancing loops can be a great hindrance, and pose significant challenges to the change initiative.

The Dance of Change presents multiple balancing loops representing 10 different types of challenges. These challenges are organized into 3 major challenge areas:

- Challenges of Initiating
    - Not Enough Time
    - No Help (Coaching and Support)
    - Not Relevant
    - Walking the Talk
- Challenges of Sustaining Transformation
    - Fear and Anxiety
    - Assessment & Measurement
    - True Believers and Nonbelievers
- Challenges of Redesigning and Rethinking
    - Governance
    - Diffusion
    - Strategy & Purpose

The details of each type of challenge are presented in the Dance of Change [Senge 1999]. The balancing loops in each type of challenge are structured according to the Limits to Growth archetype, and include actual performance elements, corrective action elements, a balancing loop target element, and possible delays.

An example of one of these challenges and its balancing feedback loops is "Not Enough Time" (see Figure 3).

In the Not Enough Time scenario, as the Investment in Change Initiatives goes up, there is a corresponding increase in Time Required of the individuals involved. Given no change in the constraints of Time Flexibility and Time Available, there will be an increase in the Time Gap between Time Required and Time Available. An increase in the Time Gap will lead to a decrease in the Effectiveness of the Change Initiative, and a corresponding decrease in Learning Capabilities – the "B1 - Ineffectiveness" balancing loop. An increase in the Time Gap will also lead to an increase in "Frustration" which will in turn lead to a decrease in "Enthusiasm & Willingness to Commit" – the "B2 - Frustration" balancing loop.
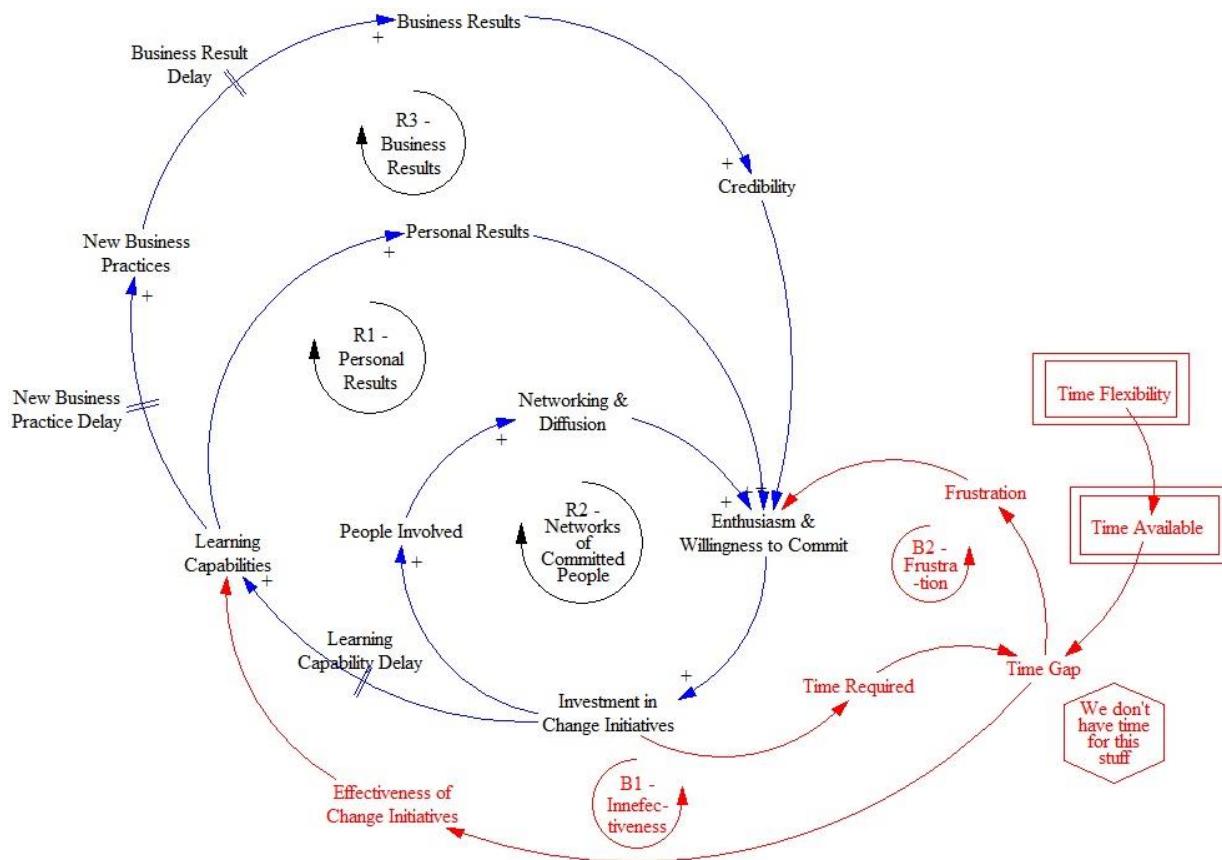
Figure 3 – Balancing Feedback Loop Example: Not Enough Time

Interestingly, the mental model at work in the Time Gap that is the driving force for the negative feedback loops is "We don't have time for this stuff". This mental model exists because of the operational constraints of Time Flexibility and Time Available. If these constraints are relaxed, the Time Gap can be reduced, and the impact of the balancing loops can be ameliorated.

4   CCSFs for DQ initiatives

While there is some anecdotal evidence concerning the impact of social issues on data quality issues, there has been no hard research. Better DQ initiative implementation strategies would result from better understanding in this area.

Toward that end, the DQIC project has so far undertaken several studies. These studies constituted an initial exploration of Critical Cultural Success Factors (CCSFs) through an opinion survey of principals involved in Information Quality Initiatives. The first study was a survey of UALR student projects, and the second was a Delphi study of DQ industry professionals. The intent of the studies was to identify the social, cultural, and organizational CCSFs of typical DQ initiatives.

Student Project Study – The DQIC project first conducted a literature survey of prior work on defining the variables considered critical to the issue of integrating information quality into an organization. In a 2013 study by Xu, the project found a starter list if 25 critical success factors (CSFs) for data quality [Xu 2013]. From this initial list of CSFs, the project focused on 14 factors determined to be based on organizational culture:

1) Top management commitment to Information Quality
2) Middle management commitment to Information Quality
3) Education and training
4) Clear IQ vision for the entire organization
5) Establish an IQ manager position to manage overall IQ
6) Appropriate organizational structure
7) IQ policies and standards
8) Organizational culture of focusing on IQ
9) Focus on information users' needs and their quality requirements
10) Effective employee relations
11) Management of changes
12) Continuous improvement
13) Teamwork/Communication
14) Personnel competency

These factors were then used as a basis for the student survey. The survey was conducted among recent UALR master's degree Information Quality Program graduates. Of a possible ninety-seven graduates, forty-six responded to thirty-two questions concerning their experience and views of data quality improvement projects they were required to complete as part of their degree program.

The result was an ordering of the initial list of 14 CCSFs based on how they affected the success of information and data quality projects and programs. The top CCSF was the "Focus on information users' needs and their quality requirements". This is seen in both the selection of this factor as important and the non-selection of this factor as un-important. Other top CCSFs include "Top management commitment" and a "Clear IQ vision for the entire organization".

Delphi Study – The DQIC project then facilitated a Delphi study utilizing top industry practitioners on a panel of experts. The purpose was to take the initial results from the Student Project Study, and refine the definitions of the CCSFs and add new ones if necessary. Then, using a voting scheme, the list of CCSFs was ranked according to importance. This was accomplished through three separate rounds with the expert panel.

The Delphi study resulted in a final list of 6 clearly defined CCSFs for data quality initiatives:

- Executive Commitment to Information Quality
- Management Commitment to Information Quality
- Education, Training, and Communication

- Appropriate Organizational Structure
- Focus on the Value of Information to the Organization and the Motivation for IQ
- Continuous Improvement

The results of these two studies positioned the DQIC research group to pursue construction of a dynamic model showing the general influence of these factors on the outcomes of data or information quality projects. It is expected that this modeling and simulation effort will form the basis for possible future rigorous scientific experimentation.

5   Where do DQ Initiative CCSFs fit into the Dance of Change?

Given a good consensus list of CCSFs for data quality initiatives [Williams 2016], and given the DQIC group's adoption of the Dance of Change model as an appropriate and workable representation of the dynamics of organizational change management, the next step was to determine how to incorporate CCSFs into the Dance of Change model.

The group initially attempted to simply include the CCSFs as parameters that impacted various elements in the 3 reinforcing loops included in the Growth Processes of Profound Change (Figure 2). However, this approach did not actively engage any of the Limits to Growth balancing loops within the Dance of Change. Nor did it provide a satisfactory mechanism for understanding the issues involved in DQ initiatives and working with them to better understand what adjustments could be made, and what the short and long term impacts of those decisions might be.

Concept of Operations – As the DQIC group envisions how the completed process will operate, the organization will first establish what the current values are of its CCSFs for a given DQ initiative. Then using the model, the organization will work through a determination about what level of success the organization can expect from its DQ initiative, given their organization's CCSF values. This determination should permit them to point to various strategies the organization can adopt to address their current approach. These strategies would involve working to cause adjustments to be made to the CCSFs to bring about better outcomes. Under this operating scenario, the CCSFs are acting more like constraints than simple input variables.

CCSFs as Constraints – In a balancing loop, a constraint is compared against a performance variable. If the gap between the two is large, the negative reinforcing actions in the system will be increased, the system will, in effect, resist the attempt to change, and the change initiative will be more prone to failure. If the gap is small, there will be less resistance and have a greater chance of success. An organization confronted with a lot of resistance to its change initiatives (e.g., big gaps between its constraints and its performance variables) can pursue two basic strategies: 1) work to move the performance variables closer to the constraints, or 2) work to move the constraints closer to the performance variables. In this way, the gaps can be reduced, and the impact of the balancing loops can be ameliorated.

Thus, the better method to incorporate the CCSFs into the Dance of Change model is to think of them as constraints, and try to match them with the different constraints, challenges and mental models already incorporated in the Dance of Change challenges and balancing loops. Table 1 provides a preliminary mapping of the final six DQ initiative CCSFs to the Dance of Change challenges and constraints.

Table 1 - Mapping of CCSFs to the Dance of Change

DQ Initiative CCSF	Dance of Change			
	Constraints	Challenge	Challenge Area	Mental Models
Executive Commitment to Information Quality	• Clarity & Credibility of Management Values and Aims • Safety for Reflection & Dialogue	Walk the Talk	Challenges of Initiating	• "They're not walking the talk."
Management Commitment to Information Quality	• Metrics in Use • Implicit Time Horizon	Assessment & Measurement	Challenges of Sustaining Transformation	• "This stuff isn't working."
Education, Training, and Communication	• Help Available	No Help	Challenges of Initiating	• "We have no help." • "We don't know what we are doing."
Appropriate Organizational Structure	• Tolerance for Independent Self-governance • Local Capabilities for Managing Interdependence (Integration) • Tolerance for Local Management of Interdependence	Governance	Challenges of Redesigning and Rethinking	• "Who's in charge of this stuff?" • "They won't give up the power."
Focus on the Value of Information to the Organization and the Motivation for IQ	• Clarity of Business Case • Degree of Personal Connection	Not Relevant	Challenges of Initiating	• "This stuff isn't relevant."
Continuous Improvement	• Collective Capacity for Re-thinking and Re-creating	Strategy and Purpose	Challenges of Redesigning and Rethinking	• "Where are we going?" • "What are we here for?"

5.1 Executive Commitment to Information Quality

The definition for the "Executive Commitment to Information Quality" CCSF produced by the Delphi study is:

> *Active, continual and visible engagement by Executive/Senior management in gaining maximum value from information assets that goes beyond commitment. Leadership for information quality involves articulating direction for the Information Quality program, building a critical mass of organizational support, getting the right people in place, and doing whatever is necessary to advance the IQ agenda. This involves:*
>
> - *Understanding and personal conviction for the value of information and why IQ is important to the organization;*
> - *Ensuring a clear and shared vision and the development of a long-range strategic plan for IQ which is aligned to the core organizational strategies, goals, opportunities and priority programs;*
> - *Authorizing necessary funding and resources for organizational IQ initiatives;*
> - *Creating incentives and/or restructuring to maximize positive and minimize negative influences which will enable good IQ practices.*

This CCSF significantly deals with trust, and aligns most closely with the "Walk the Talk" challenge in the Dance of Change "Challenges of Initiating" group. The Walk the Talk challenge has two key constraints: Clarity and Credibility of Management Values and Aims, and Safety for Reflection and Dialog. In the Walk the Talk scenario, as the Investment in Change Initiatives goes up, there is a corresponding increase in Trust in Management Required of the individuals involved. They need to be able to trust that management "has their back", in which case they will be more willing to take the time, effort, and risk needed to pursue the initiative. However, given no change in the Clarity and Credibility of Management Values and Aims constraint, the Trust Gap will increase which will in turn directly decrease the Credibility of the initiative, the "B1 – Lack of Trust" balancing loop (see Figure 4).

Interestingly, another constraint that must be considered is Safety for Reflection and Dialogue which operates through a separate balancing loop called "B2 – Lack of Reflection". As people begin to engage in a change initiative they will need to begin to align their personal values and aims with the initiative to be able to develop the personal commitment to the project that will be required. This will necessitate some refection on their part. To do this, the team members need to feel safe. So, as the Investment in Change Initiatives goes up, there is a corresponding increase in Reflection Required of the individuals involved. However, if there is also an increase in the Trust Gap, then there will be a corresponding decrease in the Safety for Reflection and Dialogue causing an increase in the Reflection Gap. An increase in the Reflection Gap will lead to a decrease in the Clarity of Personal Values and Aims, which will in turn decrease Enthusiasm & Willingness to Commit.

The underlying limit or constraint for the Walk the Talk challenge is Clarity and Credibility of Management Values and Aims. The Clarity and Credibility of Management Values and Aims constraint can be directly replaced by the Executive Commitment to Information Quality CCSF, and can drive both of the balancing loops.
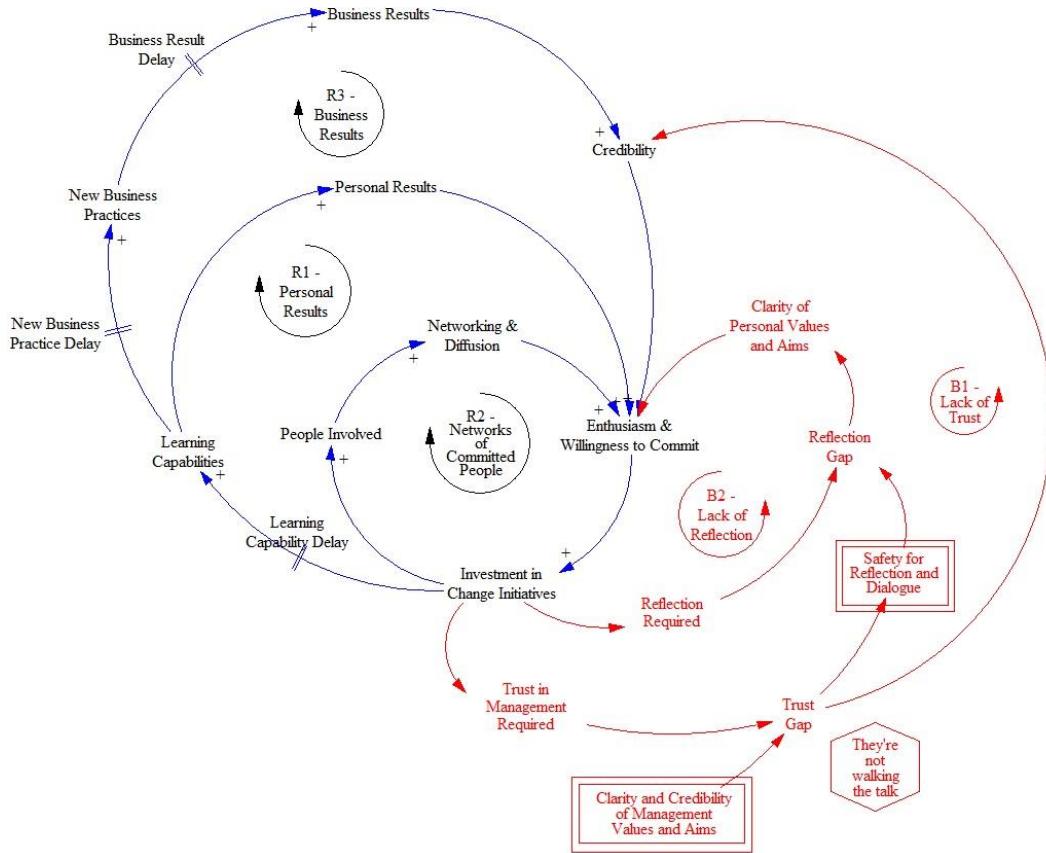

Figure 4 – Walk the Talk Balancing Loops

5.2   Management Commitment to Information Quality

The definition for the "Management Commitment to Information Quality" CCSF is:

> *Management is accountable for gaining maximum value from information assets by ensuring that organizational operations and decision making necessary to implement the organization's IQ strategic plan are implemented, and ensuring that information products meet expected standards for quality. They ensure that all employees understand and believe in the IQ-related roles, responsibilities, and practices for their respective organizations, remove roadblocks as needed, empower their people, and actively deliver against these commitments.*

This CCSF aligns most closely with the "Assessment & Measurement" challenge in the Dance of Change "Challenges of Sustaining Transformation" group. Line management is most responsible for delivering the business results of the organization. Because of the significant time delays between the beginning of the initiative and its effect on business results, the most important factor affecting the perception of progress is the Implicit Time Horizon. So, in the Assessment & Measurement scenario, as the Investment in Change Initiatives goes up, there is a corresponding increase in Expectations of Results. However, given no change in the Implicit Time Horizon constraint, the Results Gap between Business Results and Expectations of Results leads to an increase in Negative Assessments which will in turn decrease the Credibility of the initiative, the "B1 – Late Results" balancing loop (see Figure 5).

The "Assessment & Measurement" scenario also has a second balancing loop called "B2 – Wrong Metrics". This balancing loop comes about because a change initiative will typically have very different objectives from, and employ very different tools and techniques than those used by traditional projects. These different objectives, tools and techniques will have different Business Results which will probably not be properly measured by the Metrics in Use to assess the organization's projects. This situation can lead to an increase in Organizational Negative Assessments which will then lead to a decrease in Credibility.
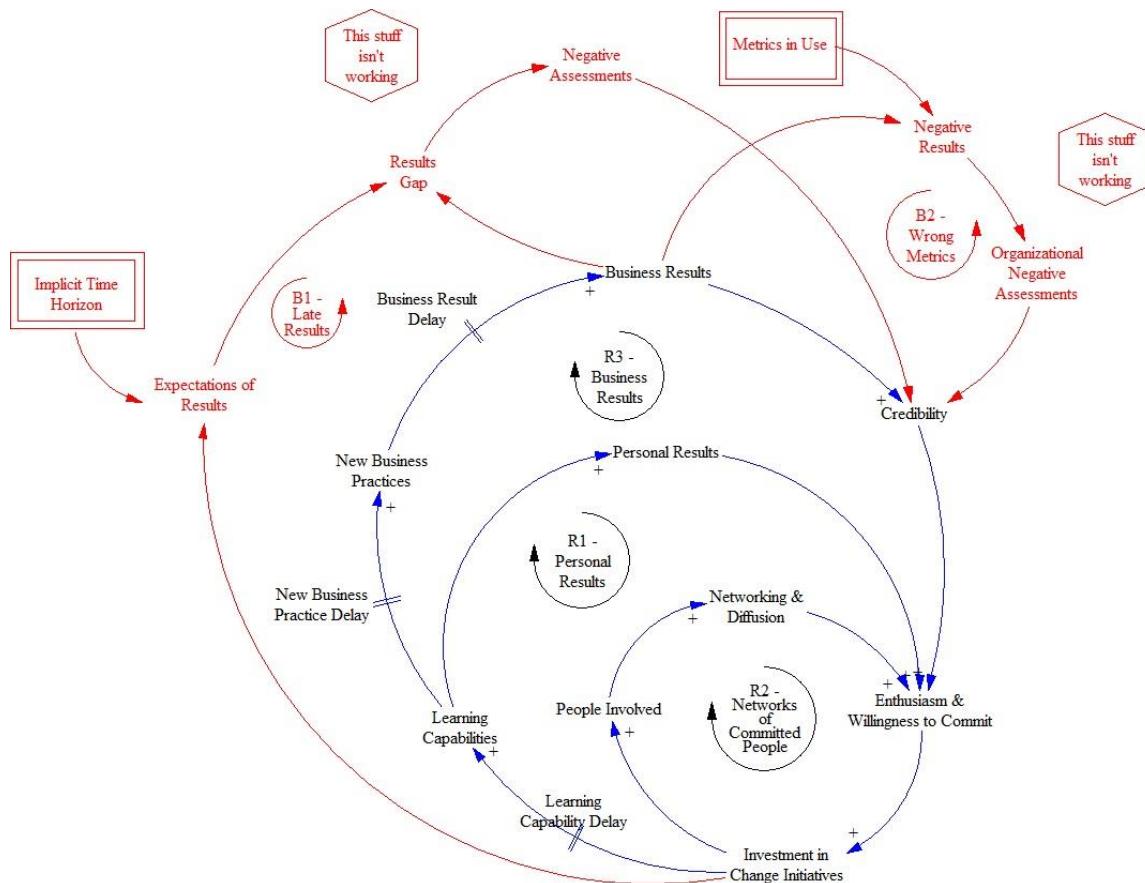

Figure 5 – Assessment & Measurement Balancing Loops

The underlying limit or constraint for the "B1 – Late Results" balancing loop is Implicit Time Horizon, while the underlying limit or constraint for the "B2 – Wrong Metrics" balancing loop is "Metrics in Use". However, for the Management Commitment to Information Quality CCSF to be used with this challenge, the CCSF must be split up and reinterpreted to serve for both different constraints. Management must step up to the responsibility to make sure the initiative is doing whatever is necessary to receive positive assessments and maintaining its credibility.

5.3   Education, Training, and Communication

The definition for the "Education, Training, and Communication" CCSF is:

> *Maximize the value of information assets by providing information stakeholders with the knowledge and skills they need to improve information quality through continuous and long-term education, task-specific training and clear depiction of organizational IQ initiatives relevant to key business performance objectives. All stakeholders should come to understand:*

- *The manner in which information is a valuable asset to the organization;*
- *The growing role that information plays in the sector, the industry, and the world;*
- *A sense of urgency for getting information right and using it well; and*
- *A commitment for encouraging the capacity for change.*
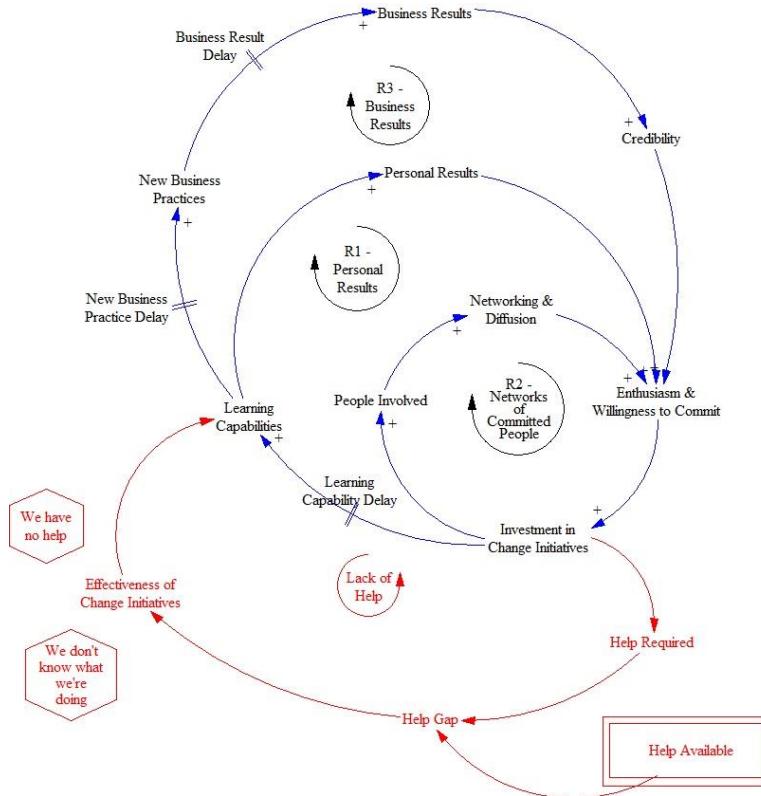
Figure 6 – No Help Balancing Loops

This CCSF aligns most closely with the "No Help" challenge in the Dance of Change "Challenges of Initiating" group. So, in the No Help scenario, as the Investment in Change Initiatives goes up, there is a corresponding increase in amount of Help Required. However, given no change in the Help Available constraint, the Help Gap will expand. The increase in the Help Gap will lead to a decrease in Effectiveness of Change Initiatives which will in turn decrease the Learning Capabilities of the initiative, the "B1 – Lack of Help" balancing loop (see Figure 6).

The underlying limit or constraint for the No Help Challenge is Help Available. The Help Available constraint can be directly replaced by the "Education, Training, and Communication" CCSF. Education, training, and communication are all important aspects of the help available to the initiative, and are critical to the development of learning capabilities.

5.4   Appropriate Organizational Structure

The definition for the "Appropriate Organizational Structure" CCSF is:

> *An appropriate organizational model that establishes roles, responsibilities, duties, accountabilities, decision rights, rules of engagement, and communications related to IQ. The model includes:*
>
> - *the necessary roles at all levels: executive, senior, managerial, tactical, and operational; and*
> - *cross-functional teams with a specific focus on IQ in addition to IQ-related roles that are part of existing operational teams.*
>
> *The organizational model clearly defines for each information asset the persons responsible, accountable, consulted, and informed in the management of that information asset. The model should also clearly communicate a vision for information quality that encourages a capacity for change by minimizing fear and maximizing business value.*

This CCSF aligns most closely with the "Governance" challenge in the Dance of Change "Challenges of Redesigning and Rethinking" group. Over time the DQ initiative will have developed new Learning Capabilities that will enable them to better manage themselves, as well as to anticipate and manage interdependence with other entities inside and outside the organization. However, if the organization has little tolerance for different business practices adopted by the initiative, then the organization will impose traditional or additional management and controls that can then depress Enthusiasm & Willingness to Commit (see Figure 7). This scenario plays out in three different balancing loops:

- B1 – Lack of Autonomy
- B2 – Integration Clash
- B3 – Integration Pushback

Each of the balancing loops has its own underlying limit or constraint:

- Tolerance for Independent Self-governance
- Local Capabilities for Managing Interdependence (Integration)
- Tolerance for Local Management of Interdependence

Given no change in any of the three constraints, the system's corresponding Governance balancing loops will come into play to reduce overall Enthusiasm and Willingness to Commit. Thus, the Appropriate Organizational Structure must be evaluated for how well it addresses each of these three constraints. The more that the Appropriate Organizational Structure addresses these constraints, the more successful the DQ initiative will be at translating the Learning Capabilities into Enthusiasm & Willingness to Commit.
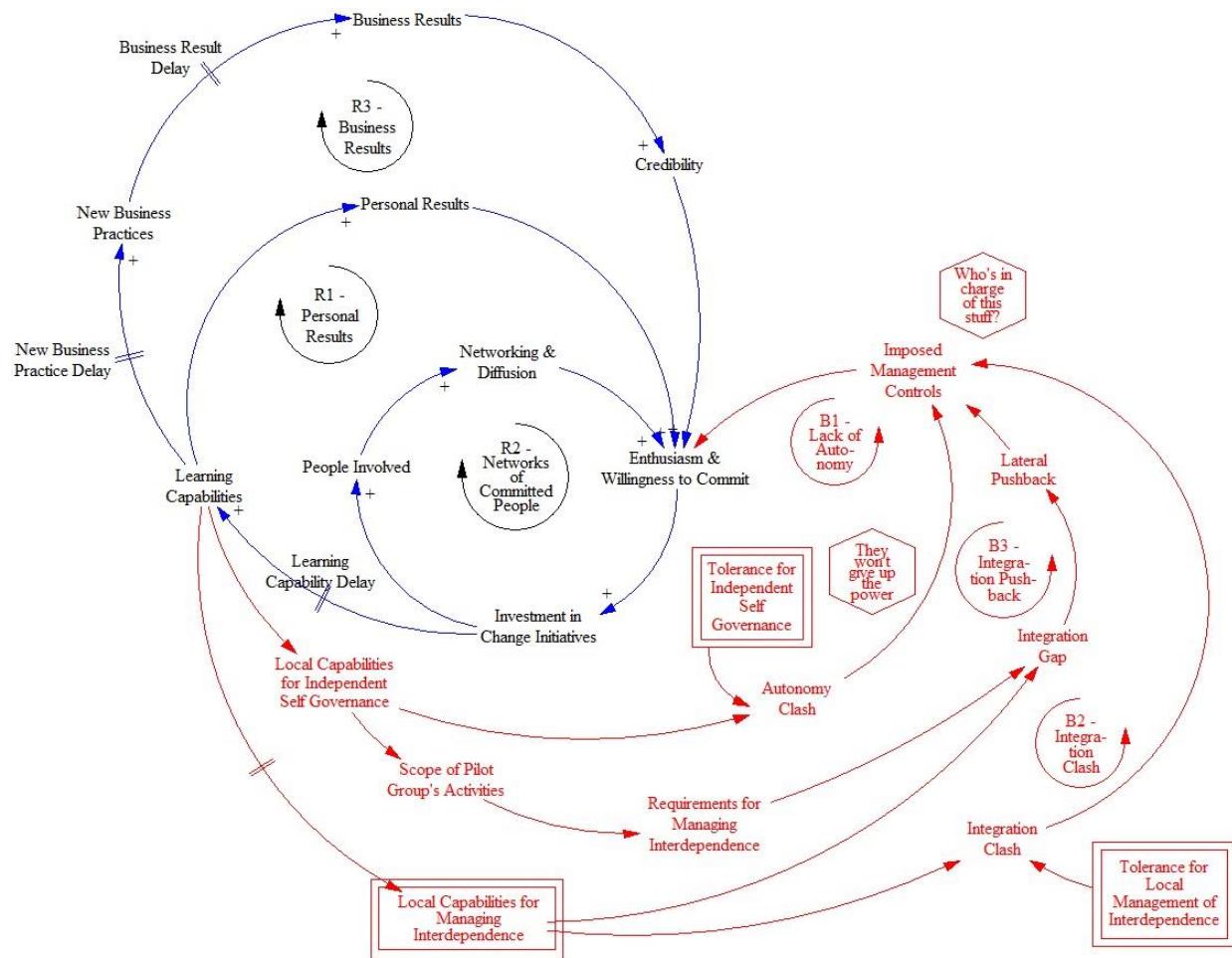

Figure 7 – Governance Balancing Loops

5.5 Focus on the Value of Information to the Organization and the Motivation for IQ

The definition for the "Focus on the Value of Information to the Organization and the Motivation for IQ" CCSF is:

> *Understanding how IQ supports business needs (strategies, goals, issues, opportunities), and provides motivation for IQ to an organization.*
>
> • *This motivation can be internal (e.g. improved operations) or external (e.g. better meeting consumer needs' and their information quality requirements).;*
> • *Focus on information value can provide a sufficient sense of urgency, priority, and perceived value to incentivize an organization, and its teams and individuals to take action related to information quality.*
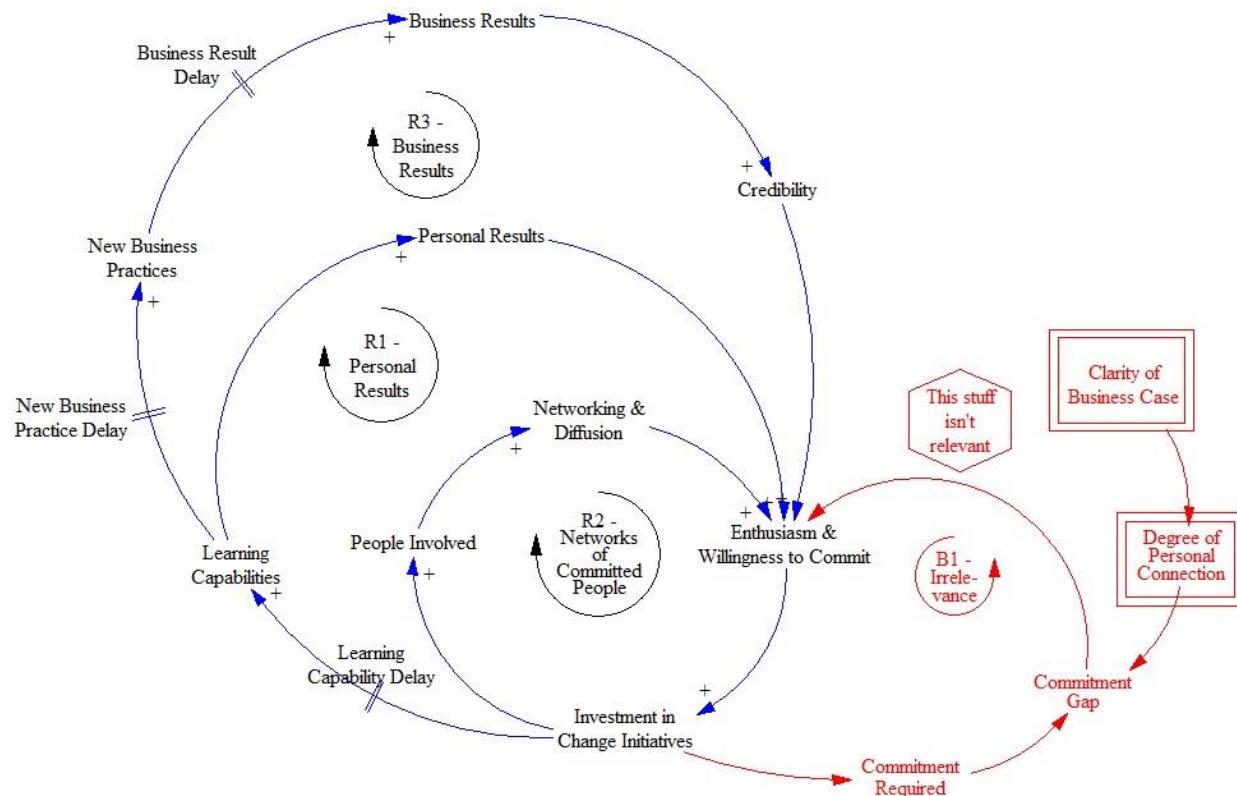
Figure 8 – Not Relevant Balancing Loop

This CCSF most closely aligns with the "Not Relevant" challenge in the Dance of Change "Challenges of Initiating" group. The Not Relevant challenge has two key constraints: Clarity of Business Case, and Degree of Personal Connection. In the Not Relevant scenario, as the Investment in Change Initiative" goes up, there is a corresponding increase in Commitment Required of the individuals involved. They need to be able to make a personal connection to the change initiative. They need to see that the initiative both supports the business results of the

organization and engages them on a personal level. Given no change in the constraints of Clarity of Business Case, and Degree of Personal Connection, there will be an increase in the Commitment Gap between Commitment Required and Degree of Personal Connection. An increase in the Commitment Gap will lead to a decrease in the Enthusiasm & Willingness to Commit, the "B1 – Irrelevance" balancing loop (see Figure 8).

The underlying limit or constraint for the Not Relevant Challenge is Clarity of Business Case. The link to the business results must be clearly stated since this will drive the degree of personnel connection to the change initiative. For the DQ initiative, the Clarity of Business Case constraint can be directly replaced by the Focus on the value of information to the organization and the motivation for IQ CCSF.

5.6   Continuous improvement

The definition for the "Continuous Improvement" CCSF is:

> *An organizational awareness of the need to analyze and correct the performance of data lifecycle processes in all stages: planning, development, operations and sustainment. Continuous improvement is evidenced by the existence of a robust change management process and also by the inclusion of change management or improvement in the operation budgets.*

This CCSF aligns most closely with the "Strategy and Purpose" challenge in the Dance of Change "Challenges of Redesigning and Rethinking" group. The Strategy and Purpose challenge has one key constraints, Collective Capacity for Rethinking and Recreating. In the Strategy and Purpose scenario, as Learning Capabilities increase, there is a corresponding increase in New Aspirations of the individuals involved. These arise because of confidence, competence and inquisitiveness. They lead to an increase in New Ideas about Strategy and Purpose. However, given no change in the greater organizational constraint of Collective Capacity for Rethinking and Recreating, there will be an increase in the Reinvention Gap between New Ideas about Strategy and Purpose and Collective Capacity for Rethinking and Recreating. An increase in the Reinvention Gap will lead to an increase in the Loss of Key Ideas which will in turn lead to a decrease in the Investment in Change Initiatives, completing the "B1 – Lack of Improvement" balancing loop (see Figure 9)

The underlying limit or constraint for the Strategy and Purpose challenge is Collective Capacity for Rethinking and Recreating. For the DQ initiatives, the Collective Capacity for Rethinking and Recreating constraint can be directly replaced by the Continuous Improvement CCSF.
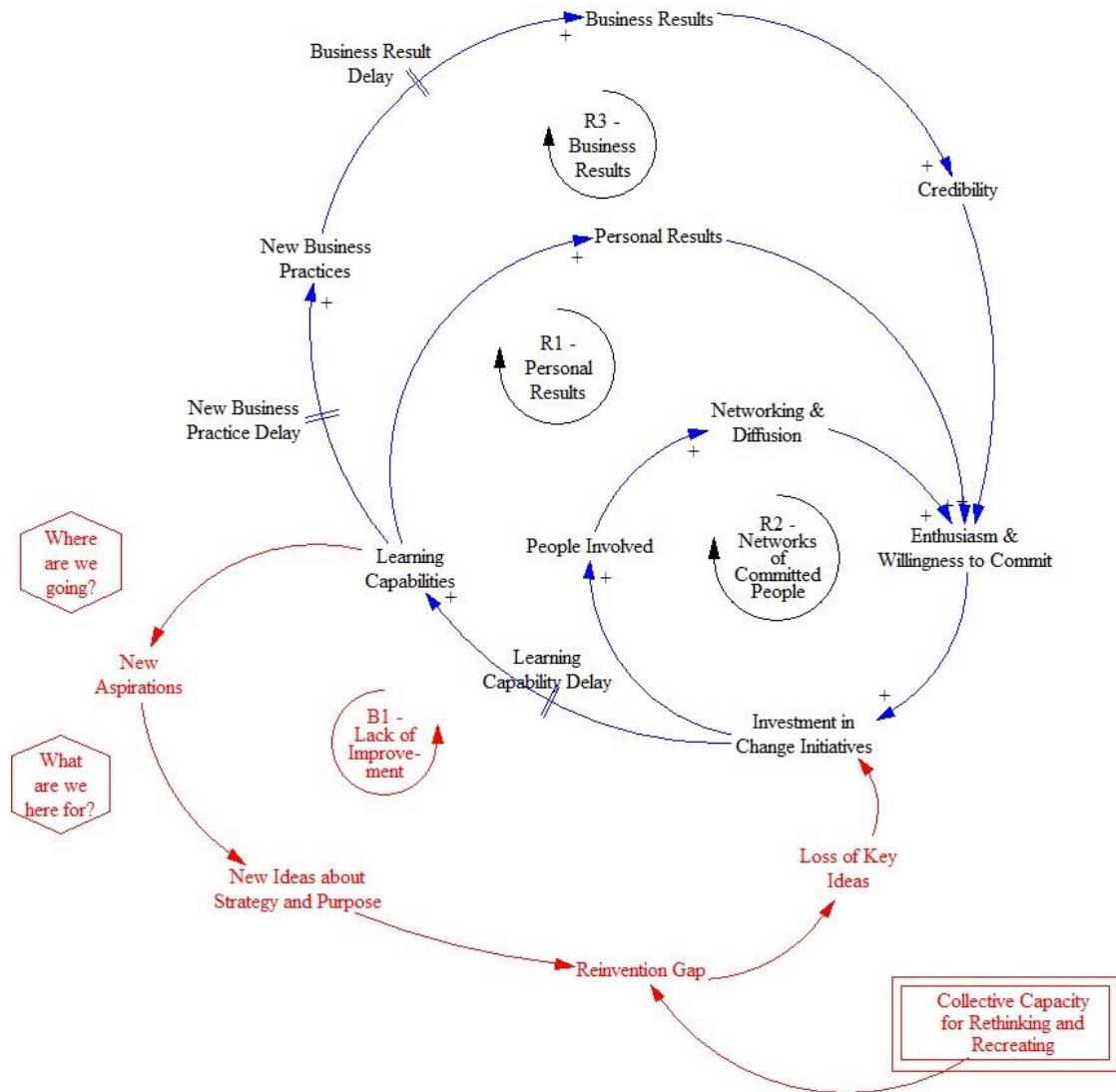
Figure 9 – Strategy & Purpose Balancing Loops

6   Future Work

This paper has presented many of Senge's Dance of Change causal loop diagrams that represent a number of key characteristics of data quality initiatives attempting to bring about significant change in how an organization manages its data. These characteristics are denoted as critical cultural success factors, and are mapped to the appropriate Dance of Change models and their constraints.

Each of these diagrams is a model of organizational behavior. It is first important to note as Box has stated that "All models are wrong, but some are useful" [Box 1979]. So, the primary objective of a causal loop diagram is to be useful. It should represent as many cases as possible. While understanding the models will not be a perfect reflection of reality, the models should be as accurate as possible.

As this research proceeds, a significant portion of the DQIC project's energy will be focused on validating the models presented in this paper, and adjusting them as indicated by the validation results. The validation effort should address some of the different criteria discussed by Burns: clarity, variable existence and quantification, causality existence, causality sufficiency, additional causes, cause and effect reversal, predicted effect existence, tautologies and simple leaps of faith [Burns 20101]. This validation effort will be undertaken with groups of willing participants from the DQ industry involved in various stages of DQ initiative implementation.

Another significant portion of the project's work will be directed toward deeper exploration of individual models of behavior within the Dance of Change framework. This would involve construction of stock and flow models of the balancing and reinforcing loops, followed by rigorous quantification and scientific experimentation of the model with selected organizations and DQ initiative teams.

The results of these two future avenues of investigation should begin to permit the generation of better diagnostics of DQ initiative status while enabling the production of greatly improved strategies for DQ initiative implementation.

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