Modeling Manifest and Latent Structures in a University: Understanding Resources and Dissent Dynamics

by

Raafat M. Zaini

A Dissertation

Submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the Degree of Doctor of Philosophy

in

System Dynamics & Organizational Behavior

Approved by Doctoral Program Committee:

Professor Khalid Saeed	SSPS, WPI	(Chair)	----------
Professor Michael Elmes	FSOB, WPI	(Member)	----------
Professor Oleg Pavlov	SSPS,WPI	(Member)	----------
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Abstract

Using modeling and computer simulation, this research focuses on studying two different views to organizational design and their implications for performance in the context of academic institutions. One view represents the manifest structure that includes resources (students, faculty, administration, facilities, finances, partners, donors, etc.); the other view represents the latent structure that focuses on dissent. The dissertation addresses the following two questions;

1. What are the tangible dynamic interdependencies constituting the manifest structure within academic institutions and their impact on performance?

2. What is the impact of the latent structures composed of intangible organizational processes, especially dissent, on performance?

The dissertation proposes generic system dynamics simulation models untangling the complexity of the topic by tackling various slices of the problem in separate papers. The models are based on three different theoretical frameworks addressing resources and their composition, dissent, and stakeholder engagement. It is observed that while both the manifest and the latent parts of the university organization impact its performance, the latent part, being invisible, is often ignored. In the long run, the influence of the latent part of the organization can slowly but seriously compromise intangible performances components like quality, reputation, and attractiveness.

When the manifest part of the organization is dysfunctional, its tangible performance rapidly suffers. The damage control policies will often impact the latent organizational performance leading the institution into a vicious cycle. The presence of time delays in this framework may create an oscillatory behavior that might modulate a growth or decline trend. Performance measures addressing intangible performance components must be factored into the organizational design since faculty, students, and other stakeholders are not only driven by financial rewards, but also by the organizational environment. The research, besides addressing the important question of the role of latent elements in organization design and demonstrating this can be done using system dynamics modeling and computer simulation, should also be of value to the design and management of higher education institutions.

Keywords

computer modeling and simulation, university management, innovation management, theory building, organization behavior, organization communication organization design, system dynamics, higher education, strategic management, stakeholder engagement, performance management, employee voice and silence, economic development, organizational learning, organizational culture.

Dedication

To my parents,

My mother, Azzah, who named me after Dr. Raafat ..

My father, Mahmoud, who kept dreaming that I become Dr. Raafat ..

I dedicate this work!

Your son,

Dr. Raafat

Acknowledgment

In the Name of Allah, the Most Gracious, the Most Merciful. All the praises and thanks be to Allah Almighty, the Giver of bountiful blessings and gifts. Prayers and peace of Allah be upon the noble Prophet and his family.

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A special shout out to the WPI System Dynamics Club members for their support during our weekly Collective Learning Meetings and our monthly SDghetti socials; Tim Clancy, Christine Tang, Shiya Cao, Fred Kautz, and Jim Hacunda. I single out my best friend Dr. Saeed Langarudi for boosting my confidence all along. I also thank my brother and friend Raid for putting me on the path to learning system dynamics and apply it in my quest to know more about organizations.

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Warm love and many thanks are due to my wife Heba Alamasi for her patience and love and my children Mahmoud, Saffanah, Maan, and Alkhuzama who have been living this dream with me for a long time and helped me reach to this moment with their unwavering support.

Thanks to my parents who envisioned this moment since my birth, and my brothers and sisters who had the vision and encouragement for me to pursue my dream.

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Chapter 1 : Introduction

The focus of this dissertation is on studying two different views to organizational design and their implications for performance in the context of academic institutions through modeling and simulation. One view represents the manifest structure that includes students, faculty, administration, facilities, finances, partners, donors, etc., while the other view represents the latent structure that includes culture, norms, values, rules, stories, assumptions, etc. In this work, the manifest structure will delineate the mechanics of designing and building a world class university (WCU) based on a framework suggested by Salmi (2009) and two real world cases. The latent structure will portray the dissent dynamics in organizations as theorized by (Kassing, 2011) and its role in driving performance towards attaining the institutions' goals and status.

This dissertation seeks to address the following two questions;

1) What are the tangible dynamic interdependencies constituting the manifest structure within academic institutions and their impact on performance?
2) What is the impact of the latent structures composed of intangible organizational processes, especially dissent, on performance?

The dissertation will propose generic system dynamics simulation models untangling the complexity of the questions to facilitate communication on strategic issues facing academic institutions and to promote learning through model experimentation with different policy decisions. It will be composed of four parts that were completed over the course of the research progression path (see Figure 1-1) The first part introduces a contentious topic in higher education institutions, enrollment expansion, through a real-life study focusing on bringing different stakeholders to the table to collaboratively build a simple model for learning and experimentation for addressing this complex issue (see no. 1 in Figure 1-1). The second part focuses on a framework for building a world-class university

followed by an operational model based on a real-world case for a university in its startup phase (see no. 2 in Figure 1-1). The third part will introduce a conceptual framework for the dissent dynamics and its implications (see no. 3 in Figure 1-1) . The fourth part will lay out the dissent framework in a system dynamics model in a higher education context where it can be used for policy analysis (see no. 4 in Figure 1-1).

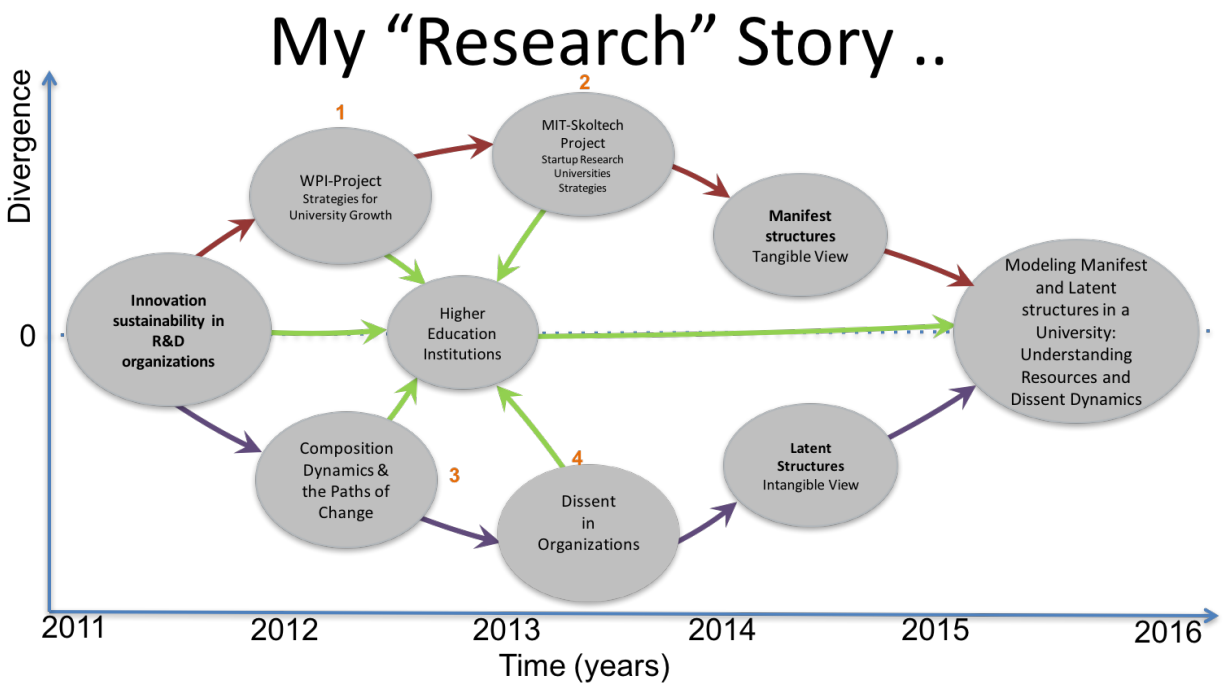

Figure 1-1: Research progress showing major dissertation deliverables along the evolution path

Background

When it comes to organizational design, the first image that pops into one's mind is an organizational structure linked with clear lines of functions, communication, coordination, authority, and control, which are typically represented by organizational charts (Morgan, 2006, p. 26). This critical image is influenced by the mechanistic view to organizational design which is inspired by both the classical management theory and scientific management that became prevalent over the last century (Morgan, 2006, p. 26). The mechanistic view of the organizations is mostly concerned with identifying the parts of the organization and how they fit and work together.

There are many views that describe organizational functions and their underlying structure. Scholars like (2010) suggest that organizations are social systems which are fundamentally interlinked through communication and relentlessly conducting experiments to maintain their viability. Organizations as social systems incorporate forms of complexity beyond the mechanical system due to the intangible characteristics found only in human groups like norms and values (Daft, 2001). The experiments include setting and implementing strategies, goals, processes, and control. Those vital management functions are determinants to key tangible organizational features. They are formulated against an intangible organizational communication backdrop where organizational members express their ideas and viewpoints, argue to convince each other, negotiate and compromise on how they define and perceive the organizational success (Achterbergh & Vriens, 2010, pp. 3–4).

Universities are higher education organizations that can be viewed from both the mechanistic and socio-cultural view. However, considering higher education as a competitive service industry competing for students and high rankings (Frost, 2015) gave more prominence to the mechanistic image of the academic institution. The manufacturing plant metaphor of a university, inspired by the value chain approach (Porter, 1985), represents faculty as a production resource that is expected to deliver the best experience to the consumer (the student) and maximum value to the organization (Pathak & Pathak, 2010). The mechanistic view of academic institutions, combined with recent reforms in higher education policies emphasizing operational efficiency, gave favor to executive oversight over the collegial decision-making process with little evidence of success (Ginsberg, 2011; Shattock, 2002). This top-down governance model is being adapted around the world in some of the emerging research universities established through government led directives where faculty role is limited to teaching and research (Mervis, 2012; R. Zaini, Lyan, & Rebentisch, 2015). The long-term efficacy of this approach for managing both the existing and the startup academic institutions around the world is controversial and calls for careful research.

The use of simulation models in the management literature and organization studies, in particular, has been progressing at a slow pace. Only 3.7 % of the published papers in Organization Science journal

included simulation models (Harrison, Lin, Carroll, & Carley, 2007). In organization design, models are advocated for different purposes using various methods. Few of the application areas include business process design (Giaglis, Paul, & Hlupic, 1999), studying and inventing organizations (Levitt, 2012) using validated, calibrated, and refined agent base models, or organizational development using multi-method simulations including but not limited to system dynamics (Jacqueline Mayfield & Milton Mayfield, 2013).

System dynamics modeling has been used to explore different topics in higher education management at multiple levels of aggregation. These topics, according to Kennedy (2011) taxonomy, cover organizational processes including strategic planning, resourcing, budgeting, human resources, enrollment, pedagogy, quality, performance, governance, external forces, and legislation. The issues related to these topics are modeled at different levels of hierarchy including generic, national, regional governmental, university-wide, and at the department and faculty level (Kennedy, 2011). Few authors in this taxonomy (Saeed, 1996, 1998) explicitly applied modeling and simulation to address socio-political issues like collegial governance and maintaining professional competence in academic institutions.

System dynamics models can be useful for representing different metaphorical views to organizational design. System dynamics models and organizational designs are based on different views to the problem at hand (Morgan, 2006; Saeed, 1992). They comprise a series of successive representations that are incomplete but can be gradually refined with more details. For example, an organization chart could be part of a more refined design because it is more exact in its relationship to what is specified[1] and the same is applicable to a model structure. Eventually the design representation will be very clear about what is being specified -but that clarity comes at the end of the process (S. S. Taylor & Barry, 2014). They facilitate discussion and help us see things in different ways and explore potential design options. They are also useful tools for specifying policies and rules for the organization. Simulation models has

[1] Part of a commentary be Steve Taylor in his Organizational Design class at Worcester Polytechnic Institute.

the added advantage of the ability to test different design before costly investments into building physical prototypes are committed.

My dissertation seeks to build generic dynamic models addressing both the strategic and communication issues in academic institutions based on three different theoretical frameworks addressing strategy, dissent, and composition dynamics. Each framework addresses different issues with minimum level of detail. The strategy model is based on the World Class University framework by Salmi (2009) . The core of the communication model is based on Kassing (2011) dissent framework and the composition of homeostasis and the paths of change on Saeed and Pavlov (2008) dynastic cycle structure.

Salmi (2009, p. 5) defines world class universities as those institutions achieving superior results in the form of highly sought graduates, leading-edge research, and technology transfer. These results could be linked to three complementary sets of success factors found in top universities. They include a high concentration of talent in both faculty and students, abundant resources to support a rich learning environment and to conduct advanced research, and constructive governance features that encourage strategic vision, innovation, and flexibility that enable institutions to make autonomous decisions and to manage resources without being burdened by excessive bureaucracy (Salmi, 2009, p. 7). The interaction between these factors is dynamic. When the success factors shown in Figure 1-2 are aligned, they can drive the university into reaching the status of a world-class university (Salmi, 2009, p. 31)

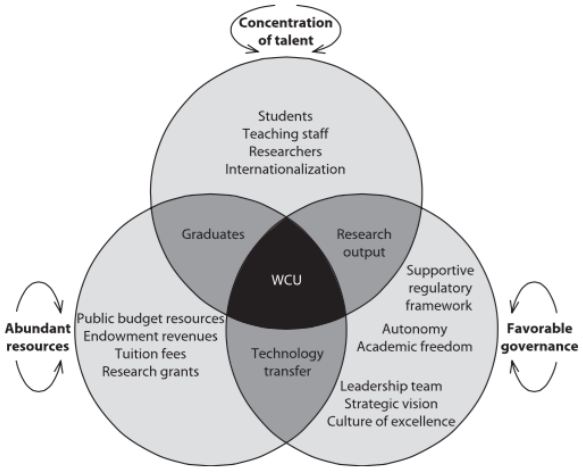

Figure 1-2: Characteristics of a World-Class University (WCU): Alignment of Key Factors, ref.:(Salmi, 2009, p. 32)

The WCU framework shown above can create either a virtuous or vicious cycle that a university could get into but does not indicate any unexpected transient behavior that could result due to time delays inherent in most of its processes (R. Zaini et al., 2015). It is critical to notice how favorable governance acts as a necessary element in starting up and sustaining the virtuous loop to bring the university to a world-class status (Salmi, 2009, p. 38) facilitating performance, attracting talent, and making better utilization of resources. Favorable governance is facilitated through open communication and transparency that is part of a latent structure in the organization (Gouldner, 1957). Latent structures are hidden and overlooking their presence and power leads to many failed improvements attempts (Saeed, 2009). Dissent as a form of organizational communication is deeply rooted in universities by design. Therefore, the dissent dynamics framework will be addressed in the dissertation as an organizational latent structure.

Dissent can take many forms in the organization including expressing discontent with management constraints or with expectations that are not met, or simply the surfacing of differences of opinion, perceptions, goals, and beliefs about the issues. Dissent often challenges the status quo. Furthermore, both of its manifestations and significance can be witnessed in the organizations' decision-making process (R. M. Zaini, Saeed, Pavlov, & Elmes, 2014). Dissent can take one of three forms: upward dissent, latent dissent, and displaced dissent (Kassing, 2011). Upward dissent is what a party expresses directly to management with the intent that it will be viewed as constructive. Latent dissent is typically antagonistic in nature and is expressed to coworkers inside the workplace to minimize the risk of punishment or embarrassment. Kassing (2011) uses the term latent and lateral interchangeably where lateral refers to the direction of dissent expression towards peers. I chose to use latent as it is more inclusive in my case. Displaced dissent such as whistleblowing is expressed outside the workplace and is typical in situations where individuals expect retaliation from management for expressions of dissent. The displaced dissent is not considered in this dissertation since it takes place outside the organizational boundary addressed. Upward dissent can be dismissed, ignored, or processed by managers (Kassing, 2011). Latent dissent calls for no action, as it remains unaccounted for despite its presence in the

organization dissent climate. Kassing (2011) articulated three states of dissent tolerance in organizations and their implications for organizational performance. The first state, high tolerance for dissent, can overload the organization. The second state, low tolerance for dissent, can lead to under-representation of dissent and the loss of valuable opportunities for learning and feedback. The third state, moderate tolerance for dissent, is optimal. Kassing (2011) has suggested that the accumulation of residual dissent in organizations is an unexplored area in the organizational communications field. Cooper and Burke (2013) point to the need for more research into the volume of voice expression and perception of dissent climate over time. The following questions are raised: What are the implications of dissent expression, suppression, and accumulation? Can an organization's tolerance for dissent change over time and why? If so, how does it affect organizational performance?

To answer those questions, a conceptual framework to explore the dynamic nature of dissent expression and its implications is needed. I have applied the Saeed and Pavlov (2008) dynastic cycle metaphorical model of Farmers (who produce), Bandits (who plunder), and Soldiers (who serve a control function) to build a generic structure that represents the organizational composition from the dissent perspective by identifying the key players in the organization who either exercise dissent or are influenced by dissent. Both the dissent expression mechanisms and the dynastic microstructure can be combined into a conceptual framework explaining their interactions and their implications on the organization.

The three theoretical frameworks; world-class university (Salmi, 2009), organizational dissent (Kassing, 2011), and the dynastic cycle structure (Saeed & Pavlov, 2008) has been utilized in addition to the field work to formulate the core of the generic structures addressing both the strategic (tangible) and communication (intangible) views to academic institutions design.

Significance

This study is unique in the following ways:

First; it looks at the manifest and latent structures that coexist in organizations through modeling and simulation. The task is accomplished by the operational representation of theoretical frameworks related to designing a world-class university at a strategic level and to the organizational communication processes that take place in the organization as it attempts to accomplish its aspirations.

Second, the dissertation combines theoretical frameworks from different fields namely economic development (Salmi, 2009), organizational communication (Kassing, 2011) and political economy (Saeed & Pavlov, 2008) in an attempt to understand the strategic drivers and the dissent dynamics and their implications for organizations and academic institutions in particular. Through modeling and simulation, the dissertation will unravel how the factors involved in the theoretical frameworks interconnect and influence each other over time through feedback and accumulation and depletion processes.

Third, the approach to modeling in this dissertation is focused on collaboration, simplicity, and flexibility. The strategy model in particular benefited from both a theoretical framework and direct collaboration with faculty and administrators as documented earlier (R. Zaini et al., 2013, 2015). The models also strived for simplicity by focusing on clarity of the causal structure through the exclusion of unnecessary details to facilitate engagement and insightful experimentation. Furthermore, the models are modular to allow for increasing the level of detail and complexity as deemed necessary in the future.

Fourth, the practical implication of this dissertation is the creation of experimentation and a learning canvas for the academic institutions to share, reflect, and debate over strategic issues related to both their tangible and intangible processes and outcomes. The models will facilitate communication and understanding through experimentation with different scenarios representing the stakeholders' multiple views to the design of their organizations. Sharing the strategic options and their implications - with the interested parties including boards of trustees, faculty, students, and the community as a whole - would help gain support and mitigate resistance to change. Such a tool will benefit universities administrators, higher education consultants, and policy makers.

Finally, the simulation models representing the theoretical constructs provide the actionable basis for conducting practical field studies in academic institutions. The interdependencies and assumptions

constitute a set of questions that can guide what the institutions need to measure and monitor over time. The questions will facilitate exploring how strategies unfold, how the dissent climate shifts and how all this could influence the reputation and impact. The outcome of such studies will enhance the confidence and usability of the models and their value.

Essays

The dissertation is composed of four chapters based on four autonomous papers. The first of these papers introduces a contentious topic in higher education institutions - enrollment expansion, through a real-life study focusing on bringing different stakeholders to the table to collaboratively build a simple model for learning and experimentation for addressing this complex issue. This paper was published in the Systems Research and Behavioral Science Journal (R. M. Zaini, Pavlov, et al., 2016). The second paper focuses on a framework for building a world-class university followed by an operational model based on a real-world case for a startup university, Skolkovo Institute of Science and Technology (SkolTech) in Moscow Russia. This article contributes to the existing body of research in architecting world class universities by presenting an operational strategic modeling framework that is grounded in the existing body of literature for developing WCUs (Salmi, 2009). It can be used to test assumptions, reveal strategic levers, and analyze dynamic complexity inherent in the task of scaling a startup university. We argue that the operational framework and findings derived from the case of SkolTech can be generalized and applied to other efforts in that area (R. Zaini et al., 2015). This paper was published in the Triple Helix journal (R. Zaini et al., 2015).

The third paper introduces a conceptual framework for the dissent dynamics and its implications for organizations. This work highlights the intangible view to organizational processes that drives strategy execution. By combining the dissent expression framework (Kassing, 2011) and the dynastic cycle structure (Saeed & Pavlov, 2008) through performance, we construct a generic model for dissent in organizations. Using system dynamics methodology, we illustrate the dynamic interaction of composition, dissent climate, and performance to explain how organizations evolve concerning dissent

tolerance and its accumulation and depletion. This work is published in the journal Management Communication Quarterly (R. M. Zaini, Elmes, Pavlov, & Saeed, 2016).

The fourth paper documents experimentation the dissent model in a generic higher education context where it can be used for policy analysis of current universities including growth strategies and attempts to improve performance. The content of this paper is in part based on a paper presented at the 32nd International System Dynamics Conference (R. M. Zaini et al., 2014).

Finally, the conclusion summarizes results and points towards further research possibilities.

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Chapter 2 : Let's Talk Change in a University: A Simple Model for Addressing Complex Agenda[2]

Abstract

This paper reports on a real-life study in a US university. In response to financial issues, administration at a tuition-dependent university pushed for growth in student enrollment. The faculty who argued that the quality of education had been declining resisted the expansion. More students also affected the use of university infrastructure. By actively engaging key stakeholders, we developed a simple system dynamics model of university expansion. A major insight suggests that improvement policy decisions made in isolation might result in counter-intuitive outcomes that could take considerable time to recover from.

Introduction

This paper emphasizes the role of system dynamics in the process of organizational change. The authors focus on helping modelers learn about the realities of modeling in an organizational context and improve their ability to facilitate change.

Researchers in system dynamics modeling and simulation methodology (Forrester, 1958; Richardson, 1999; Sterman, 2000) claim that the behavior of complex social systems is a consequence of an endogenous feedback-rich structure (Forrester, 1968). System dynamics has been used successfully in studying complex feedback systems in organizations (Anderson & Lewis, 2014; Black, Carlile, &

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[2] A paper based on this chapter was published in the journal Systems Research and Behavioral Science (R. M. Zaini, Pavlov, et al., 2016)

Repenning, 2004; Rahmandad, 2012; Repenning & Sterman, 2002). Change in *universities is a topic that evokes active debate and has received increased attention in the higher education policy and management literatures and could benefit from simulation modeling.*

"The history of decision support tools in all fields is replete with examples of valuable models that failed to have any impact as they are rejected by the organizational immune system.." yet the challenge remains to *" encourage the use of the model as an engine of inquiry rather than as a tool for performance assessment and employee evaluation"* (K. Cooper & Lee, 2009, p. 1). The immune system metaphor used in the preceding statement is illustrative of the internal working of organizations. It is ironic to realize that the same protection mechanism could also be the deteriorating mechanism that resists positive change (Kegan & Lahey, 2009). Therefore, focusing on building high fidelity models that remain as foreign objects in the organization does not promote organizational learning and change (O'Reilly, 1995; Vennix, Akkermans, & Rouwette, 1996).

A lack of understanding for modeling and simulation may inform the lack of credence for such research on organizational settings (Harrison et al., 2007). Therefore, a successful modeling experience goes beyond meeting modelers' desires to build intricate models. Although this is an important part of the issue, modelers must also encourage people to buy in or at least start a conversation to entice learning based on a systemic view of how the system works and how the problem exists within that system (Argyris, 1990). This is more likely to occur when stakeholders agree on the basic model structure. Therefore, to demonstrate the application of system dynamics in facilitating change, the project on which this paper is based needed to facilitate an institutional debate about an issue through a system dynamics model. The model draws upon people's knowledge of organizational processes and provides a different language for discussing issues. Active stakeholders' participation is needed to grow the model's level of complexity, promote model ownership, and utilize it in the organizational strategic planning process.

The impact of undergraduate students' enrollment growth on quality and resources in a specific US university is modeled. The selection of the topic was fine-tuned following extensive interviews with project stakeholders. The issue is ubiquitous in any tuition dependent educational institution (Carlson,

Blumenstyk, Thomason, & Newman, 2013). The university in the past have operated below the profit line. This issue is why the university needed to grow student enrollment. Net revenue growth, in turn, helps the university to grow facilities and faculty to attract more applicants. A topic of much debate centers on both the unintended consequences of growth and mitigation of those consequences over time. University resources, as the definition evolved along the course of this project, include faculty and facilities. Quality also evolved after deliberations to include faculty academic experience.

Stakeholders have different backgrounds and their involvement in the project varies degree. Three are faculty members have extensive system dynamics background with involvement in different committees. One is a senior faculty member, and an alumnus of the university, who acts as the voice of the faculty. This stakeholder has dissented with the administration as a member of numerous administrative committees. In addition, this stakeholder has limited exposure to system dynamics. The fourth stakeholder is a high level administrator, overseeing strategic decisions in the institution.

The project objective was achieved in this study. For example, the stakeholders' thinking was successfully translated into a small working model replicating the historical trends. In addition, the model helped gain insights into some key policy decisions. The project scope includes a subset of a larger content that could include finance, administration, graduate enrollment growth, and the associated research focus, which could result in showing more interesting behavior to deepen the understanding of the issue in question.

In the next section, we describe the role of system dynamics models in organizational change and review the existing system dynamics work in higher education management with emphasis on the areas of planning, resourcing & budgeting. We then explore the historical trends of the topic, construct the reference modes, discuss the causal loop diagram, and build the model and the user interface. Finally, we conduct experiments to determine the impact of policy decisions on quality and resources.

Previous System Dynamics Work in Organizational Change and Higher Education Management

System dynamics models have been used in the study of organizational change (Milling & Zimmermann, 2010; Zimmermann, 2011), or demonstrate the role of policy recommendations for informing organizational change (Godlewski, Lee, & Cooper, 2012; Roberts, 1978). Researchers have argued that engaging the organizational members in collaborative model building (Hoppenbrouwers & Rouwette, 2012; Hovmand et al., 2012) facilitates learning (Morecroft & Sterman, 1994; Vennix et al., 1996), the implementation of model findings (Rouwette, Korzilius, Vennix, & Jacobs, 2011), and establishment of precursors for organizational change (Franco, 2014). Stakeholders' participation is important because they are the best to identify their own relevant problems and to conduct verification and validation tests (Kennedy, 2011).

System dynamics modeling has been used to explore different topics in higher education management. The topics, according to Kennedy's (2011) taxonomy, cover organizational processes, including: (a) strategic planning, (b) resourcing, (c) budgeting, (d) human resources, (e) enrollment, (f) pedagogy, (g) quality, (h) performance, (i) governance, (j) external forces, and (k) legislation. These issues are modeled at different levels of hierarchy, including: (a) generic, (b) national, (c) regional governmental, (d) university wide, and (e) department and faculty level.

Over the span of 30 years, Galbraith (2010) addressed competition over resources under limited funding conditions. He modeled the decision-making processes of a university and the ramifications of management decisions to stimulate change through incentives on the behavior of faculty staffing and budgeting. He looked at funding allocation depending on enrollment growth and on grants allocation per faculty as a function of academic research output.

The virtual university game, "Virtual U", is a highly sophisticated higher-education management simulation game initially developed to elevate strategic learning among players. The game, widely used in teaching, contains many details and customizations (Baker, 2003). The impact, however, of this game on university planning processes has not been reported.

Barlas and Diker (2000) developed an interactive dynamic simulation model into a university management game, "UNIGMAE". The researchers generated numerous performance measures and demonstrated the systemic nature of university management. This game allowed for stakeholders to understand that individual decisions, in isolation, yield counter-intuitive results when not coordinated with related decisions. The model in this game was built without involving multiple clients. Both faculty members and high ranking administrators used the game; however, no formal follow-up on the games impact was determined[3].

Dennis Meadows (1999) created multiple games to demonstrate the effect of growth. The most widely recognized game, "Fish Banks", was used in university contexts. Meadows found that a proper game design is very important for its effectiveness and realized after many sessions of gaming that more complication means less learning and kept searching for a simpler way of conveying insights.

Szelest (2003) explored a range of university enrollment management theories. In testing these theories, he built a sophisticated dynamic simulation model. He analyzed several strategic initiatives and confirmed the inherent tradeoffs between competing objectives (e.g., teaching and research). At the same time, he found that some conflicting objectives could be simultaneously achieved. His results also emphasized the role of information delays and loop dominance shifts governing the financial resources allocation process and the unintended consequences of policy decisions made with good intentions.

The reviewed literature confirm our stakeholders' centered approach, that considers their priorities, with a focus on creating a simple model to capture their thinking about the issue of the impact of students' enrollment growth. Model complexity will be gradually increased based on the stakeholders' own discoveries. The desire is to leave a positive impression from this experience leading to the adaption of model based approaches in strategy discussions.

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[3] According to a correspondence in November 2012 with the two authors. They generously provided us with the game, the original model, and Diker's thesis. Professor Barlas expressed the intention to update the game in the near future.

Historical trends

During interviews, stakeholders pointed out several references of published data related to the issue of undergraduate enrollment growth. According to a subcommittee report (A. Hoffman, Tichenor, Burnham, Clark, & Heinricher, 2011), the university went through growth in enrollment rate from 2005 onward (see Figure 5‑1) resulting in the growth of the undergraduate student body (see Figure 2-2).

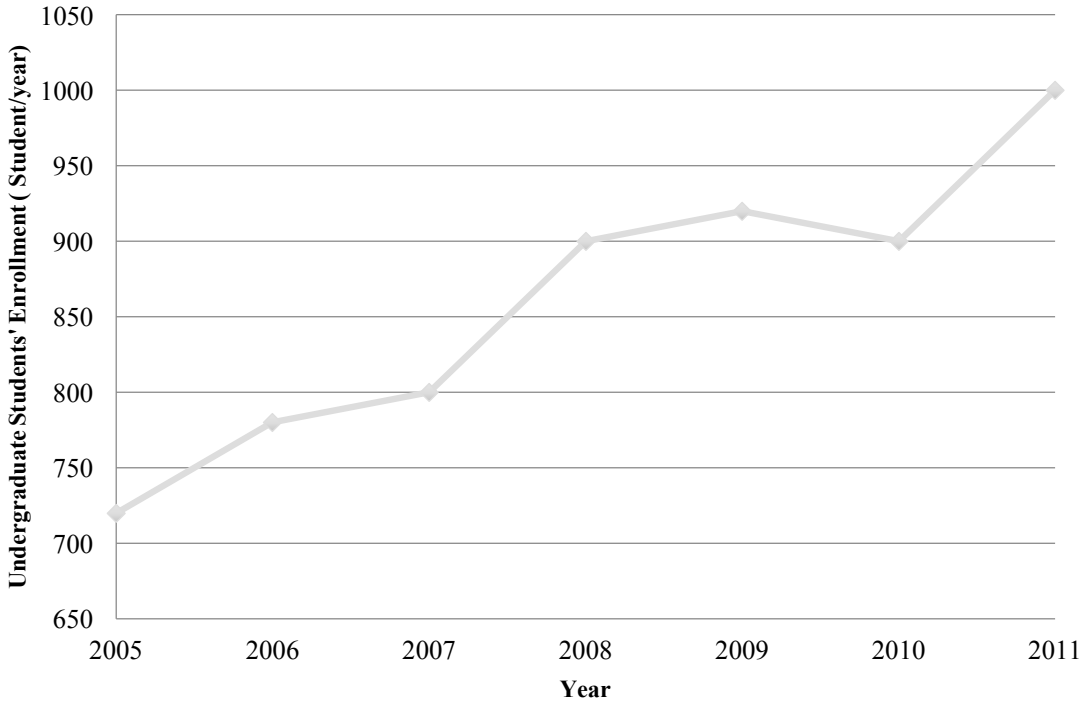

Figure 2-1: Undergraduate students enrollment rate (Hoffman, Tichenor et al. 2011)

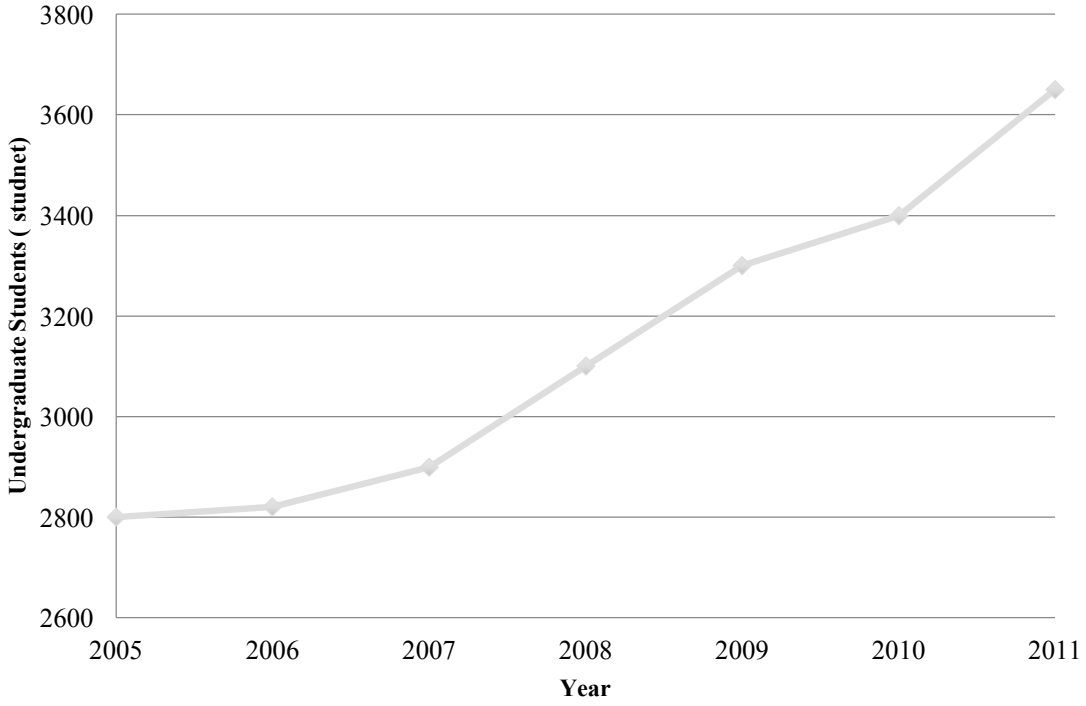

Figure 2-2: Growth of undergraduate student body (Hoffman, Tichenor et al. 2011)

The number of faculty over the same period (see Figure 2-3) shows a relatively constant increase of Tenured/Tenure-Track faculty after 2008. Full-time faculty numbers oscillated over the years under study. In addition, Part-Time faculty numbers declined between 2005 and 2008 but increased in the last two years of the study. During the early years of enrollment growth, faculty numbers did not follow the same trend of continuous growth. This indicates that faculty were overloaded during the initial four-year period of growth in student enrollment.

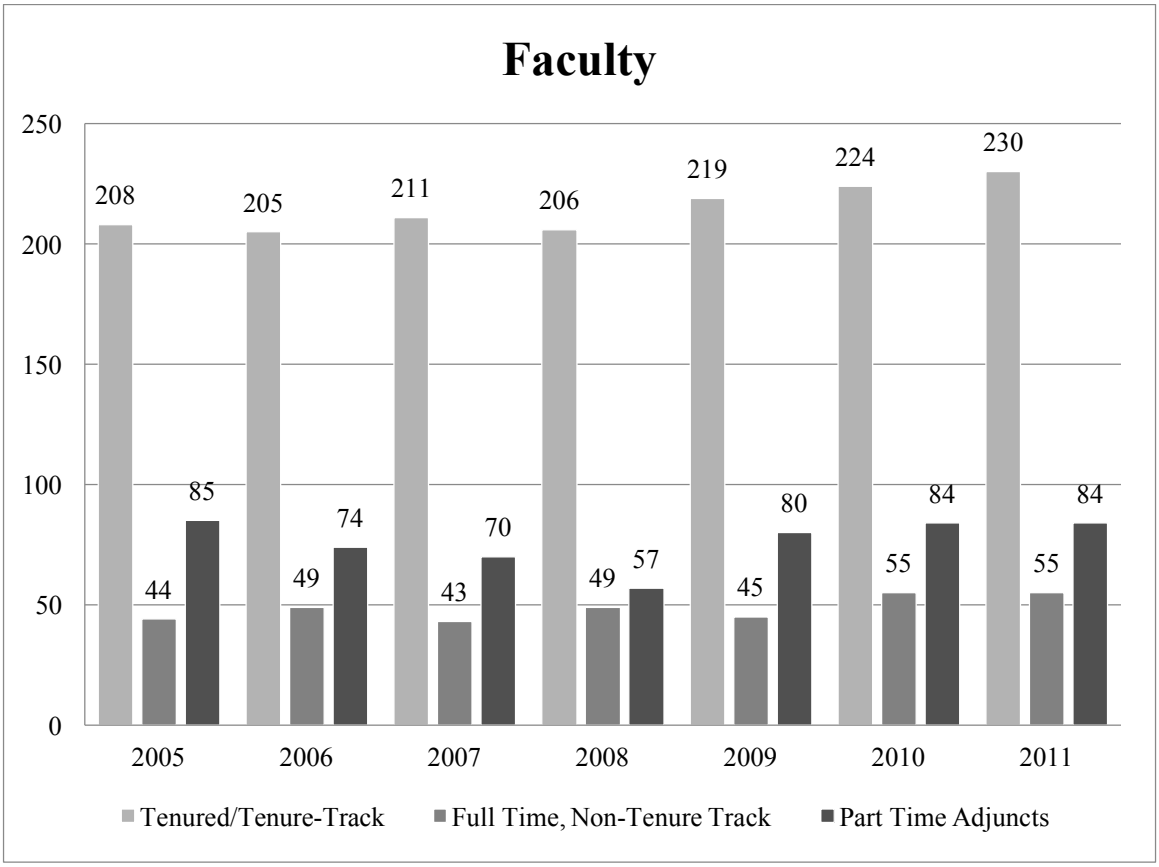

Figure 2-3: Faculty numbers (NEASC, 2012)

According to the New England Association for Schools and Colleges self-study (NEASC, 2012), the need to develop a new faculty workload model was indicated. The current faculty workload includes; teaching, project advising, academic advising, and innovation in courses. Reviewers also noted the shortage in faculty office space and undergraduate laboratory space. The study contained information on the capacity of campus housing to accommodate the growth of student enrollment. Finally, the study provided evidence to support the conclusion that university efforts to replace the budget deficit in Fiscal Year 2001 through FY 2005 with budget surplus from FY 2007 through FY 2010 was successful.

Reference modes

After group interviews, researchers summarized responses and constructed the reference mode diagram illustrating the key variables frequently repeated during the interviews (see Figure 2-4). The

continuous growth of undergraduate students (see curve 1 in Figure 2-4) is believed to continue; however, some university faculty hope to limit the growth at its current value. The growth of faculty members (see curve 2 in Figure 2-4) was at a lower rate in comparison to students' enrollment. Faculty numbers are hoped to increase and meet the growth of students and reach equilibrium. A fear exists among some faculty that faculty numbers may drop in response to increased faculty workload and any associated drop in quality (see curve 4 in Figure 2-4). Faculty load (see curve 3 in Figure 2-4) grew with a hope to drop and reach equilibrium. There is a fear that faculty load will increase as long as students' numbers continue to increase. Quality (see curve 4 in Figure 2-4), defined as faculty academic experience, dropped with the fear that this will continue to drop. The scenarios illustrated in Figure 2-4 would materialize if students' enrollment remains constant without further increase while faculty numbers do not decrease.

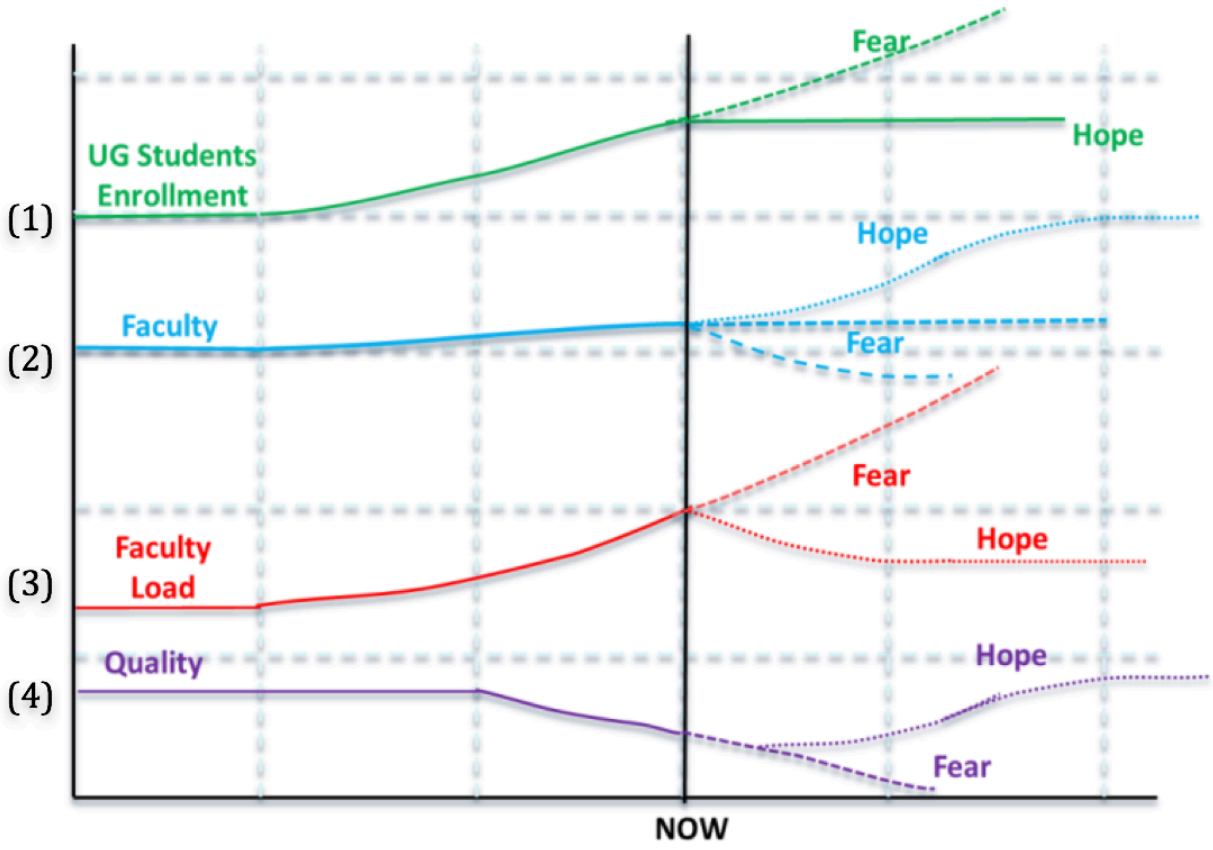

Figure 2-4: Reference Mode Diagram illustrating behavior overtime of key variables reflecting the stakeholders' views of the current situation and their future hopes and fears.

Dynamic hypothesis

Although the main concern was the same for all group members, that is the impact of enrollment growth on faculty, facilities, and quality; individual members had different views on how this concern emerged. Over the course of a few sessions, the stakeholders were able to quickly prioritize two issues to explore, namely; the impact of enrollment on both (a) faculty and (b) facilities. Figure 2-5 illustrates a rather simplified causal loop diagram (CLD) for the feedback structure generated by growth in students' enrollment. The CLD includes key variables associated with students, faculty, and facilities.

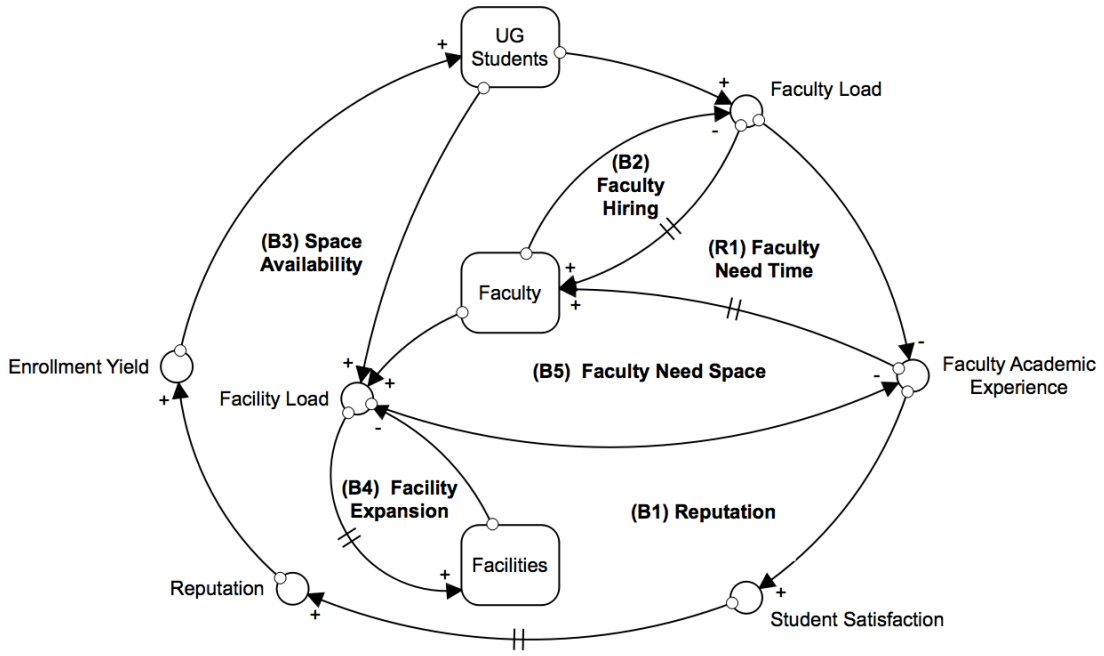

Figure 2-5: Causal Loop Diagram showing the feedback back loops generated by enrollment growth. (B) And (R) at the beginning of each loop title indicate a balancing and reinforcing loop respectively.

The loops description goes as follows:

1. Reputation loop (B1):

As enrollment increases, the student body grows, and faculty load increases overwhelmingly; leading to a degraded faculty academic experience, lower student satisfaction, and negative impact on the

institution's reputation. This would lead to a reduction in the fraction of admitted applicants considering enrollment. Time delay is shown by the two parallel lines between student satisfaction and the effect on reputation, which is assumed to be the time until students graduate from the university or the time needed for school counselors to learn and talk to their students about the school reputation.

2. Faculty Hiring (B2):

As the faculty load increases, and after a time delay needed to hire more faculty, the number of faculty increases to reduce faculty load.

3. Space Availability (B3):

Growth in undergraduate students and faculty puts more load on facilities, which degrades the faculty academic experience, student satisfaction, reputation, and enrollment yield.

4. Facility Expansion (B4):

As facilities load increases, more projects could be initiated to either modify classrooms, laboratories, and dorm rooms. These actions are taken to accommodate more students and faculty or reduce facility load. The results of those actions take time to materialize.

5. Faculty Need Time (R1):

An increase in faculty load degrades faculty academic experience and leads to faculty attrition and further increases the load on faculty.

6. Faculty Need Space (B5):

As more aggressive faculty hiring takes place, more load is placed on facilities. This decreases the faculty academic experience for faculty overloaded by their academic load. Shortage in facilities makes it hard for the faculty to find proper space to teach, counsel students, or conduct research. This would lead to further faculty attrition.

Modeling

The model was constructed while refining the CLD in Figure 2-5. Eventually the group identified more important feedbacks during the process, including the feedback of faculty growth on facilities and

faculty. This reflected both stakeholders' understanding of the structure and engagement in the process. The first version of the model was demonstrated to the group in a storytelling mode. Storytelling enables presentation of the model components one component at a time. This proved to be helpful in discussing each variable and feedback as the model unfolds. The model, at an aggregate level, was constructed in 4 sectors namely students, faculty, quality, and facility (see Figure 2-6).

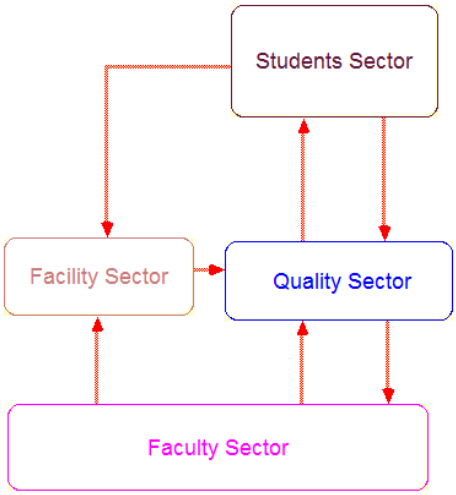

Figure 2-6: aggregate level view of the model sectors

A more detailed version of the model is provided in Figure 2-7. The students sector contains the stock of undergraduate students, which grows with enrollment. Enrollment is a function of applicants, percent admitted of that pool, and the fraction of them who end up enrolling. An enrollment cap limits enrollment. Students' graduation over time reduces their numbers.

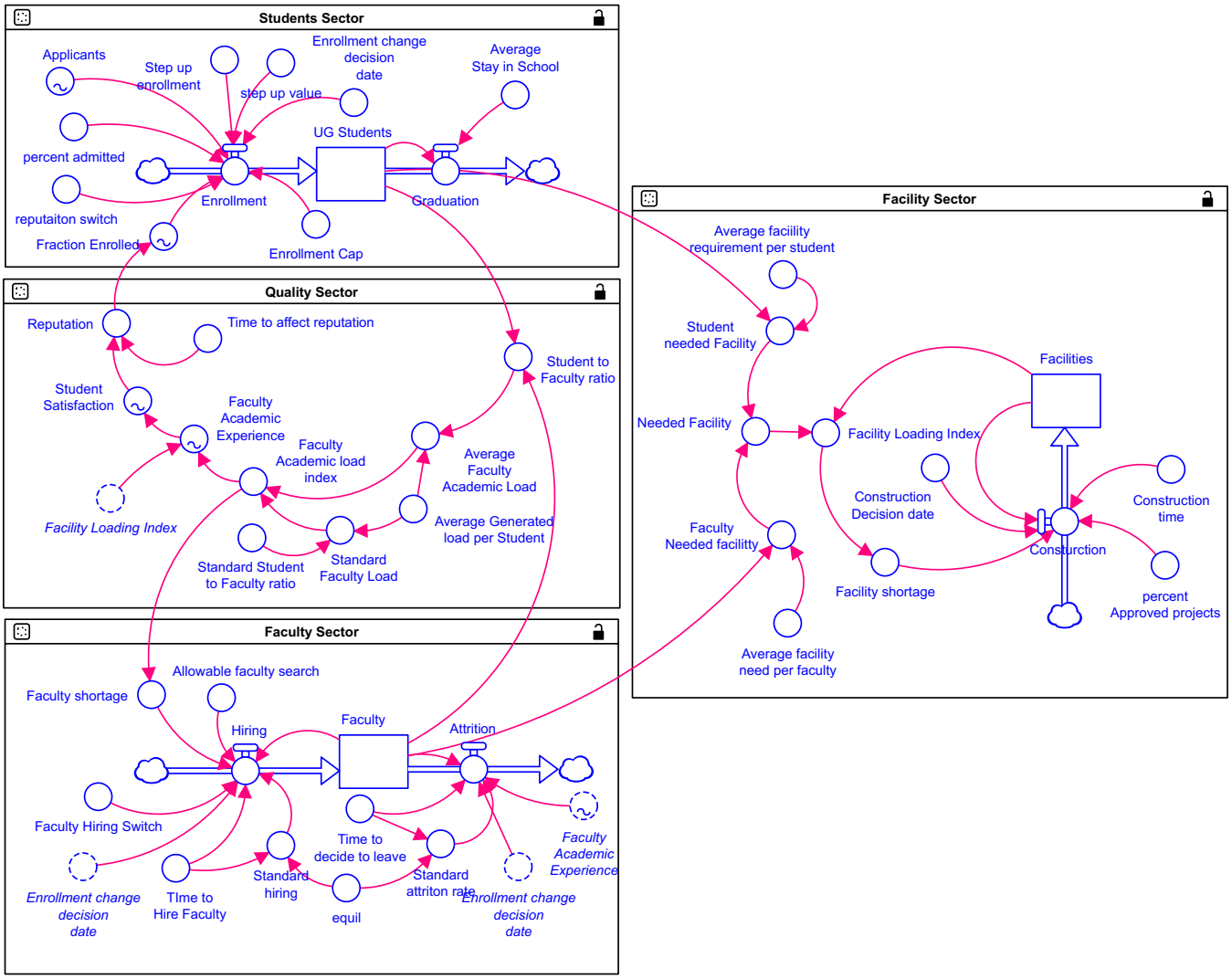

Figure 2-7: Full simulation model shown in sectors

The fraction of students enrolled is influenced by the reputation in the quality sector, which takes time to be influenced by student satisfaction. Student satisfaction, in turn, relates as a function of faculty academic experience affected by faculty academic load index and facilities loading index. Faculty academic load index describes the ratio of the average faculty academic load to an assumed standard load. Finally, the average faculty academic load is the ratio of students to faculty and multiplied by the load generated per enrolled student.

The faculty sector shows that faculty grows by hiring and reduces through attrition. Faculty hiring requires time and is driven by faculty shortage, while limited by the allowable faculty search. Faculty shortage is a function of the faculty academic load index in the quality sector. Similarly, attrition is driven by faculty academic experience and the time it takes them to make the decision to leave.

Finally, facilities grow by construction, which takes time to finish. Construction is driven by the facility shortage and is limited by the percentage of approved projects. Facility shortage is determined by the facility loading index. Facility loading index is the ratio of the needed facility to the facilities stock. The facility loading index, as mentioned earlier, affects the faculty academic experience. Both the student and the faculty space needs, determine the needed facility. Student needed facility is determined by the number of students multiplied by an average facility requirement per student. The same applies for the faculty needed facility where it is determined by number of faculty multiplied by the average facility need per faculty. The complete model with its equations can be provided upon request.

Simulation experiments and discussion

To conduct our experiments, a graphical user interface (see Figure 2-8) was designed to include switches, buttons, and displays that would enable clients to interact with the model and change parameter values. Both the model and the interface were implemented in the iThink© simulation software.

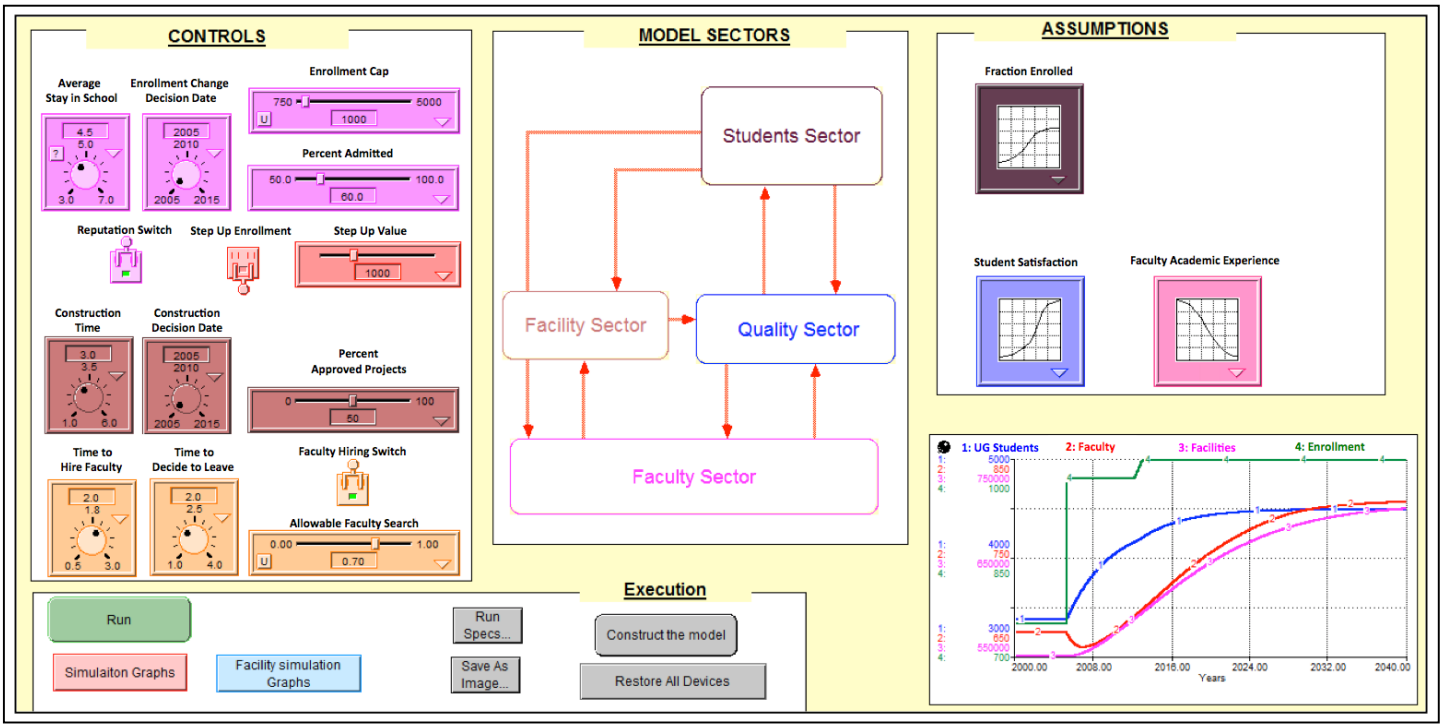

Figure 2-8: Graphical User Interface GUI for the model

Two sets of experiments were conducted. One set used the historical data of students' enrollment (see Figure 2-1) and faculty numbers (see Figure 2-3) to drive the model and was documented in a previous work (R. M. Zaini et al., 2013). This experiment demonstrates how the situation developed over the years from 2005 to 2011. We switched to a policy-testing mode in the second experiment. In this experiment the model was initiated in equilibrium and then disturbed by a step change in students' enrollment. Additional parameter changes were implemented in subsequent experiments. The purpose of conducting these experiments in a state of equilibrium was to improve the understanding of the effect of policy decisions on a system not currently under stress. This approach is thought to provide a better base for understanding the impact of different decisions and interactions. In this paper, we report results from the experiments using the policy-testing mode.

After initiating the model in equilibrium, our model was disturbed by stepping up enrollment, followed by accelerating faculty hiring, and concluding with a reduction in the faculty allowable search. Parameter values for initializing the model in equilibrium are listed in Table 2-1.

Table 2-1: parameter values to initialize the model in equilibrium

Average stay in school	*4.5*	*Year*
Enrollment change decision date	*2005*	*Year*
Enrollment cap	*750*	*Student/year*
Percent admitted	*60*	*Dimensionless*
Construction time	*3*	*Year*
Construction Decision date	*2005*	*Year*
Percent approved projects	*50*	*Dimensionless*
Time to hire faculty	*2*	*Year*
Time to decide to leave	*2*	*Year*
Allowable faculty search	*1*	
Reputation switch	*Off*	
Step up enrollment	*Off*	

We conducted two sets of experiments: one set with an inactive reputation loop (B1) and the other with an active reputation loop.

Inactive reputation loop (B1) experiments:

In these experiments, the feedback loop of reputation effect on enrollment (B1) is kept inactive. This resembles the prevalent mental model that members of the university hold. This mental model assumes the demand will remain in the foreseeable future.

Four cases were simulated and results, illustrated in figures 9 through 16, will be discussed. During the discussion, *curve 1 in all figures* corresponds to the case of initiating the model in equilibrium, *curve 2* corresponds to the case of stepping up enrollment to 1000 students per year, curve *3* corresponds to the case of reducing faculty hiring time to 0.5 year, and *curve 4* corresponds to the case of reducing the allowable faculty search to 0.5.

Figure 2-9 shows the model in equilibrium (curve 1) and when the enrollment is stepped up (curves 2,3, and 4). Figure 2-10 shows how the growth in students numbers a result of the step up in enrollment (curves 2,3, and 4). The nonlinear growth is due to the presence of a draining flow of students graduating over an average period of 4.5 years.

Speeding up hiring by reducing the hiring time making it 4 times as fast did not improve the faculty academic experience as would have been expected. Curve 3 *and* curve 2 in Figure 2-13 are close to each other as the faculty academic experience shown in curve 3 recovers slowly. This is happening since hiring more faculty would increase facilities loading index (see curve 3 in Figure 2-14) resulting in a lower faculty academic experience, as explained earlier by loop (B5) in Figure 2-5, despite the fact of having lower academic load as depicted by curve *3* when compared to curve 2 in Figure 2-12.

Finally, the reduction of faculty allowable search would set a new equilibrium level for the school both in faculty academic load (see curve 4 in Figure 2-12) and faculty academic experience (see curve 4 in Figure 2-13). This is a result of a decision the organization has consciously made to maintain a certain operational capacity, which translates into a new norm for faculty load and academic experience.

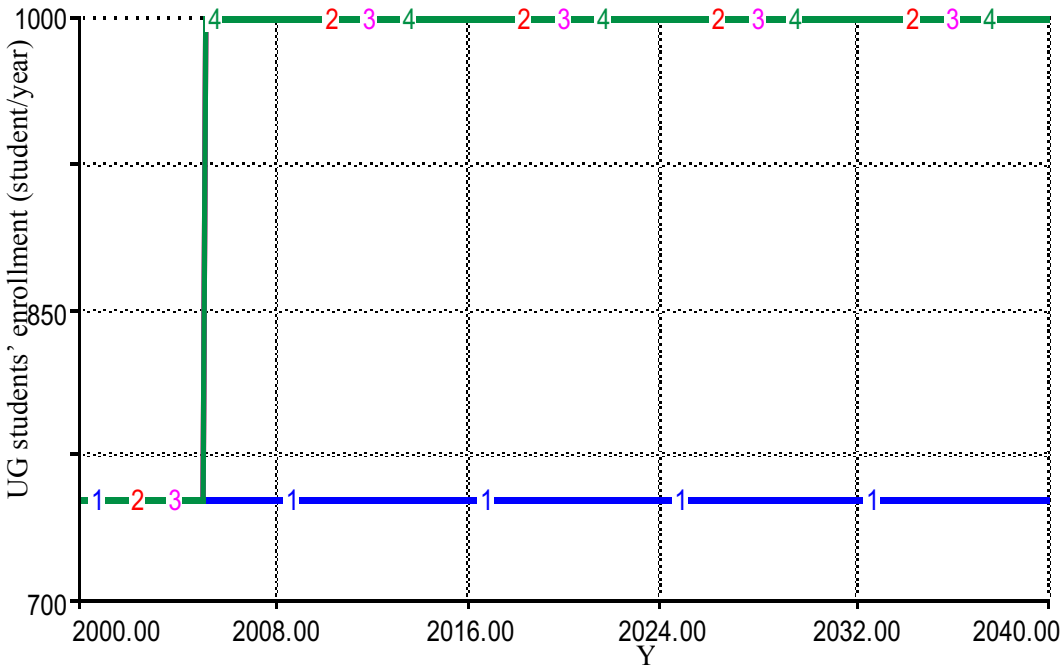

Figure 2-9: undergraduate students' enrollment (student/year)

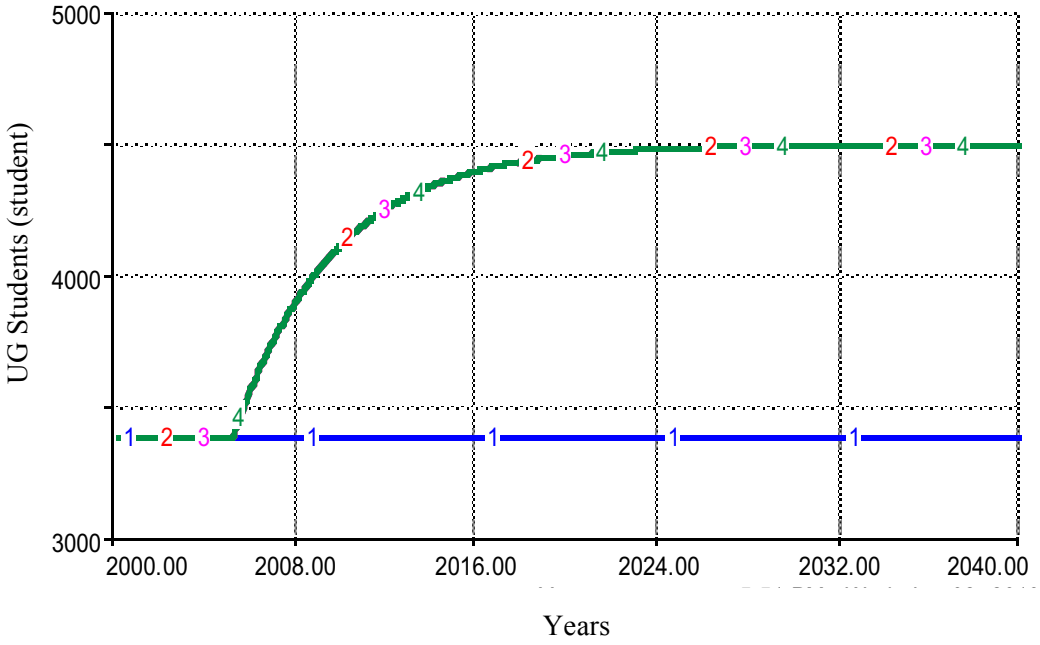

Figure 2-10: Undergraduate students body

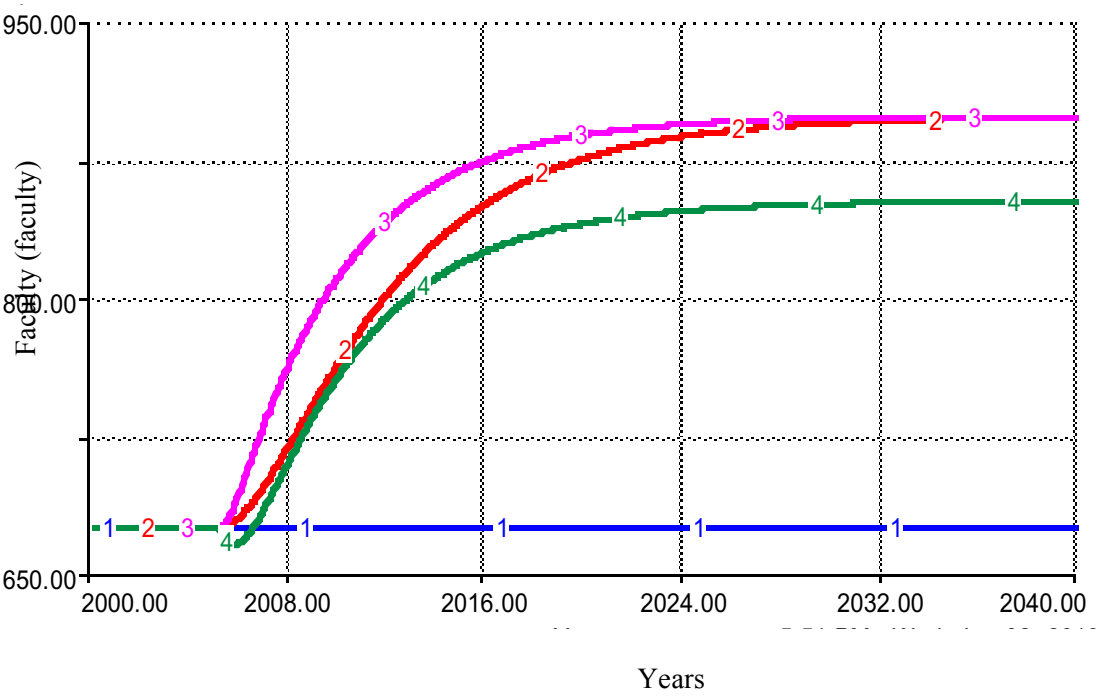

Figure 2-11: Faculty numbers

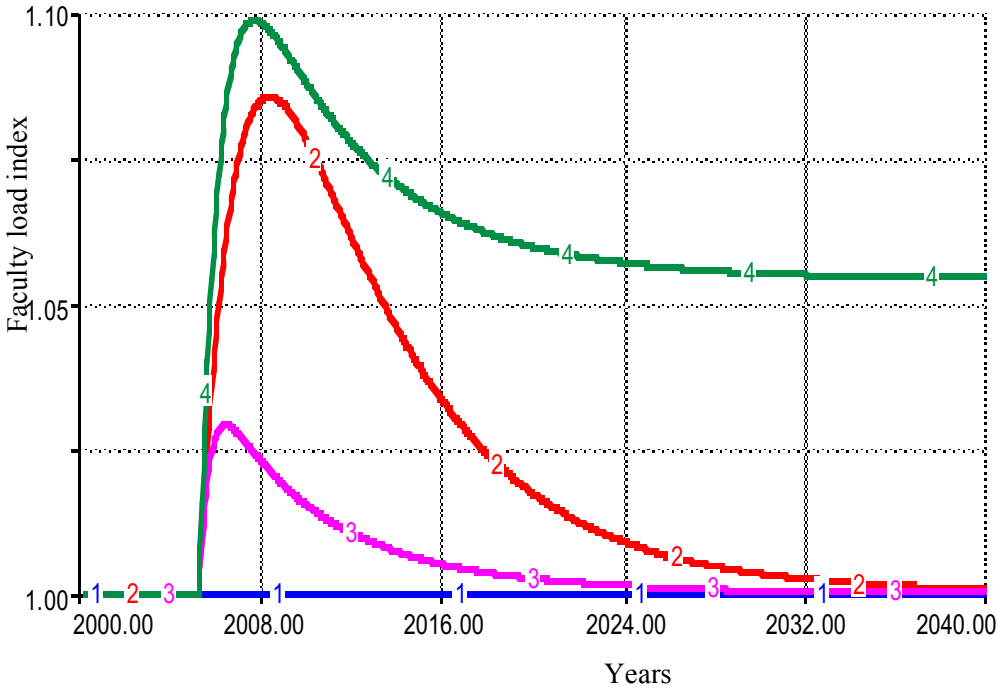

Figure 2-12: Faculty academic load index

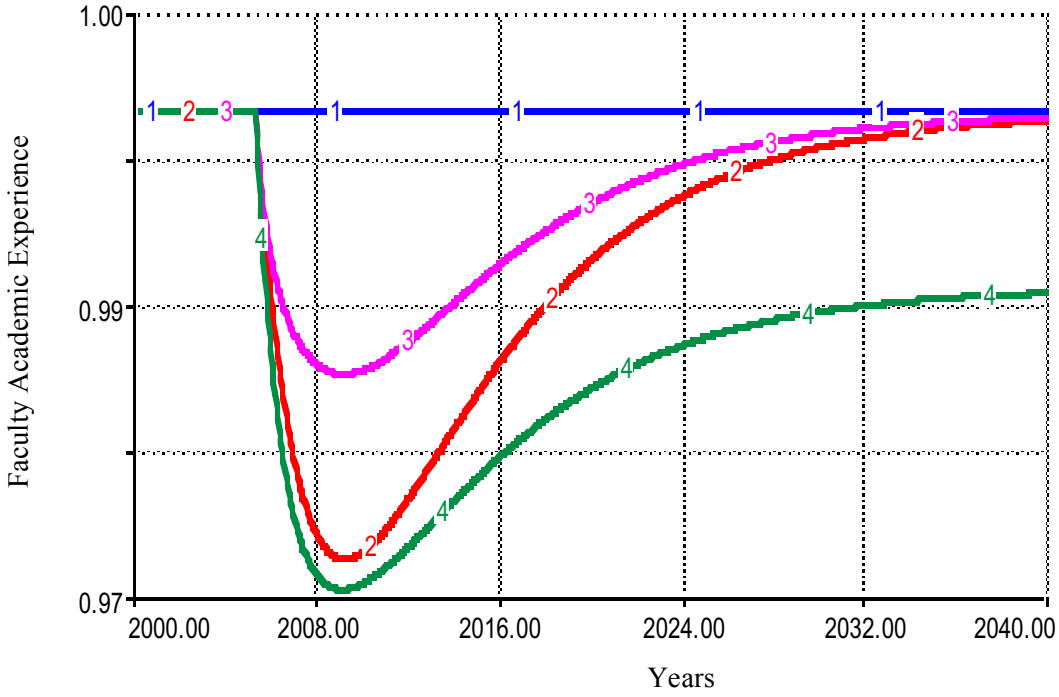

Figure 2-13: Faculty academic experience

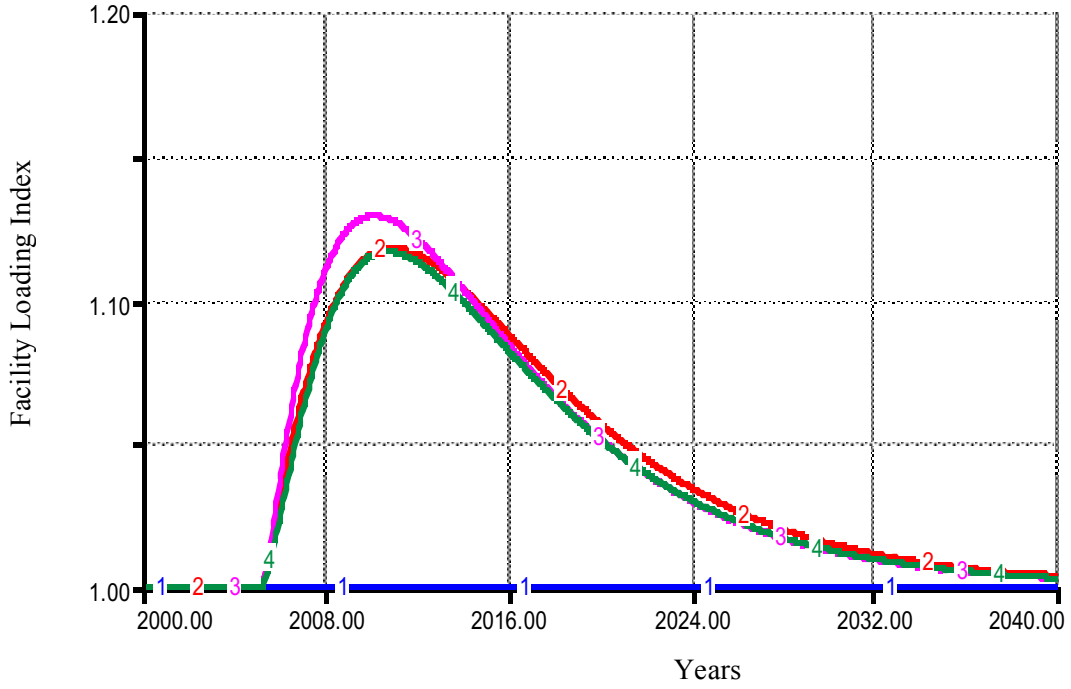

Figure 2-14: Facility loading index

Active reputation loop (B1) experiments:

Activating the reputation feedback loop to test its effect is of paramount importance as this reflects the faculty mental model. The administration at the same time asserts there will be no change in academic standards for admission and for degree requirements. The simulation results of the experiments are shown in figures 15 to 22.

Three cases were simulated. Starting from equilibrium (curve 1), the experiments are conducted by keeping the enrollment at 1000 student per year and reducing faculty allowable search to 0.5 to be closer to reality (curve 2), then allowing a slightly higher faculty search value of 0.75 in an attempt to improve the situation (curve 3).

Enrollment is shown to step up, stabilize for a period of time, and then drops to a much lower value (see curve 2 in

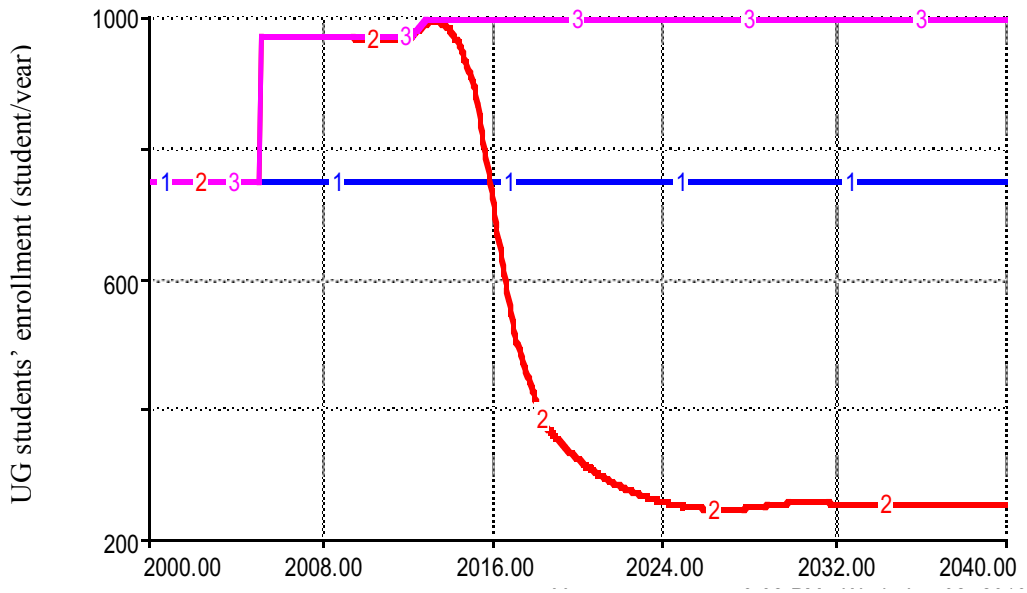

Figure 2-15). This is translated into a severe reduction in the number of students (see curve 2 in

Figure 2-16), faculty (see curve 2 in Figure 2-19), faculty academic experience (see curve 2 in Figure 2-20), and facility loading index (see curve 2 in Figure 2-22). High faculty academic load (see curve 2 in Figure 2-18) resulting in high attrition rate (see curve 2 in Figure 2-19) reduces faculty population as explained by the (B5) balancing feedback loop. With the reduced number of faculty and the decline of faculty academic experience, reputation will suffer. If the admission standards are not changed, enrollment yield and student body will decline (see loop B1). Accordingly, the facilities load will decline and their utilization would fall below unity. This means that there are offices, laboratories, classes, and dorms with neither enough students nor faculty to use them. Such a university is not economically viable to survive and might have vanished earlier should a financial sector was included in the model.

Raising the allowable faculty search to 0.75 sustains enrollment (see curve 3 in

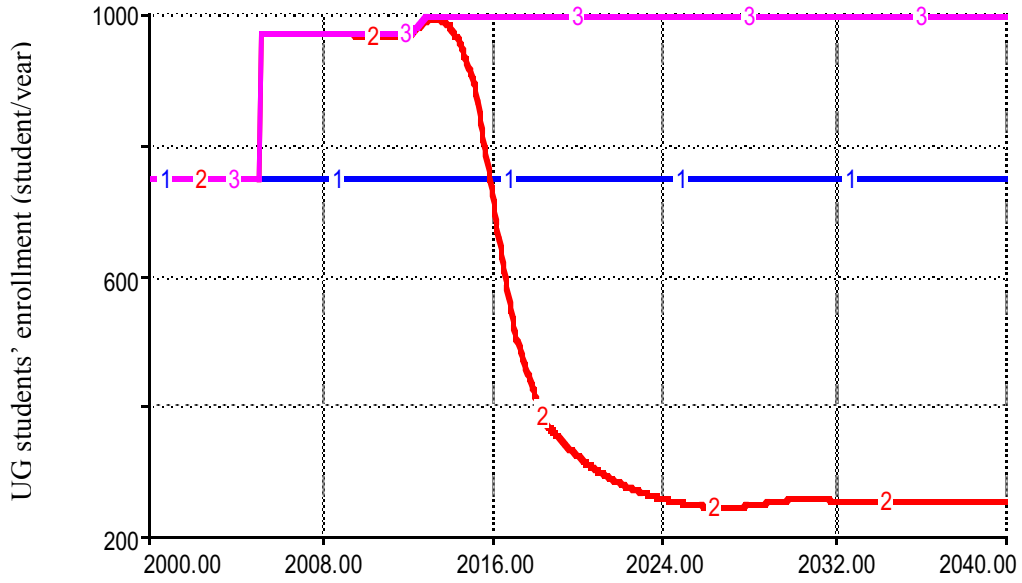

Figure 2-15 and

Figure 2-16). Although faculty numbers are growing (see curve 3 in Figure 2-17), the growing attrition rate (see curve 3 in Figure 2-19) is likely driven by the degraded faculty academic experience (see curve 3 in Figure 2-20) due to the increase in facility loading index from loop B5. These changes in the model keep the faculty academic load (see curve 3 in Figure 2-18) at a higher and unsustainable level. This also indicates operational policies designed to maintain a certain load on faculty and facilities. Including financials in the model may better explain the reasons behind such policies.

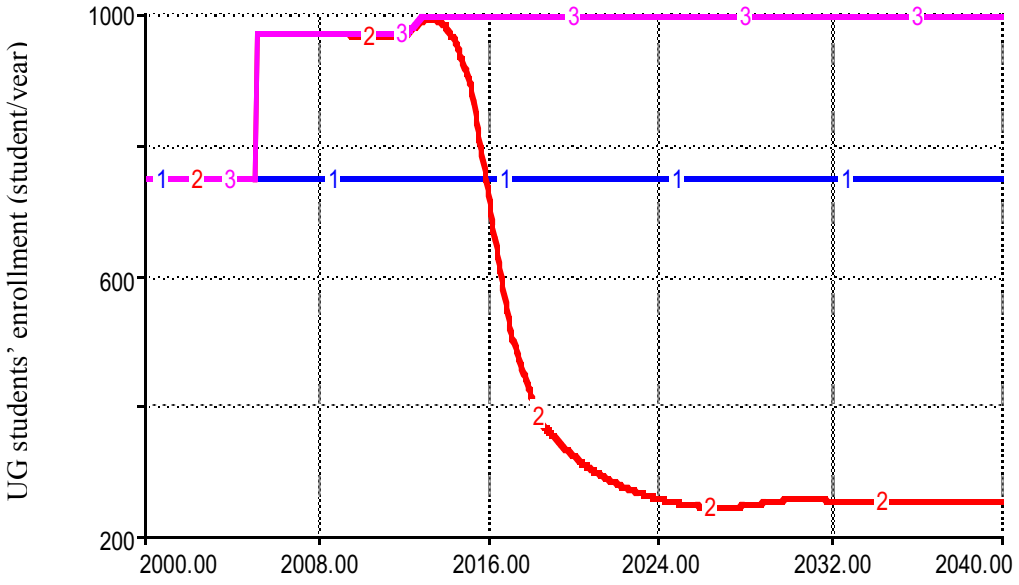

Figure 2-15: Undergraduate students' enrollment

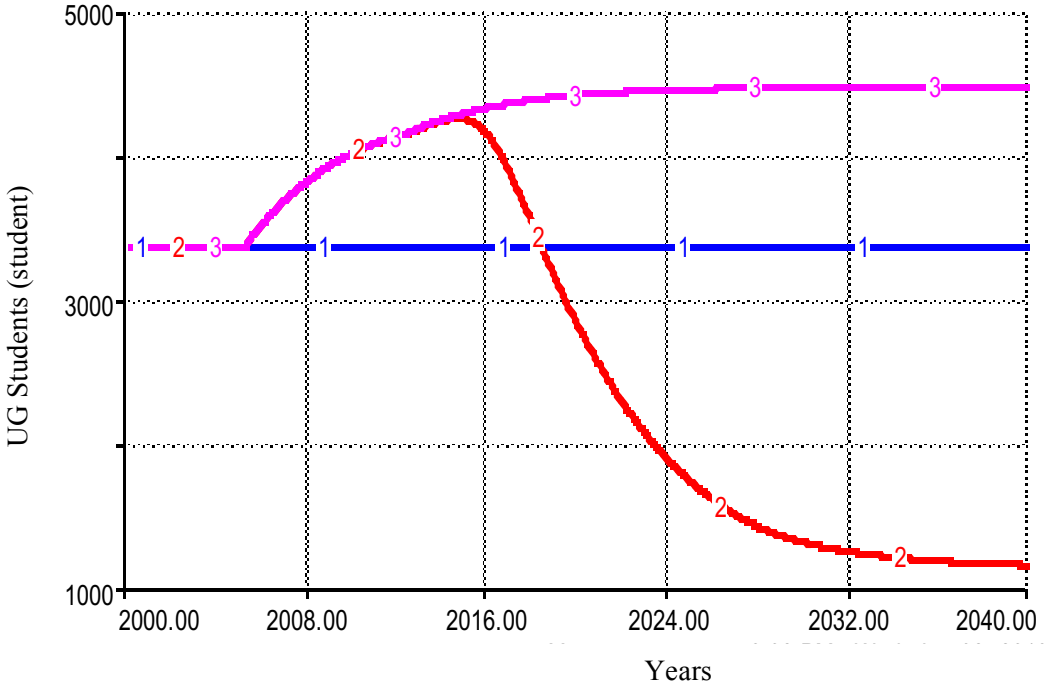

Figure 2-16: Undergraduate students body

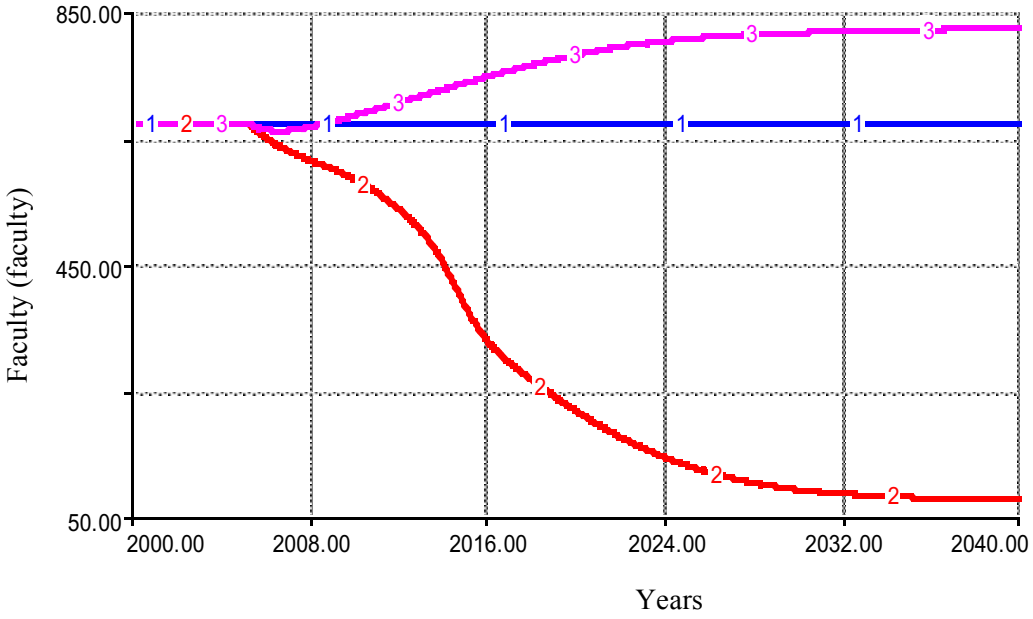

Figure 2-17: Faculty numbers

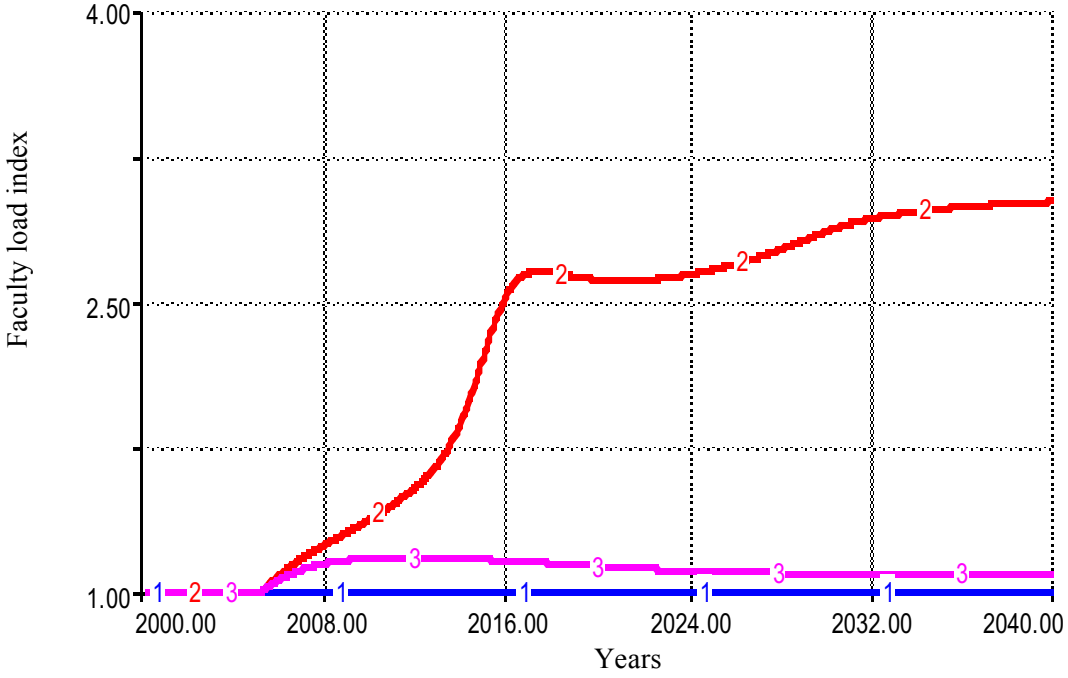

Figure 2-18: Faculty academic load index

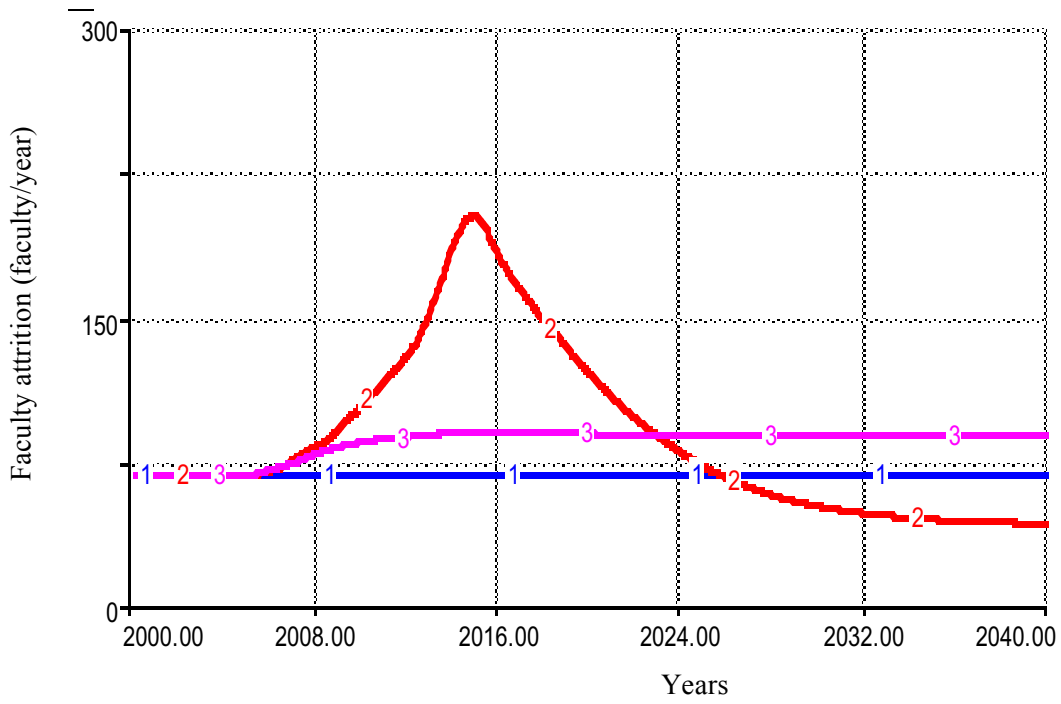

Figure 2-19: Faculty attrition

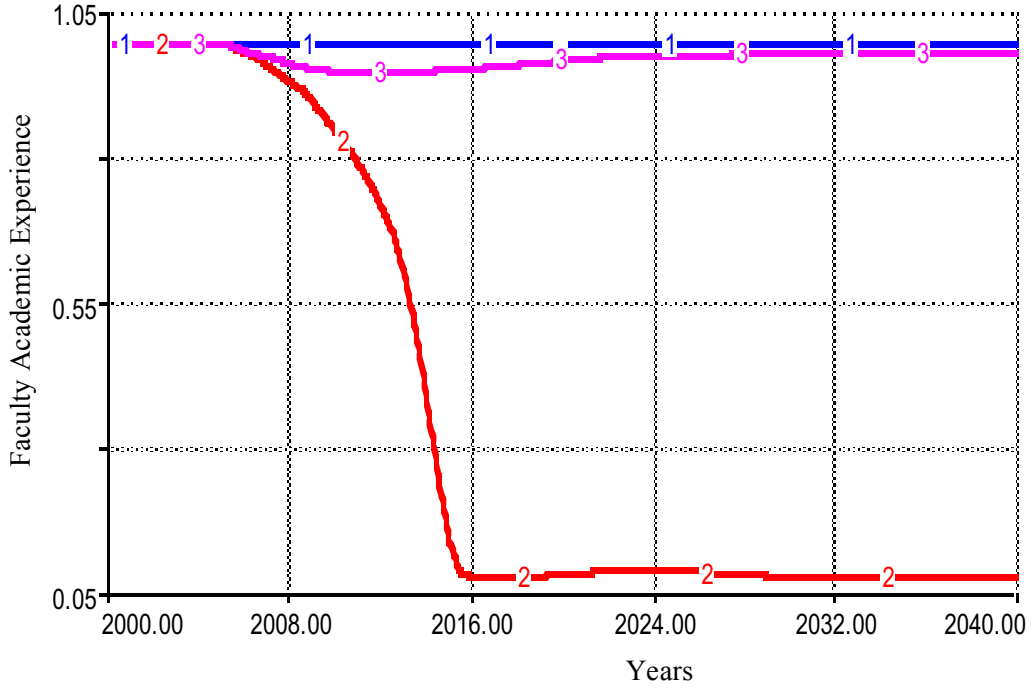

Figure 2-20: Faculty academic experience

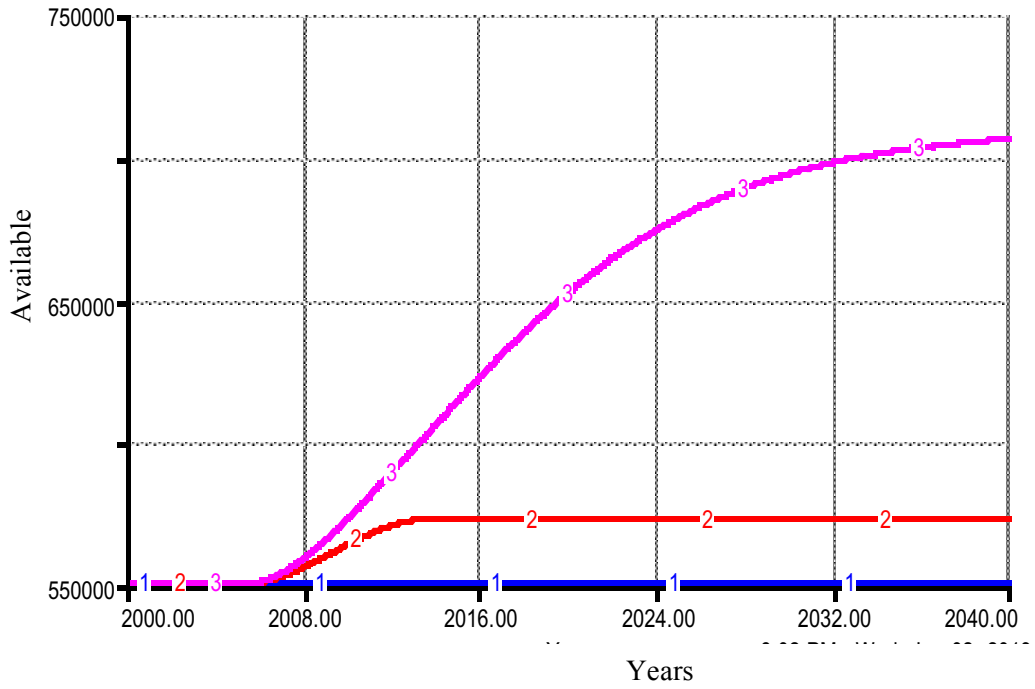

Figure 2-21: Available Facilities

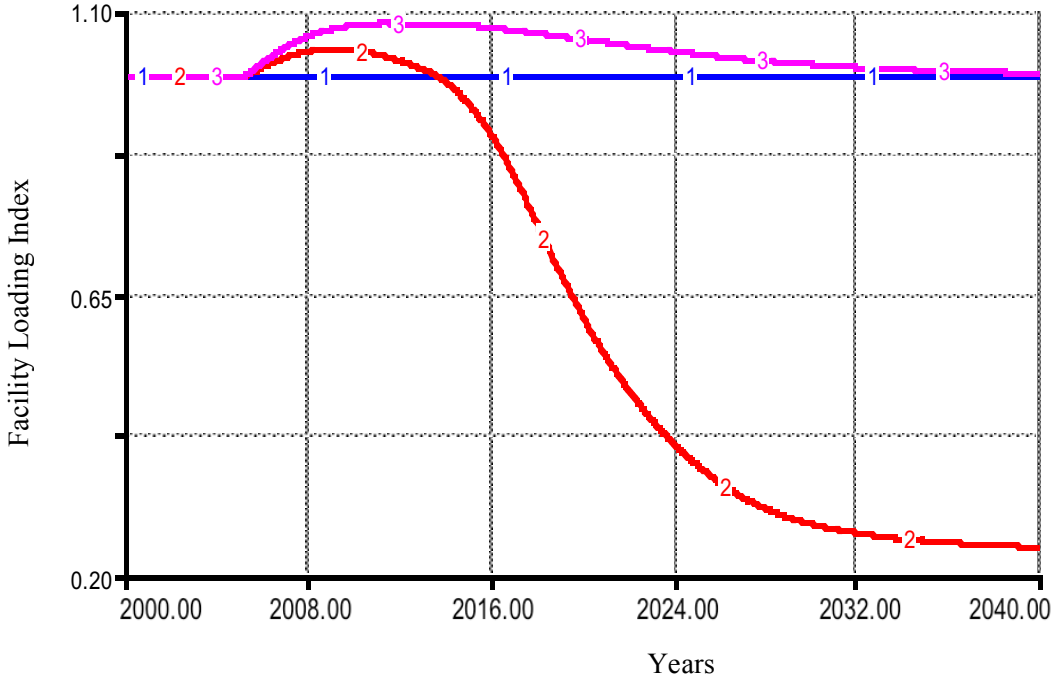

Figure 2-22: Facility loading index

The results of the experiments are summarized in Table 2-2.

Table 2-2: Summary of experiments and their reuslts

Experiment	Policy instrument	Original value	Changed to	Results
Inactive reputation feedback loop (B1) Figures (9-14)	Enrollment target (Curve 2)	750	1000	Long recovery time.
	Faculty hiring time (Curve 3)	2	0.5	Higher load on facilities and lower faculty academic experience and high attrition.
	Allowable faculty search (Curve 4)	1	0.5	Sets a new operating standard of higher faculty load and lower academic experience
Active reputation feedback loop (B1) **Figures (15-22)**	Allowable faculty search (Curve 2)	1	0.5	Collapse of the institution by being not economically viable.
	Allowable faculty search (Curve 3)	1	0.75	Economically viable yet overloaded faculty and facilities, a question mark over the policy sustainability.

Overall, our results show that improvements in one domain creates problems in another domain. This outcome is highly probable when departments work in isolation and make decisions independently. Growth decisions, made at any time, take time to recover from unintended consequences. Additionally, decisions in the form of long term financial commitment to facilities construction, when combined with a limitation on hiring high quality faculty, leads to negative consequences to the institution.

Conclusion

Working with key stakeholders, we were able to engage with these stakeholders on the topic of students' enrollment growth impact. In doing so, we captured and translated their existing mental models into a working model. Despite a lack of detail in comparison to the larger and more extensive models built by other scholars in the domain, our model replicated the reference modes and unveiled the systemic feedback structure that produced them. Our model simulation outcomes, however, were not as conclusive and do not favor any one strategic choice. Ultimately, our model demonstrated the agenda complexity and facilitated different mental models' representation and their consequences.

High aggregation level in combination with storytelling and proper user interface helped improve both stakeholders' understanding and engagement in experimenting and gaining insights from model behavior. Of note, we conclude decisions made in isolation without coordination with other related decisions yield counter-intuitive outcomes. In addition, some outcomes were irreversible (e.g., underutilized newly constructed facilities) or will require extensive effort and extended periods of time to reverse their impact (e.g., restoring quality and reputation).

The slow and gradual progress, as unsatisfying as it might be to a modeler, really paid off and helped gain willingness from the clients to pursue future model development within an organizational charter that brings more people onboard. Future expansion of the model, as suggested by the stakeholders, includes financials, graduate students' growth, and associated focus on research. This allows for a more in-depth analysis of different growth strategies and their outcomes on the university's performance. The hope is to utilize the model as a vehicle for communication and exchange of views around delicate organizational issues and high priority topics typically raised when making strategic choices requiring effective collaboration and organizational change. The model efficacy can hardly extend beyond this to influence organizational change. The presence of change agents who understand the model insights is instrumental to leading and sustaining the change efforts as Franco (2014) have suggested. In fact, a few months after this project was concluded, a university wide email went out soliciting nontraditional ideas for university growth. We offered to participate in the evaluation of suggested ideas based on our previous work; however, our offer was politely declined.

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Chapter 3 : Startup Research Universities, high aspirations in a complex reality: a Russian Startup University case analysis using Stakeholder Value Analysis and System Dynamics Modeling[4]

Abstract

There have been several initiatives by the governments in different parts of the world to establish world class universities (WCU). Such initiatives have been attempted only several times and yielded varied results. This article contributes to the existing body of research in architecting world class universities by presenting an operational strategic modeling framework that is grounded in the existing body of literature for developing WCUs (Salmi, 2009) which can be used to test assumptions, reveal strategic levers, and analyze dynamic complexity inherent in a task of scaling a startup university. We present a research study that leveraged stakeholder analysis and system dynamics modeling to architect and test a long-term strategic plan of scaling a newly created Skolkovo Institute of Science and Technology (SkolTech) in Moscow, Russia. We find that existence of patient capital and favorable governance is conditional on university leadership's ability to effectively manage stakeholder expectations, maintain high quality standards of its faculty and student population and protect its brand of a world class institution. We argue that the operational framework and findings derived from the case of SkolTech can be generalized and applied to other efforts in that area.

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[4] A paper based on this chapter was published in the journal Triple Helix (R. Zaini, Lyan, & Rebentisch, 2015)

Introduction

The Skolkovo Institute of Science and Technology (SkolTech) is a private graduate research university in Skolkovo, Russia. It was established in 2011 as an initiative to integrate Russian scientific capabilities with entrepreneurship and innovation as a means of increasing the dynamism and diversity of the Russian macro economy. It has been developed in collaboration with the Massachusetts Institute of Technology (MIT) and is supported from MIT by the MIT SkolTech Initiative. It is unique in its mission and setting – create an equivalent Cambridge MA or Silicon Valley on the outskirts of Moscow – with its combination of world-class research university and vibrant entrepreneurship community coexisting symbiotically. Partnering with MIT enabled SkolTech to leverage a proven path of world-class research and innovation. SkolTech chose to develop five primary education and research programs, corresponding with Russian technology priority areas: Information Science and Technology, Energy Science and Technology, Biomedical Science and Technology, Space Science and Technology, and civilian Nuclear Science and Technology. Graduate degrees are granted in each of these areas.

The case of SkolTech is an opportunity to explore and understand how complex educational systems in their startup phase behave and evolve in light of the research done in this area. For the researchers, this is a fascinating opportunity to apply tools for analysis and understanding that are themselves in the early stages of their development and are continuously evolving.

The role of research universities in transforming the economy

Over the past century, science and technology universities played an integral role in the innovation, economic development and prosperity of a region or country (Chameau, 2013; Etzkowitz, 2002). Therefore, research universities' roles extend from educating world class scientists and engineers to providing the social environment for their students and faculty to create and nurture ideas with commercialization and entrepreneurial value (Hsu et al., 2007). It was found, for instance, that the 25,800 companies founded by MIT alumni employ about 3.3 million people and generate annual world sales of

$2 trillion, producing the equivalent of the eleventh-largest economy in the world(Hsu et al., 2007). These companies create growing markets for utilities, service firms, retailers, and other local-market businesses.

Many assume a straight path from science produced in universities and research labs to innovation to manufacturing, but often neglect the time between realizing the fruits of scientific discovery and resulting economic activity (Gokhberg et al., 2013). Nonetheless, to guide countries in transforming their economies to become knowledge-based, there are four key strategic dimensions that must be present: an appropriate economic and institutional regime, a strong human capital base, a dynamic information infrastructure, and an efficient national innovation system (Salmi, 2009, p. 2).

The role of research universities is evident in training the needed professionals, high-level specialists, scientists, and researchers to generate new knowledge that supports national innovation systems (Salmi, 2009, p. 2). However, a diverse suite of institutions each with different role like research universities, polytechnics, liberal arts colleges, short- duration technical institutes, community colleges, open universities, and the like are needed to produce the range of skilled workers needed by the labor market for it to function properly and achieve the needed development balance (Salmi, 2009, p. 2).

SkolTech as a change driver

Russia, while working on its transformation into a market economy, still depends highly on its export of natural resources and lacks an internal mechanism for sustainable growth(Gokhberg et al., 2012). Despite Russia's long history of scientific and technological breakthroughs, the available high-quality human capital and scientific potential (Graham, 2013) is trapped in the Soviet tradition of keeping research separate from both enterprise and universities (Gokhberg et al., 2013). The Soviet union at the time prohibited the entrepreneurial capitalism in fear of entrepreneurs rising as power rivals (Graham, 2013, pp. 161-162). Graham (2013, p. 135) also argues that the Russian universities were mislead by the development of the research university model in Europe in the early 20th century that focused only on research without education which the American universities that followed that model soon abandoned. Russia persisted on following that model and invested heavily in creating the Russian Academy of

Sciences and its affiliated research only institutions thereby creating a rift between teaching and research which according to some prominent American scientists and academic administrators is a wrong move as teaching actually prevents stagnation and stimulates research and its applications by bringing fresh ideas through the influx of students over the years (Graham, 2013, p. 137).

In 2010, then-president Dmitry Medvedev declared "We have money but we don't have our Silicon Valley," (Saltykovsky, 2013) and gave orders to create an innovative center, Skolkovo, to develop a Russian new economic policy (Kinossian et al., 2014) . SkolTech, a new university with a focus on education and research established in partnership with MIT under the umbrella of Skolkovo, is envisioned to be one of the biggest tech innovation and entrepreneurship centers in the world (Saltykovsky, 2013). Creating a new world class research university, in addition to upgrading or merging existing ones (Gokhberg et al., 2012; Salmi, 2009, p. 43) despite the difficulties involved in the culture change process (Salmi, 2009, p. 9) reflects Russia's high ambitions for accelerating innovation facilitated by its current abundant financial resources.

SkolTech is intended by the highest leadership of the country to give "a shot in the arm" to the Russian technology industries (Saltykovsky, 2013). Government officials hope that SkolTech becomes a "factory" of new faculty that percolates through all Russian universities and affects change with their new, innovative ideas. The Moscow Government hopes that SkolTech will focus on bringing value to the local area by leveraging its engineering component. The aspiration is that other cities in Europe and around the world will recognize SkolTech as a center for technological expertise if SkolTech is able to catalyze visible results in solving major city problems in Moscow.

SkolTech is expected to facilitate access to international talent and research projects and become a major player in the development of an innovation ecosystem and an institution that will prepare students to perform this type of work that will help Russia to become competitive in innovation. In a recent visit to SkolTech to attend the 2nd international startup village conference, prime minister Medvedev expressed his government's unwavering support for Skolkovo saying that "there will be an innovation center and there will be a university –Skoltech" ("Newsletter SkolTech," 2014). The display of support by

Medvedev for SkolTech is worrisome as it does not seem to be shared by president Putin who asserted that SkolTech is not the only the scientific institution in Russia that deserves government support following a veto for its once approved exemption from the need to obtain planning permits ("Plutocrat Vs. Tech-nocrat," 2013). The public also have a skeptical stance towards the new institution as another government corruption venue to stifle the country's financial resources under a noble cause to those in power and their partners, including and not limited to MIT and the involved corporate entities accusing them of seeking their own benefits in the form of tax exempts and improved access to Russia's talent and markets (Kinossian et al., 2014; "Plutocrat Vs. Tech-nocrat," 2013). Others, including existing universities and energy sector advocates, see the mega spending on Skoltech is money squandered (Kinossian et al., 2014). To avoid being in the crossfire between governmental and special interests entities and the , SkolTech need to have robust autonomous governance structure and high degree of transparency (Salmi, 2009) like its partner MIT and many world renowned institutions. For SkolTech to disprove this skepticism and succeed, it needs to build large impact businesses and make more money than what it spends as close sources to Skolkovo assert (Saltykovsky, 2013). But how the public will realize its societal impact of open and accelerated innovation if it is placed in a gated community with a very strict security protocols that isolates it from its surroundings (Kinossian et al., 2014).

Graham (2013) suggests, that Russia's attempts to regenerate the research sector by attracting high-level scientists, upgrading equipment and making greater use of talented students are providing the basis for innovation and there are signs for the appearance of high-tech entrepreneurship in the country. Government intervention to support the national innovation system and university innovation in particular has resulted in multiple success stories, such as spin-off companies and growth in private venture investments (Gokhberg et al., 2013). But the socioeconomic outcomes are too early to be judged (Gokhberg et al., 2012) because the road to be travelled is long and the changes need to be spread more widely, as expressed by one of SkolTech members of the board of trustees[5] in a recent interview.

[5] http://www.skoltech.ru/en/2014/09/meet-the-bot/

However, with a main emphasis on technology and tangible measures (Kinossian et al., 2014) rather than societal change the outcomes might not be auspicious and the government current enthusiasm and support might just be a spasm (Graham, 2013, p. 161) that will diminish overtime simply by a change of leadership or priorities. The government high expectations from SkolTech to have a quick and huge impact and its dependence on government support makes SkolTech's future to deliver what it is designed to do too vulnerable to exogenous shocks that may result from unforeseeable changes in the turbulent political landscape (Kinossian et al., 2014).

The MIT idea

A key element of SkolTech's development is the decision by the Russian government to partner with MIT in the US to help in the creation of SkolTech. Given the central role that MIT was intended to play in SkolTech's development, it is instructive to explore past experiences involving MIT partnerships with nations to develop technical universities and accompanying innovation ecosystems.

MIT exemplifies the latest step in the evolution of universities from the medieval higher education institution concerned with the conservation of knowledge to the entrepreneurial university with the purpose of capitalization of knowledge by combining research and teaching with industrial innovation that has an impact on regional economic development (Etzkowitz, 2002). This entrepreneurial model was championed by MIT vice president Vannevar Bush and transferred then to Stanford university after the second world war through one of his PhD students, Fredrick Terman, who became a provost there (Etzkowitz, 2002). Since the 1950's and shortly after it redefined engineering education, MIT's overall strategy was and still is to become a global institution that has deep ties with research partners around the globe (Leslie et al., 2006). Its focus on entrepreneurship was evident in the startup companies that populated Route 128 which encouraged its champions to market that model to the developing world. The overarching mental model was "... that modern engineering, like modern capitalism, was essentially global and linear. The less-developed would advance by learning from, and emulating, the more-

developed" (Leslie et al., 2006). Despite all the enthusiasm, MIT's experience in exporting its educational model to other parts of the world came with mixed results and seems to have evolved overtime. India, Iran, Portugal, Britain, and Singapore are among the countries MIT was involved in and a brief discussion of its experience in those places is relevant to this topic.

As per the Indian government wish to build a world-class institution with a surrounding environment similar to Boston or Stanford, MIT was involved in India during the 1960's to establish two universities. The Indian Institute of Technology (IIT) at Kanpur was architected along the lines of the MIT way of promoting engineering sciences and preparing scientists and engineers for jobs that could exist only in the United States or Europe. IIT Kanpur succeeded in becoming a world-renowned educational institution that exports 80% of its computer science graduates to the United States. This was seen to have accelerated, in the short term, the brain drain from India rather than having curtailed it (Leslie et al., 2006) but according to recent study this brain drain declined to 40% and is reversed contributing to the emergence of India technological and entrepreneurial spirit and its economic growth (Salmi, 2009, p. 46) . The second university was the Birla Institute of Technology and Science (BITS) which, based on its founder's vision[6], had a local focus to develop field and plant application engineers taking responsibility to identify and execute solutions in the Indian society with Indian materials and workmen (Leslie et al., 2006). BITS successfully helped in educating India's top industrialists and engineers and kept its graduates in India at the expense of lower international profile.

In Iran, during the Shah's reign in the 1970's, the Aryamehr University of Technology (AMUT) was established with the help of MIT to be at the forefront of technical education, using approaches that even MIT did not introduce into its curriculum for a decade. It encompassed state-of-the-art interdisciplinary research centers that transcended traditional academic departments (Leslie et al., 2006). The AMUT mission was to indigenize technology in Iran and not simply to copy it from the west, and to

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[6] Industrialist G. D. Birla

train a group of elite engineers who could compete at international levels without abandoning their cultural values and could become key instruments in the future of economic and social development of Iran. The university delivered on its promise by graduating top-notch engineers but also became an active host for the Islamic revolution. AMUT exceeded initial expectations despite being split into two universities (Sharif University of Technology in Tehran and Isfahan University of Technology) which played a key role in Iran industrialization both in civil and defense technologies a continuous yet disputed brain drain to the developed world.

The MIT-Portugal Program (MPP) launched in 2006 for a five year duration demonstrated a specific collaborative strategy to stimulate critical changes in strategic focus areas in Portugal's leading institutions (Pfotenhauer et al., 2013). The program focused on raising the standards for student internationalization and selectivity rates, building national clusters of excellence, and to reorient engineering education towards innovation and entrepreneurship. The government intervention took the path of upgrading current institutions to foster communication between them rather than creating from-scratch universities to induce change (Salmi, 2009). MIT played an active role in moderating the relationship between the universities, research institutes, and the local industry in addition to teaching students, training faculty, and designing new educational programs. The collaborative program has proven to be a successful policy instrument and a model strategy for building human resources, research and innovation suited for long term economic growth. It was capable of seeding reform at key elements in the Portugal higher education system despite being under budgetary and time constraints. Five years is a short duration in which to cause measurable changes in higher education systems (Pfotenhauer et al., 2013). MPP avoided the pitfalls of brain drain by emphasizing the national identity of the program honoring degrees by Portuguese institutions and the "sandwich mobility anchor strategy" that allowed students to spend an intermediate period during their course of study at MIT after which they had to return back to Portugal to earn their degrees (Pfotenhauer et al., 2013). There are many interesting details about the program strategy, execution, and outcomes that go beyond the scope of this work and could be found in the cited reference (Pfotenhauer et al., 2013).

In its attempt to become a knowledge economy, the Singapore government started the Global Schoolhouse platform and launched the Singapore-MIT Alliance (SMA) with an articulated aspiration to become the "Boston of the east" (Sidhu et al., 2011). The alliance involved Singapore's two national universities, the National University of Singapore (NUS) and the Nanyang Technological University (NTU). It was devised to promote entrepreneurial engineering education and trans-nationalization (Ka Ho, 2008) in the city-state. MIT brand was leveraged to serve that purpose and to attract many international students to study in Singapore. MIT took the lead role in creating the master's degree curriculum and participated in the PhD program design too. It also facilitated joint research between its faculty and their Singaporean counterparts. MIT did not have to endure any financial risks running this experiment as the cost was totally born by the government of Singapore. For MIT, a presence in the dynamic Asia region bustling with economic growth and a plethora of international students would provide it with future collaborative opportunities to maintain its global prestige and financial superiority. The program met many of its performance indicators with respect to student enrollment, PhD completion , and patents and publications (Sidhu et al., 2011). However, Its success in generating technopreneurs is less clear given the long time delays needed for entrepreneurial activities to emerge and flourish. Indicators show that fewer graduates chose to become entrepreneurs and leave safer career choices in academia and industry. Some alumni refer to a broader social context which does not encourage failure, an essential virtue for stimulating and sustaining the entrepreneurial spirit. The assumptions made by the policy makers regarding this type of collaborative effort might explain the gap between their high expectations and the observed outcomes. The government assumed that research and development is portable independent of any local context and can be shipped from one region to another once the resources are there. The other assumption is that researchers are rational actors and can seamlessly fit into any part of the world and effectively function across borders. In fact, MIT faculty neither relocated to Singapore nor stayed for prolonged periods. Singapore, despite its relentless policy fine-tuning, continues to face challenges in its endeavor to retain world-class foreign talent—established innovators and knowledge entrepreneurs. (Ka Ho, 2008)

A transatlantic experimental collaboration program of a different flavor was initiated between two leading western industrial economies sharing many cultural similarities, the United Kingdom and the United States. A five year program was initiated in the year 2000 by the UK government and championed by then counselor Gordon Brown to link one of the top British universities, Cambridge University, with MIT to help transform research into commercial enterprises (Vandre, 2003). The focus was to address perceived issues like the lack of management skills and weak industry-university links in the UK academic institutions, which were perceived as deficiencies in the UK innovation system (Simmonds et al., 2009). The initiative resulted in the Cambridge-MIT Institute (CMI), a joint education and research partnership focusing on encouraging entrepreneurship, increased productivity and competitiveness through coordinated research and faculty and student exchange ("Cambridge, MIT join forces: Universities promote U.K. entrepreneurship," 1999). The UK government had very high expectations from the initiative predicting hundreds of new businesses as outcomes form this partnership ("MIT, Cambridge join forces: Final Edition," 1999). The program underperformed in its early years, which lead to a leadership change (Adam, 2002) resulting in sharpening the program focus and improving its monitoring and evaluation levels, especially the ones related to the consideration of use (Simmonds et al., 2009). The evaluation of the program, however, came with mixed results (Simmonds et al., 2009). The program achieved its objectives in the broader sense of delivering excellent education and research programs with good innovation potential and measurable economic impacts to both partners. Its commercialization outcomes, on the other hand, were comparable to the aggregated average performance of the UK universities with fewer-than-anticipated numbers of spinouts (Simmonds et al., 2009). It was also less successful in running as an experiment to test the CMI model and to systemize the know-how of managing multilateral and interdisciplinary cooperation across borders. MIT senior managers came to recognize, to their surprise, that there is not only one way of excellence and "… a research university can achieve and sustain world-class performance through an approach that is radically different from the 'MIT way'", which contributed slightly to a different approach towards future international partnerships (Simmonds et al., 2009).

The preceding accounts suggest that MIT's approach was constantly evolving over time, trying to learn from its past experiences and adapt its idea of engineering education and entrepreneurship. However, its partners ultimately have the final responsibility for long-term entrepreneurial performance. MIT cannot influence the vision and aspirations of a nation but it can help guide them through the process according to its own evolving approach. The cultural, social, and political challenges that MIT was committed to overcome through modifying its ideas and offer alternatives to accommodate the goals and resources of its partners seem to be harder than expected. It helped found institutions embedded in part with American experiences and expectations, as in the cases of India and Iran, that potentially put them and their graduates in conflict with their economic, and political realities (Leslie et al., 2006). Achieving research synergies between institutions in countries with vastly different histories, missions and trajectories presents many challenges, not all of which can be surmounted by generous funding and access to state-of-the art technological equipment. Policymakers need to re-imagine scientists, engineers, technopreneurs, and higher education entrepreneurs as complex human actors who are embedded in specific cultural and social contexts (Sidhu et al., 2011).

According to Skoltech plans and objectives (2011), SkolTech is an independent private science and technology university seeking to attract and educate talented students from Russia and abroad. It is planned to have 1200 graduate students, 200 professors and 300 post docs by the end of the decade . It is considered a small university with a student to faculty ratio of 6:1 close to California Institute of Technology (Caltech) in the United States, which maintains the lowest number of 3:1[7]. It strives to make a global impact on the supply of talent through education, on the body of knowledge through scholarship, and economic development through innovation and entrepreneurship. It is planning to accomplish that by working closely with local and international partners and MIT comes on top of that list. Its main funding source comes from the Russian government through a non profit Skolkovo foundation. According to the

[7] http://www.caltech.edu/content/glance

founding document of Skoltech (2011), it is interesting to know that MIT was founded to partially emulate the model of the "Russian School" of engineering education at the Moscow State Technical University, founded in 1830, i.e. 31 years before MIT was founded.

The SkolTech partnership with MIT shares many attributes from previous MIT collaborations with national universities as shown in Table 3-1 below. It is a top down government initiative that is generously funded. It involves building an institution from the ground up like the case in India and Iran with a focus on creating a Boston-like environment. This focus was also shared with Singapore, UK and to some extent the IIT Kanpur in India. The interdisciplinary nature of SkolTech academic programs is a signature of MIT philosophy in engineering education which was implemented in Iran, Portugal, Singapore, and the UK. MIT past experience with building new universities included both undergraduate and graduate programs, unlike the case of SkolTech which is solely a graduate university. Similar to the Cambridge MIT initiative, this is a partnership with an industrialized country that has a great pride in its deep scientific and cultural heritage. The most interesting feature in this partnership, however, is that it is between two institutions located in two countries who still are the world's superpowers in the contemporary history and who have totally different views of the world.

Table 3-1: Key attributes of MIT partnerships around the world

Partnership	Change Strategy	Economic development focus	Education programs	Funding source	Overall Outcomes
India (IIT Kanpur)	Building a world-class institution from scratch	Boston and Silicon valley	Undergraduate and Graduate	USAID	World class institution with high brain drain
India (BITS)	Building an institution from scratch	Technology for Serving local needs by local people	Undergraduate and Graduate	Ford foundation	Influential player in industrialization, no world-class status and no brain drain
Iran (AMUT)	Building a world-class institution from scratch	World class technical expertise with national focus	Undergraduate and Graduate	Government	Influential player in technological development with world-class status & brain drain
Portugal (MIT-Portugal Program)	Collaboration between existing institutions	Innovation and entrepreneurship with national identity focus	Graduate	National government and industries	Successful strategy and execution
United Kingdom (Cambridge MIT Initiative)	Collaboration between existing institutions	Innovation & entrepreneurship	Graduate	Shared between UK government & MIT	Relatively successful, less than anticipated spin-outs
Singapore (Singapore MIT Alliance)	Collaboration between existing institutions	Boston of the east	Graduate	National Government	Less successful in creating technoprenuers
SkolTech (SkolTech MIT Initiative)	Building an institution from scratch and encouraging collaborations with existing institutions	Boston and Silicon valley (Innovation & entrepreneurship)	Graduate	National Government	No reported results yet

Ambitious experiment in a complex reality

SkolTech, like other startup research universities, involves closely-watched experiments designed, executed, and managed by academics and administrators from elite western higher-education

institutions like MIT. Their local governments have high trust in these institutions to help safely guide the fledgling universities to their aspired future. Although many universities, as shown in the previous section, were established with high expectations for leading innovation, creating industries, and achieving long-term technological and economic development, not all of them became or will become a local version of Silicon Valley (Chameau, 2013) . This is largely because success of commercial technology depends on factors that exist outside the laboratory, such as politics, social barriers, investment climate, corruption, etc. (Graham, 2013). Hence, the degree of institutional effectiveness and impact on the innovation and prosperity of a region varies significantly due to the complexity of the issue at hand.

According to Chameau (2013), Many factors contribute to the success of such initiatives including, but not limited to the educational ecosystem that involves not only the institution of concern but the network of research universities and colleges that provide the education and manpower needed to propel the knowledge driven economy. Other factors relate to disciplinary focus, collaboration with national and international partners, and the supporting culture for technology transfer. The most important factors may involve the presence of institutional environments that support both curiosity-driven research as well as problem-driven research. The latter is short-term focused and gratifying while the first is long-term and risky but delivers great discoveries with the most dramatic impact. When this is combined with an agile operational structure that welcomes interaction with diverse stakeholders in the economic arena, a success-reinforcing culture materializes to perpetuate success. For instance, the overall MIT entrepreneurial ecosystem, consisting of multiple education, research, and social network institutions and phenomena, contributes to the outstanding and growing entrepreneurial output mentioned earlier. However, this ecosystem evolved over 150 years promoting the culture of "Mens et Manus," or "mind and hand."(Roberts et al., 2011). Chameu (2013) also emphasizes the experimental nature of the new institutions as a source of strength that allows them to pick and choose from the best practices of world-renowned universities to design and build their own experiment in areas that may be impossible to consider in established universities.

It is worth noting also that the success of Boston's Route 128 or California's Silicon Valley resulted mainly from a bottom-up approach with government support, contrary to many top-down government-directed initiatives that are found in SkolTech and others (Graham, 2013; Kinossian et al., 2014). For SkolTech also, it is not enough to become a factory for entrepreneurs and startups, it is also important that they choose to stay and invest in the region to create long-term impact since for innovation to impact economic growth it is not as important where ideas first appeared but rather where they are developed (Graham, 2013). Brain drain remains a threat to the success of these experiments when outstanding educational outcomes is faced with a lack of economic opportunities (Salmi, 2009, p. 73) in the presence of strong international industrial partners seeking the best talents for their own organizations, professors running state-of-the-art research labs and in constant lookout for the qualified graduate students, or venture capitalists seeking a more dynamic and investment-friendly environment to market their products. There are other elements involved in making that choice. According to Roberts and Eesley (2011) in their study of MIT startups, the factors that make these companies make their choices about one location versus the other are: (1) where the founders lived, (2) contacts network, (3) life quality, (4) proximity to major markets, and (5) access to skilled professional workers. Taxes and the regulatory environment were rated as less important factors for most industries. The independent judicial system, intellectual property protection, and the political system that celebrates entrepreneurs and allows dissent voices to rise up did not show up in Roberts and Eesley (2011) study because in the US the presence of these elements is simply taken for granted. These elements partly or collectively are needed for real gradual reform (Graham, 2013, pp. 162-164) in addition to what we discussed in the previous sections for innovation and entrepreneurship to flourish and make a dent in the socio economic system. This adds more dimensions to consider when analyzing the entrepreneurial ecosystem and goes beyond the scope of this study.

Towards an operational framework for building World Class Universities

In their attempt to jump start their economies in the knowledge-base entrepreneurial arena and create zones like Boston or the Silicon Valley, governments in different parts of the world opted to start

building world class universities from a clean slate (Rasem et al., 2011; Saltykovsky, 2013). Creating new institutions offers the opportunity to pick and choose both talented students and staff (faculty and admin cadre), build regulatory set of rules and incentives to organically create and grow a new culture conducive to what the new institution aspires to accomplish. This is not so easy as it may seem to be. It has cumbersome challenges including but not limited to attracting and keeping the niche spectrum of students and staff to a brand less institution (Salmi, 2009, p. 9) which does not obey the tactic of " if you build it, they will come" (Clary et al., 2011). In addition, this undertaking is a costly one and could result in distortion of the resource allocation system of the higher education ecosystem in the country (Salmi, 2009, p. 13). Eventually, many countries like Malaysia, Dubai, France, and Norway have spent millions on such an approach and failed while some like India, Israel, Singapore, and China have degrees of success in their quests which brings the question of how Russia would fit along that continuum (Graham, 2013, p. 155).

Before going further into what it takes to build a World Class University (WCU), let's define what it means. According to Salmi (2009, p. 5) World class universities are those institutions who achieve superior results in the form of highly sought graduates, leading-edge research, and technology transfer. These results could be linked to three complementary sets of factors found in top universities. They include a high concentration of talent in both faculty and students, abundant resources to support a rich learning environment and to conduct advanced research, and constructive governance features that encourage strategic vision, innovation, and flexibility that enable institutions to make autonomous decisions and to manage resources without being burdened by high bureaucracy (Salmi, 2009, p. 7). The relationship between these factors is dynamic and when aligned as shown in Fig. 3-1they create virtuous reinforcing loops that could lead to reaching the status of a world class university (Salmi, 2009, p. 31).

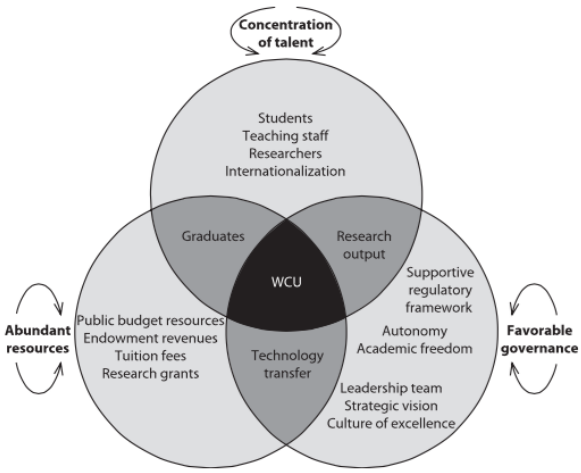


Fig. 3-1: Characteristics of a World-Class University (WCU): Alignment of Key Factors, ref.:(Salmi, 2009, p. 32)

We explicitly reveal these feedback loops and their interactions using the systems thinking feedback loops representation (Wright et al., 2012) in Fig. 3-2. Below.

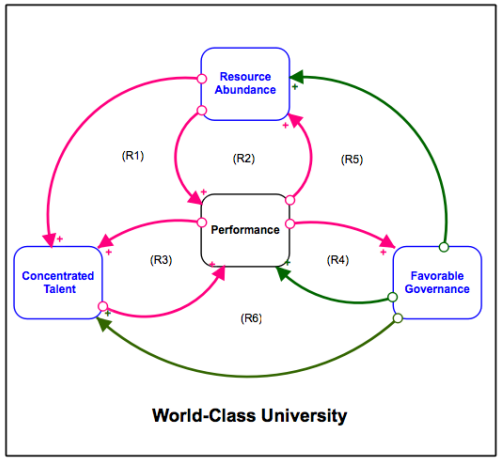


Fig. 3-2: Dynamic representation of the reinforcing loops generated by the alignment of Salmi's (2009) key factors creating a WCU

In the above diagram, the (+) sign shown at the tip of the arrows means an increase in a variable leads to an increase in the linked variable and vice versa, and the (-) sign means an increase in one variable leads to a decrease in the linked variable and vice versa. Reinforcing feedback loops occur when an action (increase or decrease in a variable) creates a result which influences more of the same action thus resulting in growth or decline behavior. They are denoted by the letter R, followed by the loop number (e.g., R1). Resource abundance in the presence of favorable governance that provides autonomy

and academic freedom help attract top faculty who attract students, hence concentrate talent. Concentrated talent and the abundance of well allocated resources due to favorable governance help performance to flourish (Salmi, 2009, p. 31) which enhances the reputation of the university and its ability in the presence of active leadership to attract more resources in the form of grants, gifts, or inventions royalties (Salmi, 2009, p. 24) resulting in more resources and better spending ability and the cycle continues (Loops R1 & R2). Improved performance and reputation attract talent (Jump, 2014) (loop R3) . It has also been reported that high performing universities have more management autonomy (Salmi, 2009, p. 31), hence the positive causal link between performance and favorable governance and vice versa (Loop R4). Its important to notice how favorable governance acts as a necessary element in starting up and sustaining the virtuous loop to bring the university to a world class status (Salmi, 2009, p. 38) facilitating performance, attracting talent, and making better utilization of resources as shown by loops (R4, R5,R6). Any lack in the above three factors will kick a vicious cycle of deterioration and decline. These generated loops could result in either continuous growth or decline in performance, and nothing in between which may overlook other interesting modes of behavior resulting from the mere fact that there are time delays involved between each action and the consequences associated with it (Senge, 1990). Time delays here include the time to attract and hire faculty and enroll students, build facilities, make spending decisions, conduct research, graduate students, and commercialize technologies to name a few. These time delays become visible when representing the loops in a more detailed fashion using the system dynamics modeling icons and connections featuring stocks and flows (Forrester, 1958, 1961). Flows represent quantities that change over time and stocks represent the accumulation and depletion of these quantities over time. Table 3-2 (Saeed, 2008) shows the icons and the processes they represent in a typical system dynamics model where the rectangle represents a stock that integrates the flows connected to it and the valve-like icon represents a flow which is the rate of change associated with a stock which may have more than one flows connected to it.

Table 3-2: Icons used for representing model relationships, ref. (Saeed, 2008)

Process	Icon	Explanation
Stock	name	Accumulation or integration of flows linked to the icon
Flow	name	A rate of change or a derivative of a stock. Empty arrowhead indicates normal direction of flow. Normally connected to a stock. Cloud at one end represents unlimited source or sink
Converter	name	Algebraic function of stocks, other converters and constants
Graphical function	name	Graphically represented function of another variable in the system
Causal link		Information relationship between two variables

A stock and flow with dynamic feedback representation of Salmi's (2009) factors shown previously in Fig. 3-1is exhibited in Fig. 3-3 below.

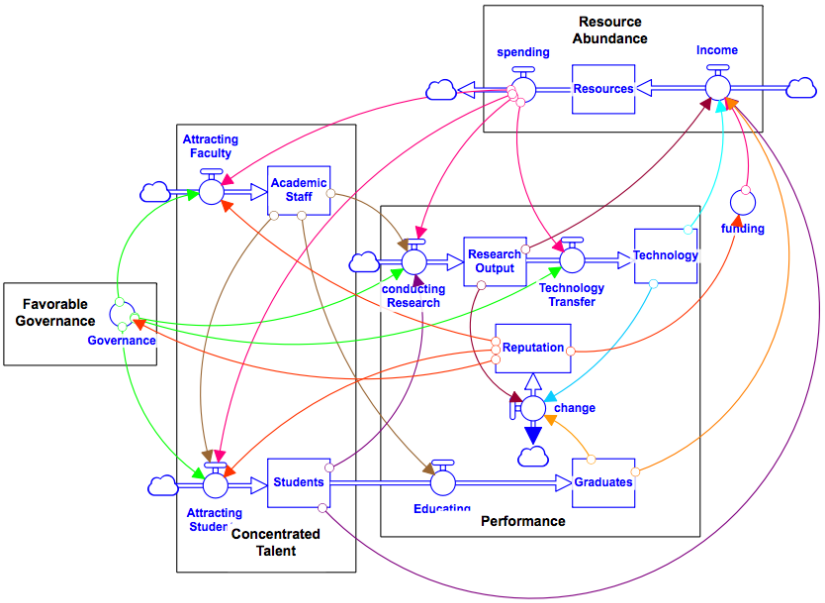


Fig. 3-3: Stock and flow with feedback representation of Salmi's (2009) factors driving the creation of WCU.

This high level diagram shows how the factors are intertwined and also shows the complexity of the issue and its dynamic nature. Hence, despite having the right people and the right resources and governance structures, performance will take time to materialize (Salmi, 2009, p. 72) and be realized both at the national and international realms. This could create difficulties in realizing the dream especially when governments have sky-high expectations to be realized over a short time horizon.

Salmi (2009, pp. 10-11) also delineates a set of 16 strategic questions supporting the three elements which governments and institutions need to think about and have answers for before embarking on establishing universities of this sort. The questions cover a wide spectrum of issues both at the macro and micro levels ranging from the economic rationale of the initiative and the government role in it to the target student population, and how quality and success will be measured. The toughest of them all is: does the country need to create a world-class university to achieve its economic development aspirations or there are alternative and less costly approaches that could be more effective and require less time to achieve (Salmi, 2009, p. 13). Answering these questions would help in building sound strategies for the institutions and the higher education system in their respective countries.

The three key factors involved in creating a world class university which are further expanded in the form of these strategic questions could lead to the formation of a strategy framework. Our study can be viewed as an operational implementation of the factors and their related strategic questions with a focus on SkolTech. It is crucial to consider, reflect, and debate over the questions and their answers, yet it is equally important to understand their dynamic nature and how they are interconnected and relate to the final goal. Using the stakeholder value network analysis (SVNA) to quantify the value delivery network between SkolTech and its major stakeholders and by constructing the strategic architecture (Warren, 2008) of the institution using system dynamics modeling and simulation methodology (Sterman, J., 2000) , we unravel how the factors and the related questions and their answers interconnect and influence each other over time and create an experimentation and learning canvas for the new institution as it progresses towards accomplishing its goals. We acknowledge the role of favorable governance in making or breaking such an undertaking as emphasized in the higher education, innovation, organizational, and system dynamics literature (Graham, 2013; Saeed, 1998; Salmi, 2009; Zaini et al., 2014). Our study assumes the existence of an effective and inclusive governance for SkolTech (2011) and hence, incorporating governance goes beyond the scope of work, however, it will be incorporated in a future and more generic framework. We also do not explore the economic rationale behind building

SkolTech nor why the Russian government chose to build a new institution in addition to upgrading or merging existing institutions in it.

Our work will address architecting SkolTech which shares many world class universities attributes discussed by Salmi (2009) like size, students and faculty talent locally and internationally, degree programs focus, and funding sources and the like. It will also consider other elements that are not explicitly mentioned by Salmi (2009) like partnerships which is an essential element to SkolTech and to many international universities.

Architecting SkolTech

Enterprises, much like products, must be architected as complex integrated systems consisting of people, technologies, processes and information components in order to achieve higher levels of performance (Nightingale et al., 2004) One of the active research areas within the evolving field of enterprise system architecting is the development of effective performance measures that could serve as leading indicators for success or failure of enterprise architecting efforts. One of the methodologies proved to be effective in testing the dynamic impact of different strategies is simulation modeling enabled scenario analysis (Sterman, 2006). An effectively-designed system that reflects how enabling processes, internal and external stakeholders interact and contribute to organizations' short-term and long-term performance can support enterprise designers in ongoing architecting and strategic decisions.

Per its mission, SkolTech strives to excel in three main domains: research, education and innovation. To sustain the development of world-class capabilities in all three areas, delivering value to its diverse set of stakeholders will be critical, and the management systems it has in place can play a major role in achieving its strategic objectives. An enterprise succeeds by supporting the objectives of its key stakeholders (Atkinson et al., 1997). Once strategic goals of the organization reflect key stakeholders' needs, aligning the organization's resources to ensure effective implementation of strategic initiatives becomes imperative. An effective performance management system enables managers not only to

diagnose progress towards achieving strategic goals but also to promote organizational learning, leading to more effective strategic management.

There are eight agreed-upon managerial purposes for measuring performance: evaluate, control, budget, motivate, promote, celebrate, learn and improve (Behn, 2003). Given the early stages of SkolTech development, where organizational architecture and the strategic direction are still forming, a system that focuses scarce managerial and engineering attention on key performance drivers (Simon, 1959) and their contribution to stakeholders' value delivery could enhance decision makers' focus as it relates to strategic planning and implementation in a complex and rapidly changing environment.

To better understand how a startup institutions such as SkolTech can most effectively use its resources to meet strategic objectives, this study focused on two primary goals: 1) to identify key SkolTech stakeholders, what outputs from SkolTech they value, and in what way that value is delivered; and 2) given the identified value streams and corresponding strategic objectives for SkolTech, to understand the factors that might influence SkolTech's ability to deliver that value, with implications for its strategy and policies.

The study leveraged stakeholder value analysis and system dynamics modeling methodologies to achieve the goals mentioned above.

2.1 Stakeholder Value Analysis

Large public enterprises often have multiple stakeholders who participate in and receive value from the operation of the enterprise. Each stakeholder has its own value or utility objective function, and while some stakeholders' objective functions may be aligned, in other cases they may be in conflict with those of other stakeholders or even in part with the enterprise itself. Understanding this complex topography of stakeholders and their values and objectives is important to ensure their continuing participation in and contributions to the overall success of the enterprise.

Stakeholder theory arguably dates back some 30 years to Freeman's (1984) work on the roles of multiple actors in the governance and management of complex public enterprises. This spawned a

number of critical questions such as: "How are stakeholders identified?", "How are their needs discovered?", "How does management adjudicate when inevitable conflicts in stakeholder interests arise?", "How fine-grained should stakeholders be divided?", "How can enterprise management judge whether their performance is benefiting stakeholders in the most efficient or effective way possible?" We build upon more recent work on stakeholder analysis (Cameron et al., 2008; Nightingale et al., 2011; Rebentisch et al., 2005) to focus on answering these questions in a rigorous but applicable fashion.

A formal stakeholder analysis founded on qualitative derivation of key stakeholder needs an objectives and quantitative breakdown of major value flows between stakeholders and the enterprise. It can reveal insights into how to prioritize strategic objectives of the organization in a way that maximizes shared value delivery to the stakeholders and therefore contributes to the sustained success of the initiative. In their work on stakeholder value network modeling, Cameron, et al (2008) developed a framework for developing stakeholder networks to represent complexity of value delivery, prioritizing system goals and linking value network models to architectural models. They also proposed that the organizational value outputs should be traced to responsibilities, processes and incentives dominant in the organization.

As we applied this framework to the stakeholder analysis of the greater SkolTech enterprise, we sought to answer these questions: "How can we architect a public enterprise that must accommodate numerous (possibly conflicting) views and ideas about how it should achieve its defined mission?"; "Who are the stakeholders?"; "How can we gain insight into their interests and values?"; and "How can we simultaneously address what are certain to be conflicting interests and values among the various stakeholder groups?"

The overall process we used to answer these questions, based on the foundational works summarized above, included:

- Identify Stakeholders
- Identify Needs (inputs) & Value Delivery (outputs)
- Identify Value Flows

- Connect Value Delivery (outputs) to Needs (inputs)
- Prioritize Flows
- Analyze the Stakeholder Value Network (SVN)

The objective of this analysis is to identify a prioritized list of specific enterprise outcomes that maximize the benefit to the strategic stakeholders. This list of outcomes would form the basis for an enterprise strategy that emphasizes the delivery of those outcomes. We interviewed 28 experts in 12 domains to understand their needs and priorities. The SVNA identified the top priorities for the system, which were used in the construction of the model. Space doesn't permit elaboration on the SVNA results in this paper (Hess et al., 2013).

2.2 Modeling the Startup Dynamics of SkolTech

Once the enterprise strategy has been developed, the natural question is whether any of envisioned or proposed enterprise architectures are likely to produce the desired strategic outcomes. Because SkolTech is in its nascence, it is too early to document outcomes. Consequently, we undertook a modeling and simulation effort to study the impact of strategic initiatives, resourcing policies and incentive structures on the dynamic development of SkolTech and its ability to deliver value to its key stakeholders.

We developed a system dynamics model of the SkolTech enterprise to model the dynamics of a startup university, leveraging existing systems dynamics methodology (Forrester, 1961) to provide decision-makers with appropriate tools to understand the feedback-loop structure underlying organizational performance which involves growth and depletion of resources over time and to identify alternative strategies to improve it (Morecroft, 2007; Warren, 2008).

The modeling effort was conducted to:

- Define the current state of SkolTech's performance based on objective measures and benchmarking analysis

- Define the desired future state of SkolTech based on leadership projections and stakeholder expectations
- Identify key factors contributing to SkolTech's ability to achieve the future state and deliver value to its most salient stakeholders
- Develop a simulation model that captures the impact of resourcing policies, incentive structures and strategic initiatives on SkolTech's short and long term performance

The stakeholder value network analysis provides guidance for the development of a strategy for an organization that emphasizes goals, means, and ends that focus organizational and leader attention on the key stakeholders and their value interests that had been identified. In the case of SkolTech, a strategy might be informed by the analysis covered in this paper. But a well-posed strategy must eventually be implemented. In the implementation, the robustness and depth of a strategy is tested and potential gaps and weaknesses revealed. SkolTech is on an emergent path that will take many years to unfold and reveal whether the path chosen was the best possible. Even small course corrections in the early stages of strategy implementation could have large and beneficial impacts later on. Given the potential payoffs, is it possible to test a strategy to identify its gaps or weaknesses prior to its full implementation? Is it possible to use this kind of perspective to fine-tune a strategy to better address any potential challenges?

In this section, we study the impact of strategic initiatives, resourcing policies and incentive structures on the dynamic development of SkolTech and its ability to deliver value to its key stakeholders. We employ system dynamics modeling methodology (Sterman, J. D., 2000) to do the following:

- Define the current state of SkolTech's performance based on objective measures and benchmarking analysis
- Define desired future state of SkolTech based on leadership projections and stakeholder expectations

- Identify key factors contributing to SkolTech's ability to achieve the future state and deliver value to its most salient stakeholders
- Develop a simulation model that captures the impact of resourcing policies, incentive structures and strategic initiatives on SkolTech's short and long term performance
- Test different scenarios to identify potential unforeseen challenges to the strategy

We used as primary data sources the strategic plan developed by SkolTech and the stakeholder value analysis cited in this study. We obtained more detailed resource plans aligned with the strategy from SkolTech that provided an early glimpse into how SkolTech intended to organize itself to meet the strategy and its goals. We also accessed public documents describing SkolTech, its mission, organization, and general overview. This modeling effort was intended as a high-level exploratory model to complement the stakeholder analysis rather than a detailed stand-alone predictive model. It is suitable for identifying issues for further study and modeling, but should not be used as a decision-making tool.

In its strategy document, the SkolTech mission is to create impact through innovation and partnerships (see Fig. 3-4.) It aims to accomplish that mission by building a community of 200 faculty members and 1200 students, with many more postdocs and staff. It will have economic and intellectual impact in the Russian Federation by accelerating entrepreneurship across a number of different sectors (see Fig. 3-5 for the goals.) The strategy goes into further detail on specifics of how SkolTech will accomplish these goals. These emerging details provided the necessary background and specific targets to develop a model of the startup dynamics at SkolTech. The intent behind building this model was to test the SkolTech goals to determine whether any specific challenges existed within the strategy itself, or within the context in which it was to be implemented.

The system dynamics model that was created was tailored to the specific setting and aspirations of SkolTech, but was based on accepted elements of models of academic institutions (Zaini et al., 2013), other organizations (Warren, 2008) , and frameworks drawn from prior research and academic publications (Salmi, 2009). As such, it was possible to quickly develop a model from existing elements,

with the primary risks in the model development being the integration of the various parts into one functioning model, and its accuracy in describing SkolTech specifically.

Fig. 3-4 SkolTech mission, as defined by the June 2013 strategy.

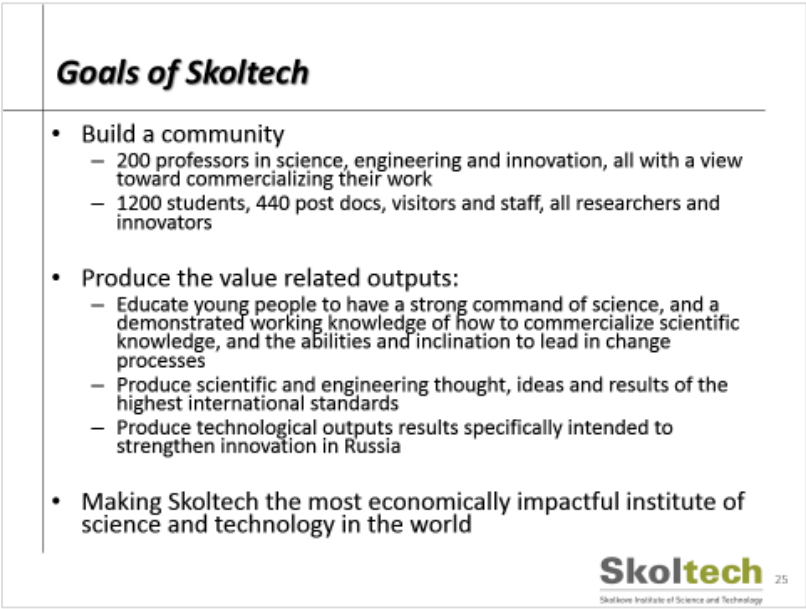


Fig. 3-5 SkolTech goals, as defined by the June 2013 strategy.

Startup research university growth model

In startup research universities focused on technology and innovation, performance is paramount to fulfilling their aspirations to become world-class academic institutions. We attempt here to summarize the major elements contributing to the performance of startup research universities and the dynamic relationships between them. To help simplify matters, we grouped similar elements sharing similar causal relationships with others and created a multilevel dynamic hypothesis in pursuit of insights that improve our understanding of key performance enablers and the strategic management decisions to realize them.

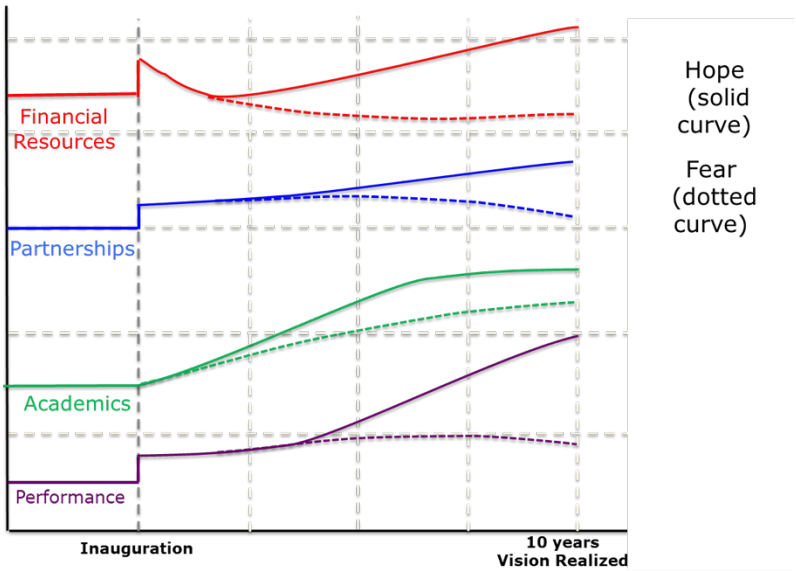


Fig. 3-6 Reference mode diagram showing the major elements contributing to the startup university performance

SkolTech shares the major attributes of international startup universities. As shown in Fig. 3-6, they often start with generous budgets sponsored by their local governments or non-profit private foundations. They tend to sign up with world-renowned institutions with the intent to jump start their performance in terms of reputation, supply of innovative research projects, and attracting high caliber academics. The hope (curves in solid line) is that the performance continues to grow to fulfill their aspirations to be world-class institutions with high economic impact in their regions, grow their academic cadre to reach their designed size, sustain and attract more partnerships, and ultimately be financially viable by at least managing to reach financial equilibrium (Cosenz, 2014) despite their enormous startup expenditures. The fear (curves in dotted line) is that performance does not pick up or in the worst case

stagnates or even declines. Losing partnerships with other institutions, not to mention growing them further is another fear scenario. The inability to attract faculty, students, or build the research facilitates at the required pace is another fear. Finally, depleting the financial resources is a major source of fear for such institutions. This top level story and some of the details behind it provide an overall framework of the issues facing a startup university, and can be represented in a multilevel dynamic hypothesis.

In the following section, we attempt to explore key feedback loops influencing both short and long term performance of SkolTech.

Key Feedback Loops Driving SkolTech Performance

Performance measures in a university could be short-term focused on tangibles like published papers, generated patents, developed and commercialized innovations, and obtained external grants, or long-term emphasizing strategic indicators like reputation, ability to attract to quality faculty and students, and economic impact (Salmi, 2009; Zaini et al., 2014). It's important to realize, though, that performance measurement is an integral part of a wider strategic management activity aimed at achieving a sustainable development of the academic institution (Cosenz, 2014). At the same time, organizational effectiveness often depends on both the quantity and the quality of its outcomes (Jain et al., 2010). SkolTech management needs to cater to stakeholders with different expectations that fall into both the short-term and long-term categories. SkolTech's ability to produce educational, scholarly and economic impact is determined in a large part by the quantity and the quality of its students and faculty. Fig. 3-7 shows a causal loop diagram (Sterman, J. D., 2000) that demonstrates key feedback loops driving SkolTech's performance from the students and faculty side. In the diagram, as explained earlier, the (+) sign shown at the tip of the arrows means an increase in a variable leads to an increase in the linked variable and vice versa, and the (-) sign means an increase in one variable leads to a decrease in the linked variable and vice versa. Reinforcing feedback loops are where an action creates a result which influences more of the same action thus resulting in growth or decline are indicated by the letter R, followed by the loop number (e.g., R1). Balancing feedback loops , on the other hand, represent actions that attempt to achieve a goal and

close the gap between the current state and the objective and are indicated by the letter (B) followed by the loop number(e.g., B1).

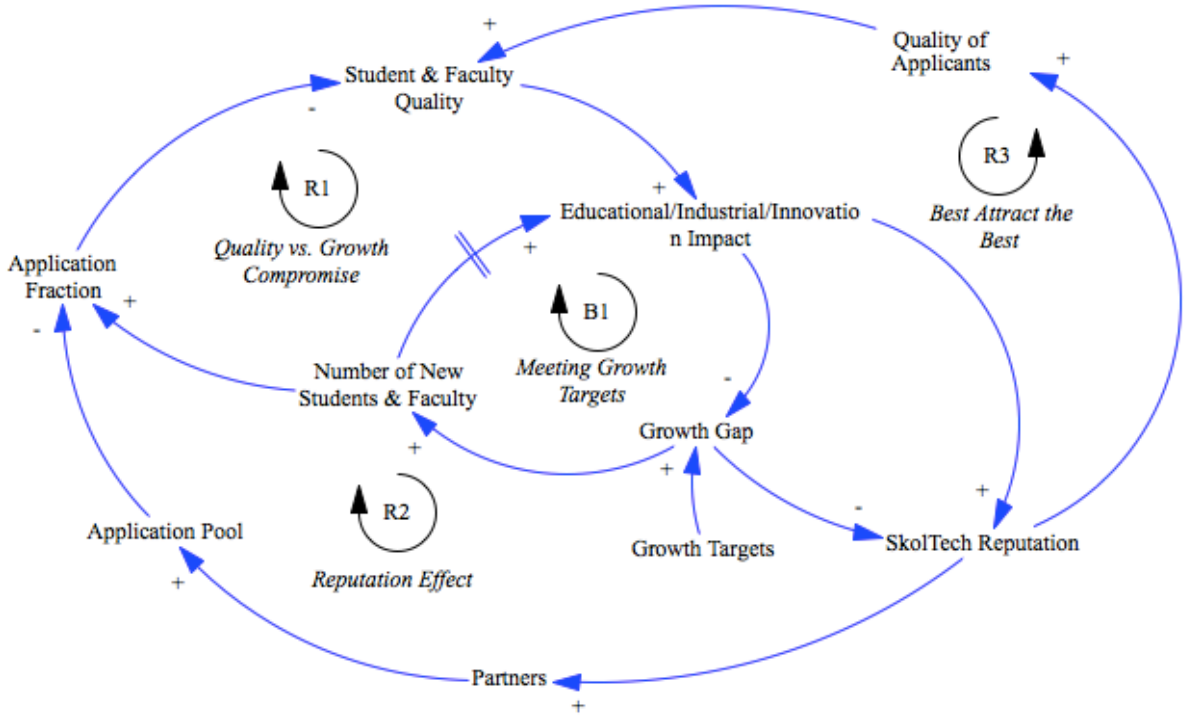


Fig. 3-7 key feedback loops driving SkolTech performance

As SkolTech fulfills its growth targets and makes significant educational, industrial and innovation impacts (albeit with considerable delay) the pressure to rapidly grow its faculty and student populations subsides, which reduces incremental increases in impacts and completes intended balancing feedback loop (B1). SkolTech's ambition to grow rapidly has the potential of diluting the quality of its graduates and faculty. If the growth of the application pool does not keep up with the need to grow student and faculty population, acceptance fraction will increase, negatively impacting the quality (Salmi, 2009, p. 21) and triggering a vicious cycle of further growth reinforcing quality and impact deterioration (loop R1). Educational, Industrial and Innovation impact in part drives SkolTech's reputation. As SkolTech's reputation becomes more widespread and known to its Russian and International partners, faculty and student application pool increases, which improves the quality of SkolTech's main assets:

students, faculty (loop R2). SkolTech's Reputation is a key determinant of SkolTech's success as it drives both the size of the application pool and the quality of applicants (Leslie et al., 2006), which trigger either virtuous reinforcing cycles of growth and impact or vicious cycles of epic collapse (Loop R3).

There are missing elements in this conceptual framework like educational programs, marketing and public relations campaigns, and the administration overhead. Their contribution to the performance and how they relate to the existing elements is yet to be explored.

A model of SkolTech

The performance causal loop diagram (Fig. 3-7) was developed into a more detailed and executable system dynamics model of SkolTech using iThink®[8] modeling software. The first step was to identify the major stocks (accumulating quantities) and flows (rates that drive the accumulation or depletion of accumulated quantities) in the model, which correspond to the variables discussed previously. An aggregate level representation of the model showing major stocks and flows are shown in Fig. 3-8.

[8] iThink is a system dynamics modeling and simulation software from iseesystems.com

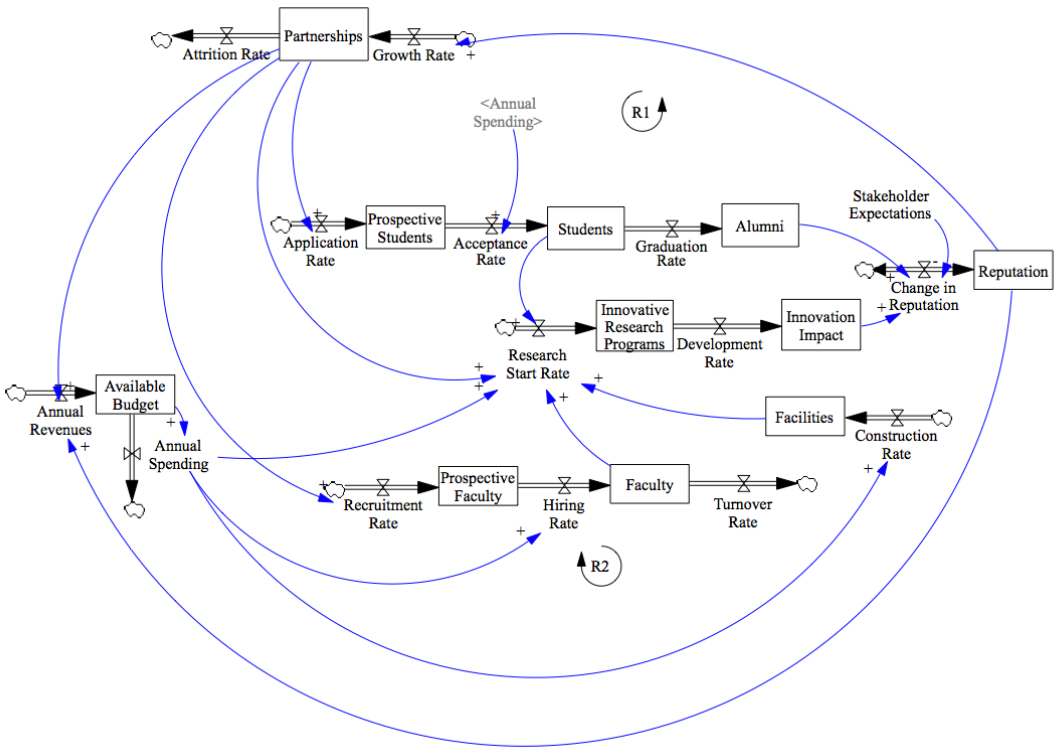


Fig. 3-8 Major stocks and flows in SkolTech system dynamics model.

The three stock and flow pipelines govern the growth of internal resources (Warren, 2008) of SkolTech: students, faculty, which Salmi (2009) refers to as talent, and facilities. Research Production is driven in large part by SkolTech's internal resources. SkolTech's Reputation, summing its performance, is another important stock that grows gradually as a function of educational, economic and innovation impact. Available Budget's growth is dependent on SkolTech's ability to meet key stakeholder expectations which are imbedded in SkolTech's reputation. Key Partnerships grow as a function of SkolTech's reputation. The strength of SkolTech's partnerships subsumes the number and the quality of prospective faculty and students as well as the size of available budget. High quality students and faculty improves both the alumni quality and innovation impact, hence improving reputation, partnerships, and both the quality and numbers of students and faculty (loop R1). Strong financial status helps accelerate hiring faculty, enrolling students, in addition to research progression and facility construction which in turn grows reputation and partnerships to further enhance its ability to receive funding in the form of grants or gifts (Salmi, 2009, p. 24) and hence improves its financial status (Loop R2).

From these stocks and flows, the model was created along major sectors, each representing a primary element of the system. These include faculty, students, facilities, partnerships, and research teams. Additionally, outcomes such as impact, reputation, and quality had their own sectors with corresponding models. Financials sector represents a major constraint in the university and allows testing of resource allocation decisions in the model that could influence the overall growth trajectory. An overview of the model sectors, left unconnected to simplify the view, is shown in Fig. 3-9. As shown in the figure, the degree of detail captured by the many variables begins to expand quickly.

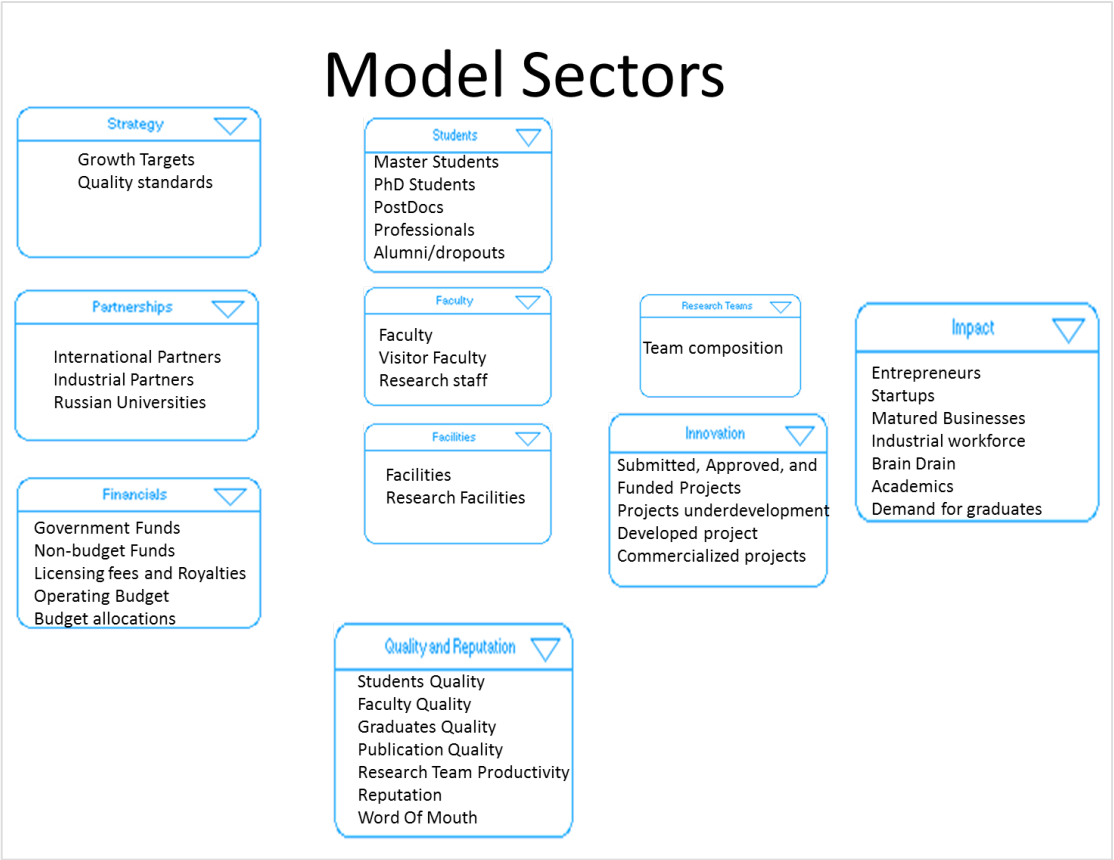
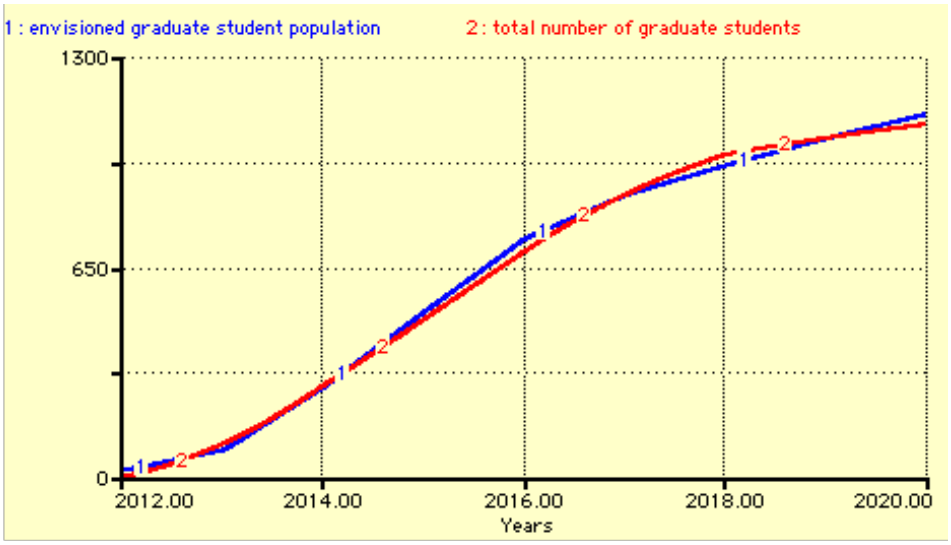


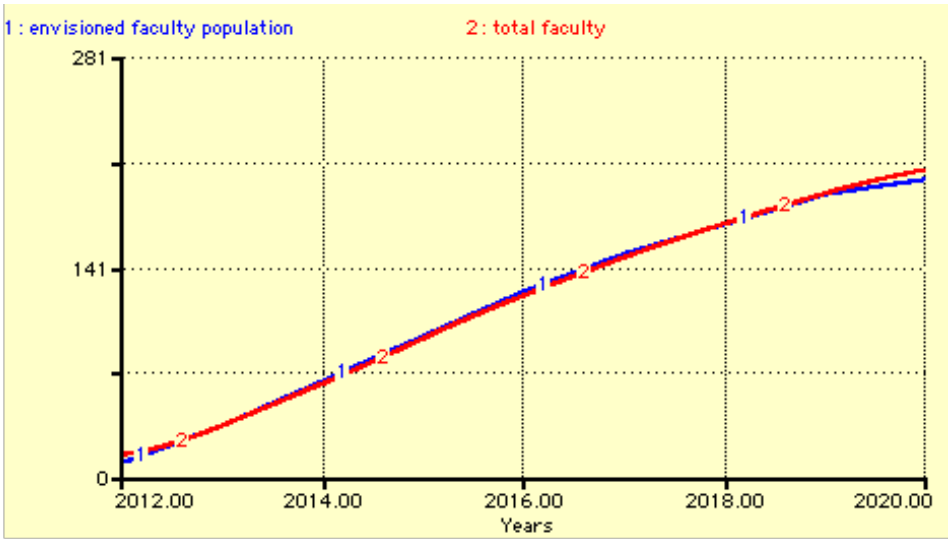
Fig. 3-9 Key sectors and variables in SkolTech system dynamics model

A high-fidelity model was developed with over 140 variables. Many of the elements of the model are based on existing system dynamics model functions found in existing publications in the area of system dynamics applications in strategy modeling and simulation (Salmi, 2009, p. 24). Sharing the full details of the development, the structure, the testing, and outcomes of such a model is beyond the scope of this paper. The baseline case for the SkolTech model was built using input data from the

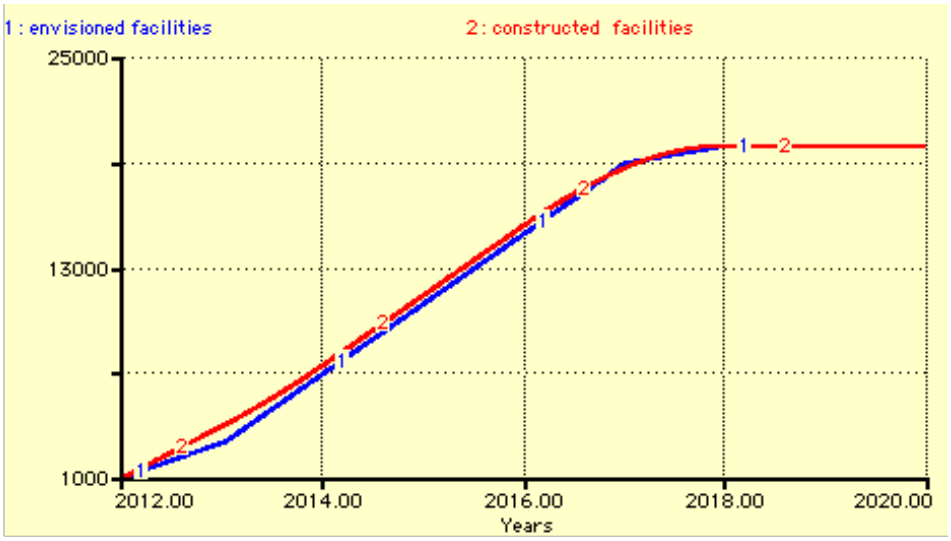
strategic plan and other SkolTech documents. The model with all relationships and variable values from the documentary evidence was then calibrated to the outcomes envisioned in the strategy—the baseline model assumes that the inputs and parameters specified in the strategy produces the outcomes also specified in the strategy. This does not include common performance limiting factors like organizational complexity, change resistance, or disturbances from the external environment (Warren, 2008). This means that it is able to reproduce the envisioned rates of growth of students, faculty, facilities, etc. The output graphs of the baseline model are shown in Fig.11. In the figure, the blue curves represent the growth targets specified in the strategy, while the red curves are the model output. It can be seen that the model is able to closely track the strategy. The model also provides the growth rates necessary to reach the specified targets in the form of operational policies like annual class size, faculty hiring rates, and facility construction rates.



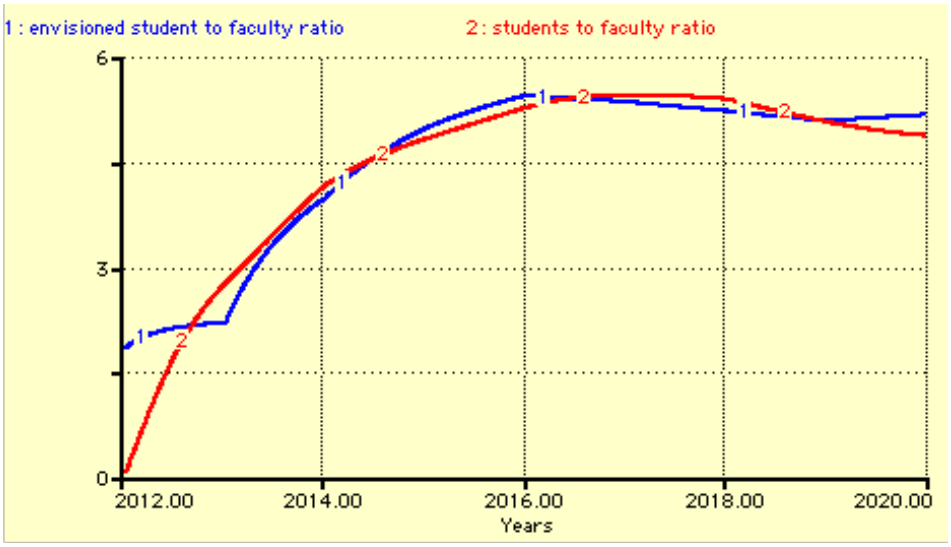
(a)


1 : envisioned faculty population
2 : total faculty
281
141
0
2012.00
2014.00
2016.00
2018.00
2020.00
Years

(b)


1 : envisioned facilities
2 : constructed facilities
25000
13000
1000
2012.00
2014.00
2016.00
2018.00
2020.00
Years

(c)



(d)

Fig. 3-10 Model base case outcomes for (a) Graduate Students, (b) Faculty, (c) Facilities, and (d) Student-to-Faculty Ratio

While it is a significant feat to produce a model of this complexity, at some point, it is not necessarily revealing any new system-level insights since the model is only producing the output of the framework that it was designed upon. There are of course more detailed outcomes at the level of individual variables, but those variables were not necessarily developed through an extensive empirical process unique to a new institution like SkolTech, so they mostly describe how generic elements of a startup university are thought to behave based on the literature (Salmi, 2009), documentation of other universities during startup phases with which SkolTech shares many attributes and/or where MIT had direct involvement (Cosenz, 2014; Leslie et al., 2006; Mervis, 2012).

Despite these caveats, the model is still useful in that it is logically correct since it s, and functionally consistent both with itself (i.e., it operates as a stable system through an acceptable and useful range of variation in key variables) and with other published models. Consequently, we expect it to resemble the behavior of a startup university at a first approximation. It furthermore becomes more useful for generating insights as it is perturbed away from the baseline case operating modes upon which it was designed.

Scenario analysis

To develop insights into possible challenges that SkolTech might face under "off-design" conditions with respect to its strategy, major constructs in the system model were varied outside of their intended range. Specifically, since one of SkolTech's strategic goals is to be a leading global institute of science and technology, we asked what would happen if it were forced to relax its standards for quality of students, faculty, work, and output pressured by the growth expectations. This represents "case 2", where quality standards are reduced, and reputation suffers correspondingly and a vicious cycle of lower quality of students and faculty lead to less demand for graduates, lower quality of research papers, higher chance of startup failures all contribute to lower reputation which attracts lower quality students. In "case 3", in addition to these quality and reputation declines, we also impose financial constraints to varying degrees. In all cases, we monitor key constructs such as the number of students, faculty, impact, research and innovation output, etc. The top-level findings of these scenarios (compared with the base case) are shown in

Table 3-3.

Table 3-3. Scenario analysis outcomes.

Case 1: Base Case	Case 2: Active Quality and Reputation Impacts	Case 3: Active Quality, Reputation and Budgetary Impacts
Graduates	Number of students and graduates did not change as there was no influence of the drop in quality on student dropouts and lower quality standards allow for a higher funnel of students being admitted.	Drop in number of students and graduates as financial limitations become effective around 2017
Faculty/ Staff	Drop in academic staff since quality drop impacts number of faculty getting tenure and reputation drop also impacts the ability to hire visitor faculty and research staff and also weakens the pool of prospective faculty.	Turning point in academic staff due to budget limitations and higher production of commercialized projects relative to Case 2. The limited financial resources could lead to further deterioration in quality standards of the faculty and students admitted under the pressure to hit performance and budgetary targets. Lower quality impacts research team productivity and quality of innovation pipeline which prompts the government to cut budget even further reinforcing the vicious cycle.
Demand for graduates	Drop in HR demand by the industry despite keeping a strong growth of startups.	Increase in HR demand due to a decline in number of prospective employees and a gradual increase in number of startups (which ultimately raises questions about the long term sustainability of this scenario.)

While some of the findings of the scenario analysis are intuitive (e.g., reducing quality of students results in lower demand from industry for graduates), others are not (e.g., imposing a tight budget increases demand for graduates[9].) This is not an unexpected outcome for a model as large and complicated as this—it demonstrates non-linear behavior in some scenarios. This behavior could be represented by simulation charts and can be systematically traced by highlighting all the active feedback loops but this goes beyond the scope of this paper. In general, its the application fraction that is reduced

[9] In this case, the increase in demand for graduates is explained by the ability to be more selective in admissions (despite relaxing quality standards) because there are fewer openings available to the pool of prospective candidates.

and hence kick in loop R1 that restores reputation and hence improves the applicants pool as shown in Fig. 3-7.

This is not necessarily due to faulty model-building, and in fact can flag the sort of reaction for which this model was intended. A classical strategy development exercise is generally driven top-down and based on assumptions of linear behavior. Developing and experimenting with a dynamic model such as this can operationalize frameworks (Salmi, 2009) to help planners put to test their intentions and reveal the limitations of linear behavior assumptions. The weak elements in the strategy can be exposed and flagged for examination in greater detail through other means.

Conclusion and future work

Nations put research universities at the heart and center of their efforts to transform their economies to become more innovative and entrepreneurial. The Russian government took a bold step in partnering with MIT to create the Skolkovo Institute of Science and Technology (SkolTech). MIT has rich experience in playing a role of a key partner in establishing similar institutes around the world for the past 50 years, with differing degrees of success and economic impact. The variation in outcomes were influenced by a multitude of factors including (1) the degree by which the MIT model was tailored to serve the local context, (2) the ambitious expectations of the governments that are based on the mental model of simply copying Boston or Silicon valley through generous funding and partnerships, (3) the complexity of the issue and the large time delays involved until entrepreneurial activities could flourish and make a dent in the socioeconomic environment, (4) and domestic issues beyond the control of the a higher education institution influence.

The two-part research study that followed and was summarized in this paper covered part of the effort in architecting SkolTech through a formal stakeholder analysis, strategy modeling, and scenario analysis.

We leveraged the stakeholder value delivery network to derive the most important outputs expected from SkolTech which included production of talent and research necessary to attract and retain

patient capital and accelerate innovation in Russia. Analysis of stakeholder expectations, which varied in nature, importance, and time horizon, provided SkolTech's leadership team with important insights from which they developed a five-year strategic plan.

In the second phase, we focused on testing the strategic plan model formulated on the basis of the institution's strategic vision and the stakeholder analysis revealing several strategic levers and raising more questions that could underpin success or failure of achieving long term strategic goals. We derived the following insights from our stakeholder analysis and modeling work.

- SkolTech's ability to meet its strategic targets relies in part on its capability to rapidly grow its student and faculty population. Under a few different scenarios, including imposing stricter quality standards in order to boost reputation, or under financial constraints due to slow income growth, it may be unable to meet those planned population growth rates. Whether either of those scenarios is realistic or not is a reasonable topic for a discussion among key stakeholders. However, a shortfall in student and/or faculty populations predictably slows the rate at which SkolTech is able to achieve its broader strategic objectives, and as such should be a key area of focus for the leadership.
- There is a clear tension between the pressure to scale SkolTech's impact and SkolTech's ability to attract and retain exceptional talent. As the pressure to increase the impact builds (e.g., through research output, graduates, start-ups, etc.), student-to-faculty ratio become unfavorable, faculty workload increases, and other factors come into play that would threaten retention of exceptional talent. Failure to retain talent impacts quality, reputation, and ultimately the goal to become a world-class research institution and an economic engine for the Russian Federation.
- The "chicken and egg" dilemma of needing brand/reputation to attract talent and needing talent to build reputation is addressed at least in part by MIT/SkolTech partnership. SkolTech could build its reputation on its own, but the time lags associated with that approach are significant and might prove to be too much given the rates of change typical of political and economic priorities. By availing itself of MIT's expertise, guidance, and reputation, SkolTech can reduce the time to

achieve self-sustaining levels of reputation and thereby accelerate its achievement of its strategic objectives.

- The enormous time delays needed, as in the case of the Cambridge MIT Initiative and others, for anchoring entrepreneurial activities and having it flourish and cause a measurable change could have a negative impact on government support and sustenance of SkolTech's development trajectory.

The observations based on a model grounded in a framework from the literature (Salmi, 2009) but not extensively-tested and as such are subject to the limitations of the model itself. The model in its current state can be used to communicate strategic challenges with stakeholders to facilitate a rich conversation. Using the model to dynamically test SkolTech's strategy would call for the next level of rigorous model development. Accordingly, next steps include:

- Validating major modeling assumptions.
- Test the impact of various resource management and macroeconomic scenarios on SkolTech's performance.
- Use the model to communicate both strategic and operational challenges and tradeoffs with key stakeholders.

SkolTech, and other startup research universities, remain as experiments worthy of pursuit and sustained support of their stakeholders as they will likely take a considerable amount of time to realize their full potential. It is also important to know that, despite their critical role in driving change through providing the knowledge capital to their nations, they are part of an intricate educational, innovation, and economic system that if fully aligned could make full and expected use of their outcomes or if uncoordinated and in conflict could see their efforts come to naught. It is prudent to closely monitor their progress towards their goals and provide the strategy models with data to validate their structures and tune in their parameters. We think that what we have learned from this study is not specific to SkolTech, but could be applicable to other start up research universities. Therefore, the provided insights would be of

value to development planners in their respective countries and to the field of research, innovation, and higher education at large. Formal stakeholder analysis and strategic modeling can be used to operationalize frameworks, , test major assumptions, and reveal various pitfalls on the road to building a world class university.

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Chapter 4 : Organizational Dissent Dynamics: A Conceptual Framework[10]

Abstract

This article proposes a conceptual framework for dissent dynamics in organizations. We integrate the dissent expression and management framework of Kassing (2011) with the dynamic institution composition structure of Saeed & Pavlov (2008) to construct a generic model for understanding organizational dissent. Our dynamic model hypothesizes the impact of dissent accumulation on organizational dissent climate, composition, and performance. Two performance measures comprise the performance grid to describe the current state of an organization and its dissent management policies -- perceived management responsiveness and organizational productivity. We argue that dissent expression, tolerance, and management policies impact whether an organization is high or low performing. The conceptual model provides a future platform for experimentation and learning by simulating different policy scenarios and their influence on the paths of change and the new homeostasis eventually achieved by the organization.

Introduction

Dissent is ubiquitous and varied in organizations (Kassing, 1997; Kassing & Kava, 2013). For instance, workers may grow discontented with management (Kassing, 2011), or a member of an organization may challenge the status quo by expressing contrary opinions, perceptions, goals, or beliefs about issues (Perlow & Repenning, 2009). Dissent is an attempt by engaged organizational members (Kassing, Piemonte, Goman, & Mitchell, 2012) to express voice and change "the practices, policies, and outputs of the organization to which one belongs" (Hirschman, 1970, p. 30). According to Graham

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(1986), principled dissent that focuses on important organizational issues provides opportunities for engagement through honest and mindful consideration of alternatives that can improve decision quality, performance and enhance innovation (Garner, 2013a; Gruman & Saks, 2011; Hirschman, 1970). Lack of dissent in an organization can contribute to groupthink behavior and disasters such as the Bay of Pigs invasion in 1961 (Janis, 1972) and the explosion of two space shuttles, Challenger in 1986 (Elmes & Gemmill, 1990) and Columbia in 2003 (Argyris, 1990). Dissent expression and management take time, patience, and resources (Kassing, 1997) and not every organization is able or willing to make those investments despite their stated performance benefits.

The accumulation of dissent in organizations and its implications are an unexplored area in the organizational communication field (Kassing, 2011). Cooper and Burke (2013) call for more research into the volume of voice expression and perception of dissent climate over time. There is currently no clear understanding in the field of how an organization's tolerance for dissent relates to performance. This raises several research questions: Will the organization's tolerance for dissent change over time? If so, why? How do changes to an organization's tolerance for dissent relate to performance? What could be the role of dissent accumulation and its implications for dissent climate, organizational composition and performance? How can system dynamics modeling help to answer these questions?

The article contributes to the organizational dissent and performance management literature through constructing a conceptual framework for dissent dynamics by creatively integrating the dissent expression and management framework of Kassing (2011) with the dynamic institutional composition framework of Saeed and Pavlov(2008). The dynamic model will explore the impact of dissent accumulation on organizational dissent climate, composition, and performance by discerning the causal relationships that drive the roles of the dissenters and administrators. It makes the assumption that dissent tolerance is directly related to productivity changes in organizations without considering variations in dissent form, quality, style, volume, or frequency. While theoreticians can explore the framework's relevance to specific organizations, practitioners can use it to learn and gain insights into managing dissent and performance in their respective organizations.

The following sections provide an overview of modeling and simulation for theory building followed by a brief introduction to basic system dynamics modeling concepts and how they can be useful in studying organizational dissent. We then introduce the two theoretical frameworks: Kassing's (2011) organizational dissent expression and management framework and the dynastic cycle structure (Saeed & Pavlov, 2008). A top-level dissent dynamics conceptual framework with a detailed description of the model structure follows. We also present the performance measures and explain how they describe the state of an organization and its dissent management policies. Finally, we propose several potential simulation scenarios and discuss the implications for further research and practice.

Modeling and Simulation in Theory Building

Computational organizational theory (COT) (Carley & Prietula, 1994) embraced what Hanneman (1988) and Poole (1996) advocated using dynamic simulation as an effective way for theory building to facilitate understanding of descriptive theories and their expected and unexpected outcomes (Hyatt, Contractor, & Jones, 1996). In organizational communication, the emergence of network analysis (Richards & Rice, 1981), self-organizing systems theory (Contractor, 1994), and organizational ecology (Monge & Poole, 2008) demonstrated the advantages of modeling and simulation over verbal descriptive theories. These advantages include the ability to more precisely define interrelationships, explore transient and long-term implications, uncover systematic connections to guide empirical studies, and deduce hypotheses based on the observation of qualitative changes in long-term system dynamics (Harrison, Lin, Carroll, & Carley, 2007; Palazzolo, Serb, She, Su, & Contractor, 2006). With the growing interest in modeling individual actions and the interactions between the individuals and their surrounding environment (Monge et al., 2011), some scholars in the field of organizational communication (Lackaff, Kozey, & Tutzauer, 2011; Tutzauer, Chojnacki, & Hoffmann, 2006) have adopted evolutionary modeling and simulation approaches such as agent based modeling (Railsback & Grimm, 2011) and network analysis.

System dynamics modelling and simulation methodology

Contractor (1994) observed that Forrester (1957) pioneered the use of modelling and simulation in social sciences to better comprehend and appreciate the process structures behind social phenomena, especially when data are not available (Monge et al., 2011). System dynamics modeling and simulation methodology (Richardson, 1999) has been used successfully in studying complex feedback systems for theory-building and in management and organizational science (E. G. Anderson & Lewis, 2014; Rahmandad, 2012).

System dynamics modelling and simulation methodology is a mathematical approach to modeling complex problems from a system perspective and focuses on the endogenous causes of behavior (Forrester, 1968). It involves constructing formal structural models as continuous feedback systems that use visual representations to explicitly demonstrate cause, effect, and feedback (Sterman, 2000). System dynamics models are transparent, refutable, and incorporate hypotheses about the causal connections among parameters and variables as functional units. The outcomes of these interactions can be tested both logically and empirically, allowing researchers to use the models as tools for theory building (Schwaninger & Groesser, 2008). These models can handle different inputs including numerical data and thick descriptions, or observations from mental models.

Under different operating conditions and over time, a model structure can have many behavioral manifestations including growth, decline, oscillatory, or homeostasis. Changes to a model's operating conditions can be invoked through policy decisions or parameter changes. Through experimentation with different policies and parameter modifications, system dynamics modeling can become a learning tool for students, educators, researchers, administrators, and policy makers.

Time delay is a fundamental concept in system dynamics methodology. Time delay occurs between actions and the consequences associated with them, or represents the time needed to complete a specific task (Senge, 1990). Different modes of behavior result from the presence of time delays and a combination of reinforcing and balancing feedback loops.

System dynamics models are founded on three building blocks: stocks, flows, and feedback loops. A stock represents quantities of tangible (e.g., water) or intangible (e.g., dissent) phenomena that change over time. A flow is a rate of change that influences the level of a stock through filling (inflow or expressing dissent), or draining (outflow or processing dissent) over time in what is known as the bathtub analogy (Richmond, 2004). A feedback loop is a circular information path connecting flows to stocks that can create endogenously driven changes in the system.

For example, dissent occurs over a varying time span and is influenced by reactions from the surrounding environment (Garner, 2015; Kassing, 2011). Its stock could increase or decrease the expression or the processing of dissent (See Figure 4-1). The change in dissent is dynamic and interactive phenomena which makes system dynamics a suitable tool for its exploration. We model dissent dynamics in organizations using a feedback structure with stocks, flows and time delays responsible for the accumulation and depletion of organizational dissent to understand its implications for dissent climate, composition, and performance.

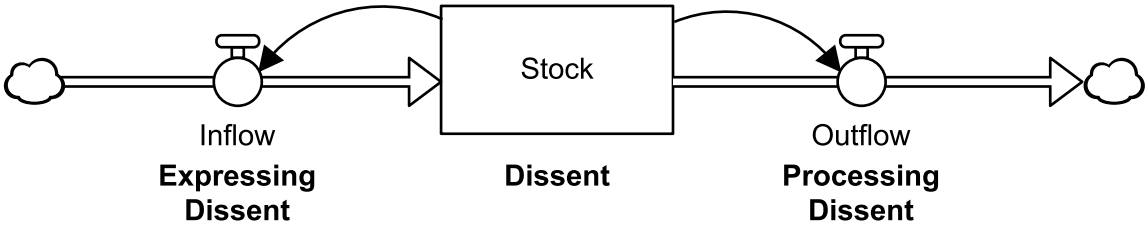

Figure 4-1: Basic stock and flow diagram representation. Boxes symbolize stocks; arrows with valves symbolize flows.

Organizational Dissent Expression and Management Framework

Dissent can take one of three forms: upward dissent, latent dissent, and displaced dissent (Kassing, 2011). Upward dissent is dissent that a party expresses directly to management with the intention that it be viewed as constructive. Upward dissent can be dismissed, ignored, or processed by managers. Dismissal typically occurs when tolerance for dissent is low and managers are not receptive to complaints, suggestions, or ideas. Ignoring dissent can be due to managerial incompetence, overload

caused by excessive dissent, or organizational treatment as a low priority issue. Dissent processing means that a dissent expression has been followed by positive communication or tangible actions to resolve the issue by engaging in a dialogue or revising policies and procedures.

Latent dissent is typically antagonistic in nature and is expressed to coworkers inside the workplace when they fear rejection, punishment, or embarrassment from their supervisors (Garner, 2015). It calls for no action, as it remains unaccounted for despite its existence in the organization's dissent climate.

Displaced dissent is typical in situations where individuals expect retaliation from management for expressions of dissent. Kassing (2011, p. 125) makes a distinction between displaced dissent which takes place solely outside the organization, and therefore it is not included in this work, and whistleblowing which can take place inside and/or outside the organization. Limiting dissent to adversarial actions like whistleblowing or framing dissent as a source of organizational inefficiency or deviance and duty negligence (Garner, 2015) can create a negative managerial attitude and deprive organizations of the benefits associated with dissent.

Empirical studies suggest that constructive upward dissent requires dissent-friendly environments to flourish and reap its value (Kassing & Kava, 2013). However, delays in management response may lead to an escalation of dissent that evokes management retaliation and employee silence. Management may sometimes interpret the lack of visible dissent as worker acceptance of the status quo; visible dissent under these conditions might be misunderstood as a form of resistance that could incur management suppression. (Kassing, 2011)

Eventually, the pattern of fear towards retaliation-silence-maintenance of the status quo can become the norm in a culture where dissent is absent. The decline of psychological safety accompanying silence can deprive the organization of opportunities for innovation and performance improvement (Anderson, Potočnik, & Zhou, 2014). Unfair management treatment is also correlated with the threat to exit the organization (Hirschman, 1970). Both unfair management treatment and response delays can lead

to circumvention of the chain of command and the expression of displaced dissent publicly both inside and/or outside the organization (Kassing & Kava, 2013).

Dissent expression and the processes that ensue (dismissing, ignoring, or processing) are captured by organizational stories (Garner, 2015) that constitute the organizational memory (Rowlinson, Booth, Clark, Delahaye, & Procter, 2010) underlying the dissent climate. Stein (1995) defines organizational memory as "the means by which knowledge from the past is brought to bear on present activities, thus resulting in higher or lower levels of organizational effectiveness." Activities mentioned here refer to decision making, organizing, leading, designing, controlling, communicating, planning, motivating, and so on. He suggests that the "collective memory" holds the societal norms, customs, and stories. Organizations often have long memories (precipitated by large time delays in information processing), especially when turnover is low, so organizational members can recollect dissent issues over time. Figure 4-2 depicts upward and latent dissent, the management processes they invoke, and how they are captured in the organizational memory as stocks of dismissed dissent, ignored dissent, and processed dissent.

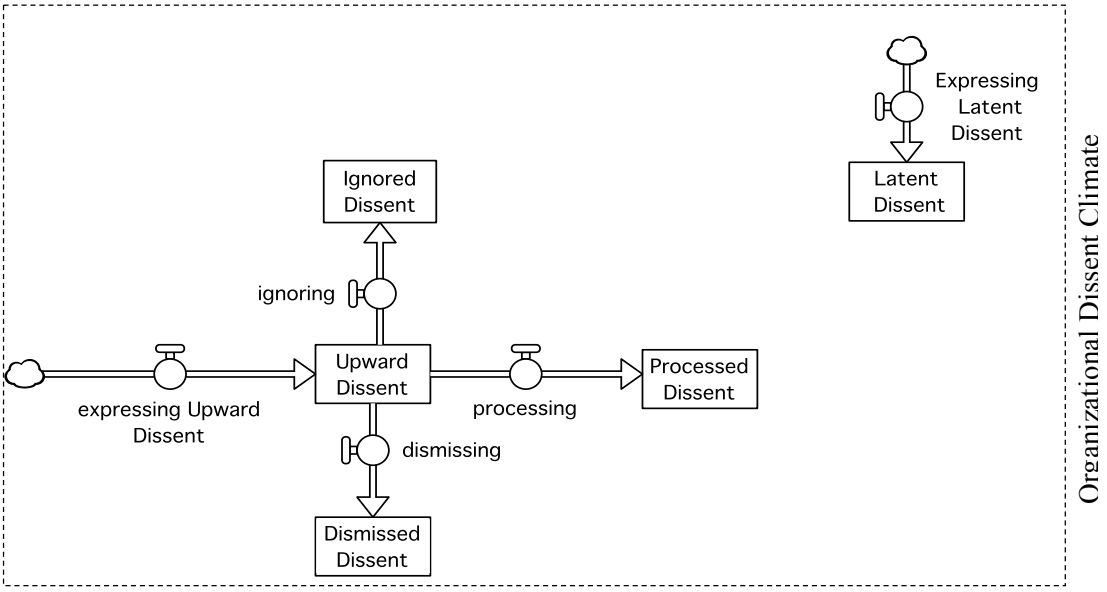

Figure 4-2: Stock and flow representation of the two dissent expression mechanisms (upward dissent and latent dissent) and how they are managed (dismissing, ignoring, and processing) and their permanence in the organizational memory (dismissed, ignored, and processed dissent).

Kassing (2011) articulated three states of dissent tolerance in organizations and their implications for organizational performance. The first state, high tolerance for dissent, could overload the organization with high dissent volume that possibly exceeds the system's receiving and processing capacity. This leads to a misallocation of productive resources that could hinder progress. The second state, low tolerance for dissent, can lead to underrepresentation of dissent and the loss of useful opportunities for learning and feedback. The third state, moderate tolerance for dissent, is optimal.

Dynastic Cycle Structure: A metaphor for organizational composition and paths of change

To explore dissent dynamics, we need a top-level structure to explicitly represent the organizational composition that expresses and manages dissent to operationalize a conceptual framework and transform it into a formal model to realize its full usefulness. Saeed and Pavlov(2008) suggested a metaphorical sociopolitical model for the composition of a society that can fit a wide range of resource allocation problems characterized by competition for a limited resource. The model comprises three competing populations: farmers, who represent production in a society or a firm; soldiers, who exercise control like government or administration by the same previous analogy; and bandits, who represent looting or asocial production in a society and/or who sabotage the firm by exploiting its members, customers or stakeholders. The model conceptualizes and simulates the state of the society and traces its evolution from one state of homeostasis to another.

Soldiers enforce state control, and their numbers grow depending on the perceived threat to the society but are limited by the revenue collected through taxes and the cost of hiring soldiers. State control deters farmers from becoming bandits and encourages bandits to become farmers. The model assumes that both soldiers and bandits come from the farmer population and return to it, while no bandits can leave banditry to directly become soldiers and vice versa.

The dynastic cycle represents a dynamic organizational composition. To adapt it to the dissent expression and management context, we suggest that the organization is composed of three personnel categories corresponding to the social, asocial and control functions. Upward dissenters (UDs) express

upward dissent and produce useful tangible/intangible output (social function). Latent dissenters (LDs) express latent dissent and disrupt others (asocial function). Administrators (Admins) manage dissent and exercise control to maintain order (control function). UDs can become LDs and vice versa, and UDs can become Admins and vice versa (see Figure 4-3 below).

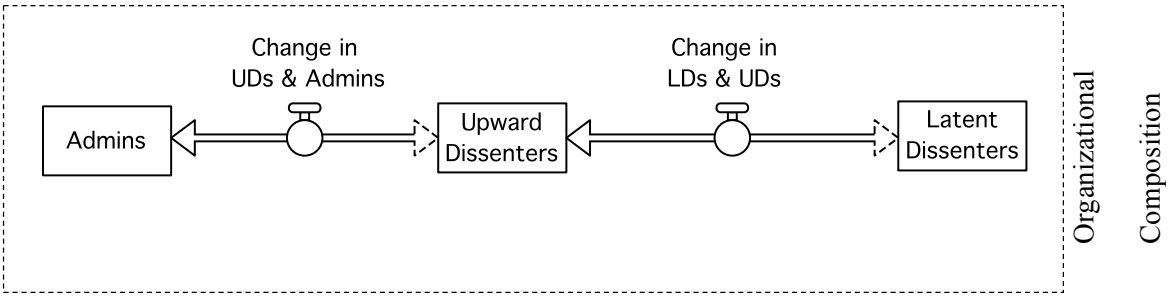

Figure 4-3: Organizational composition representation analogous to the dynastic cycle structure of Saeed and Pavlov (2008).

Movements among the three different populations are controlled in part by the composition of organizational members themselves. Three influence variables are based on Saeed and Pavlov (2008) original framework. UD influence is defined as the ratio of UDs to the Admins and LDs multiplied by a constant marginal impact factor of UDs. Admin influence is defined as the ratio of Admins to the UDs and LDs multiplied by a constant marginal impact factor of Admins. Lastly, LD influence is defined as the ratio of the LDs to the Admins and UDs multiplied by a constant marginal impact factor of LDs. Both UD and LD influence controls the movement between Admins and UDs. The rise of UD influence reduces the movement of UDs to Admins and vice versa (highly productive employees need less supervision). A high value of LD influence increases the movement of UDs to Admins and vice versa (productivity disruptors call for more control measures). Admin influence controls the movement between UDs and LDs since Admins can directly consult with their organizational members (Uhl-Bien, Riggio, Lowe, & Carsten, 2014) or create opportunities for dialogue such as town hall meetings, roundtable discussions, or focus groups that solicit feedback about different topics (Burns & Wagner, 2013). Hence, high Admin influence tends to increase the movement of LDs to UDs and back. Next, we introduce the dissent dynamics conceptual framework.

A Conceptual Framework for Organizational Dissent Dynamics

The proposed conceptual framework for organizational dissent dynamics hypothesizes the dynamic relationship between dissent expression mechanisms, organizational composition, and organizational performance in the presence of dissent accumulation. The framework seeks to explain why an organization's tolerance for dissent changes over time, how changes to an organization's tolerance for dissent impact performance, and how dissent accumulation drives dissent dynamics and its implications for dissent climate, organizational composition, and performance. The propositions presented below and in Figure 4 draw from the dissent expression framework (Kassing, 2011) and the dynastic cycle structure (Saeed & Pavlov, 2008).

P1: Organizational composition influences organizational dissent climate and vice versa.

Organizations are comprised of members who perform their tasks according to their roles, express dissent, and manage it. Organizational dissent climate is part of the overall organizational climate (Graham, 1986) and a function of how organizational members express dissent, how management reacts to it, and how members perceive the management's response to dissent (Garner, 2015). Therefore, organizational composition influences the organizational dissent climate. Similarly, organizational dissent climate influences organizational composition by, 1) turning employees from vocal upward dissenters (UDs) to silent latent dissenters (LDs) and vice versa, and 2) determining whether dissenters or administrators tend to be dominant. (See (P1) loop in Figure 4).

P2: Organizational composition contributes directly to organizational performance.

Organizations exist to achieve goals through performance. Performance is defined as what the organization accomplishes through the utilization of its resources including its members (Christensen, 1997; Warren, 2008). Organizational performance, therefore, is dependent on the outcomes of the organizational composition. (See (P2) loop in Figure 4). It is important to note that performance and its measurement can be process focused, results focused or strategy focused (Jain, Triandis, & Weick, 2010). Process focused measures are based on the activities carried out by the organization, for example processing dissent. Results focused measures refer to tangible, measurable outputs expressed in terms of

the organization goals and objectives; this can be seen, for example, through the number of organizational products or services delivered during a measured time period. Strategic performance measures are related to long term performance and include reputation, attractiveness, and job satisfaction. We adopt an aggregate view that combines process and results focused performance and suggest two measures, one that depicts the organizational support of the dissent climate and one related to organizational productivity. The latter combines organizational members' productivity by tracking the ratio of output (tangible or intangible outcomes by organizational members) to input (invested organizational resources in supporting dissent).

P3: Organizational dissent climate influences performance and vice versa.

A climate of dissent tolerance augments learning and performance quality (Argyris, 1990) which, in turn, positively influences the organizational dissent climate and makes it more tolerant (Graham, 1986). Potentially, low performance can lead to a deterioration of dissent tolerance and tighter control which in turn can lead to a vicious cycle of performance deterioration (Graham, 1986). (See (P3) loop in Figure 4-4).

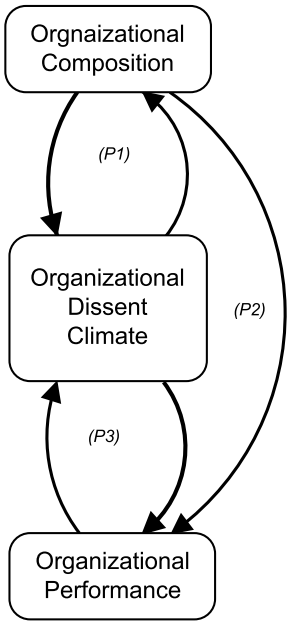

Figure 4-4:Organizational dissent dynamics conceptual framework.

Figure 4-5 shows the top-level feedback structure of the conceptual framework outlined above. It encompasses several feedback loops with additional variables. For visual clarity, the feedback loops and their variables are simplified but will be described later in sufficient detail.

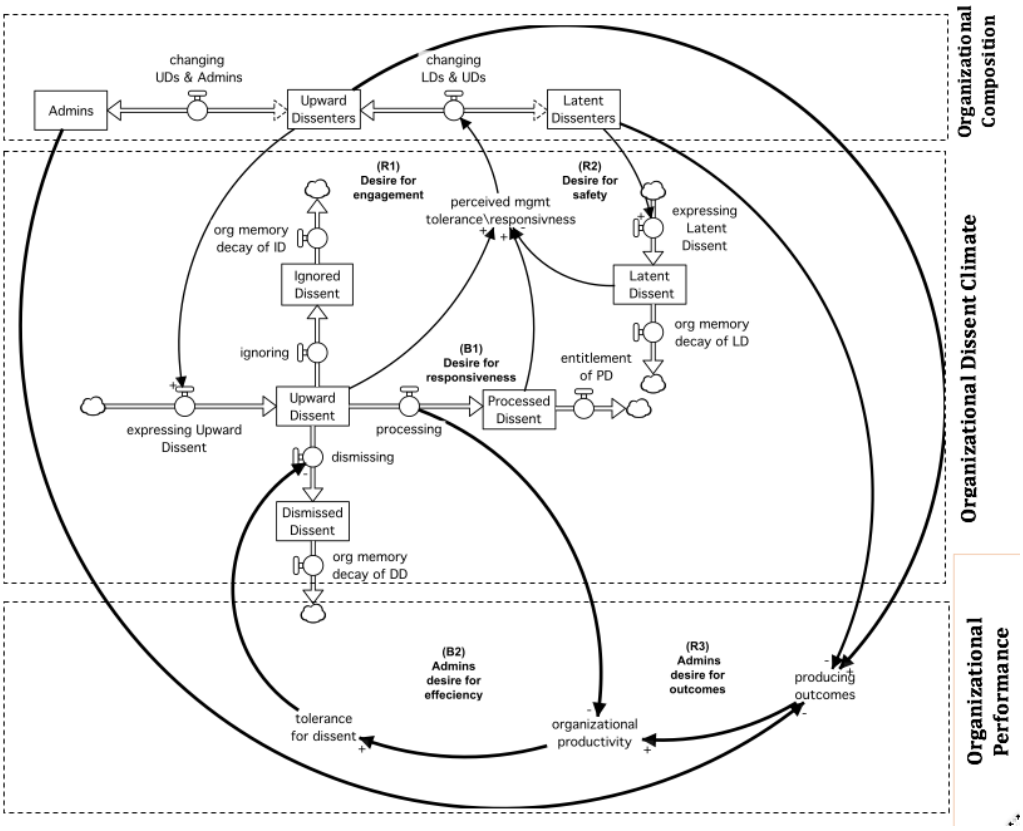

Figure 4-5: Top-level feedback structure of the model combining organizational composition, organizational dissent climate, and organizational performance from the dissent expression.

We identify the five feedback loops to be described as follows:

1. Desire for engagement reinforcing loop (R1):

UDs are engaged members who generate upward dissent, which increases the perceived management tolerance of dissent, which encourages LDs to voice their concerns and become UDs, hence increasing UDs and upward dissent. This loop is influenced by perceived management tolerance for dissent that assumes dissent to be effective once it is communicated and received (Garner, 2015). Therefore, it is quantified as the ratio of upward dissent to other dissent present in the organization

including ignored, dismissed, and latent dissent. It is also important to clarify that low perceived management tolerance for dissent implies greater levels of ignored, dismissed, and latent dissent, which fosters fear and cynicism, and encourages people to express dissent laterally, hence they remain or become LDs.

2. Desire for responsiveness balancing loop (B1):

UDs generate upward dissent, which takes time to process and become processed dissent. When it takes too long to process dissent, processed dissent increases slowly and perceived management responsiveness to dissent declines forcing UDs to become LDs, resulting in a decrease of UDs. This loop is influenced by perceived management responsiveness which assumes that dissent is effective when action is taken and the issue is resolved (Garner, 2013a). It is quantified as the ratio of processed dissent to unprocessed dissent including upward, dismissed, ignored, and latent dissent. The perception of management's responsiveness to dissent may serve as an indicator of organizational performance with respect to dissent tolerance and processing in a timely manner. However, the processed dissent stock (see Figure 4-5) will decay over time since it is considered a form of entitlement. For example, when employees advocate for a better healthcare plan and the administration approves it, it is considered as processed dissent. In the long run, however, new members may interpret it as a right rather than an outcome of management's responsiveness to dissent.

Time delays are part of the challenge for improving perceived management responsiveness to dissent since processing dissent takes time and commitment to deliver appreciable outcomes. Ironically, processed dissent often does not reside in the organization's long-term memory, which may deter organizational leaders from investing effort and resources into it.

3. Desire for safety reinforcing loop (R2):

LDs express latent dissent that accumulates in the latent dissent stock, which decreases both the perceived management tolerance for, and responsiveness to, dissent leading to more UDs becoming LDs, thus generating more latent dissent. Latent dissent can remain in that stock but decay over time as people forget and move on. The decay rate depends on the time delay, which will vary among organizations.

4. Admins' desire for outcomes reinforcing loop (R3):

UDs are an essential organizational resource that deliver tangible or intangible outcomes to help the organization accomplish its objectives. UDs productivity is influenced negatively by the distractions of apathetic LDs and the control tendencies of the Admins driven by the desire to create harmony and avoid constructive conflict (Eisenhardt, Kahwajy, & Bourgeois, 1997). High organizational productivity, on the other hand, impacts tolerance for dissent policies positively which decreases dissent dismissal, increases accumulated upward dissent, and increases perceived management tolerance of dissent as organizational members feel that their voice is heard in a fair manner. These factors also increase UDs and their produced output, thus leading to improved productivity.

5. Admins' desire for efficiency balancing loop (B2):

High organizational productivity increases tolerance for dissent, which increases accumulated upward dissent as more members feel empowered to speak their minds on different issues including, but not limited to, complaints. This calls for higher dissent processing which decreases organizational productivity. Admins measure organizational productivity on the basis of the dissenters' productivity. It is quantified as the ratio of output to input (Jain, Triandis, & Weick, 2010) where input is a function of allocated resources including the effort put into dissent processing. Therefore, high UD output is needed compared to dissent processing to justify the investment of resources in processing dissent. It is interesting to note that a decrease in dissent tolerance means less dissent processing which might lead to a short-term boost of organizational productivity and to a condition where Admins might perceive this as a better way to manage dissent.

Performance Measures and Implications

There are many potential performance measures in the model and tracking all of them would be a daunting task and might not result in useful insights. Thus, to understand the current organizational dissent climate and how it can evolve, we suggest two indices that were introduced earlier, organizational productivity and perceived management responsiveness, to describe the state of an organization with

respect to dissent management and performance and to assess the effectiveness of intervention policies. They are presented in a 2X2 diagram (See Figure 4-6).

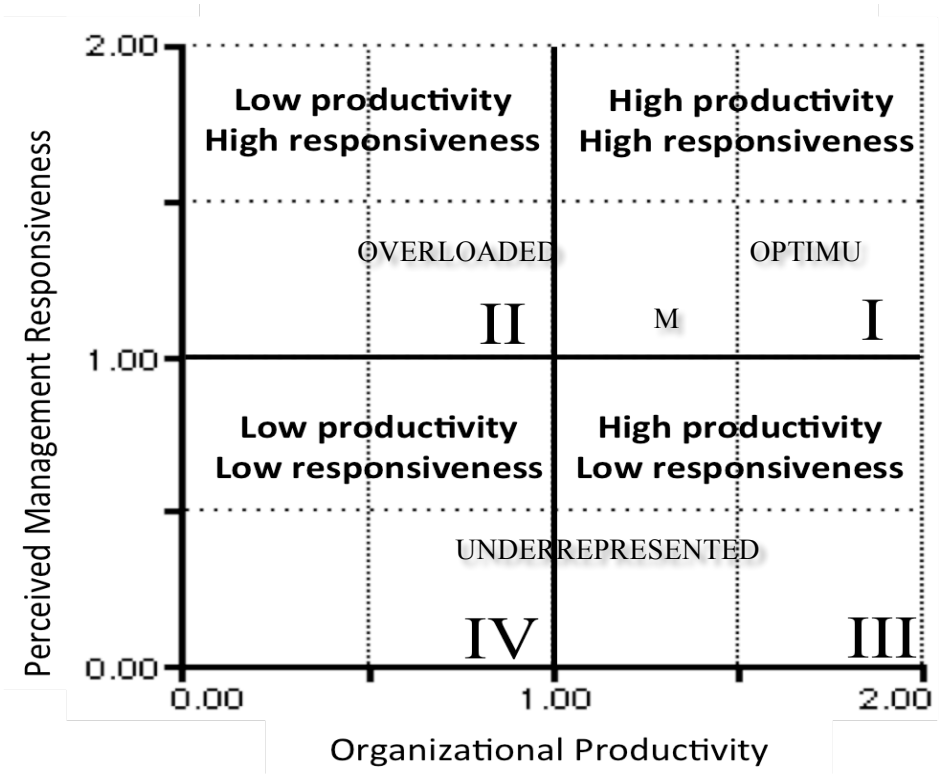

Figure 4-6:2X2 representation for the model performance indices describing the state of an organization with respect to performance and dissent management.

Quadrant I represents high organizational productivity and high management responsiveness to dissent which corresponds to Kassing's (2011) optimum dissent level and tolerance. An organization in this quadrant might be described as active, healthy and/or innovative. Quadrant II represents a state of low productivity and high responsiveness and may be described as a paralyzed or trapped organization where there is too much dissent without return. This corresponds to an overloaded organization with high levels of dissent and dissent tolerance (Kassing, 2011). Quadrant III is characterized by high productivity and low responsiveness which corresponds to an industrial–age, machine-like organization where attention is geared towards outcomes only. Quadrant IV denotes low output and low responsiveness, which could be described as a highly dysfunctional bureaucracy lacking initiative and responsiveness. Both Quadrant III and IV correspond to Kassing's (2011) underrepresented dissent. This representation is a performance

canvas that shows how an organization can exist in a state space and potentially move between different states along a certain path.

Discussion and Contribution

The conceptual framework suggests that the presence of open communication channels that encourage upward dissent improves perceived management tolerance of dissent, attracts more LDs to become UDs, and generates more upward dissent. However, perceived management responsiveness to dissent will be impacted negatively when major decisions concerning the members or the direction of the institution are made without their consultation or when their concerns are not timely and respectfully addressed. Accordingly, some employees will disengage and join the LDs, leaving the opportunity for Admins to act unilaterally as they interpret the silence as a sign of contentment or disinterest. It can also be inferred from the structure that in the long term, intolerance of dissent could negatively influence the organizational dissent climate by moving more UDs to become LDs, thus requiring more Admins to impose more controls to improve productivity. High Admin influence might have a negative impact on the processing of dissent because it could introduce more dissent processing delays, as the issue under consideration has to go through control routines for checks and approvals that are likely to reduce perceived management responsiveness and increase the number of LDs. We can also infer that when the organization is more focused on short-term performance, it is prone to become intolerant of dissent, which reinforces silence norms that are difficult to change (Perlow & Repenning, 2009).

We suggest that an organization's tolerance for dissent can change over time due to a perceived short-term productivity drop that impacts performance. Organizational composition, dissent expression, accumulation, decay, and performance are influenced by inherent time delays that prevent the organization from realizing the benefits of dissent hence negatively impact the organization tolerance for dissent.

The combination of the two performance measures depicting the support of dissent climate and organizational productivity at different levels in a state space encompasses Kassing's (2011) three dissent

states (optimum, overloaded, underrepresented). In addition, our model shows that underrepresented dissent can exist in organizations with high productivity but the question remains as to whether it can be sustained. Our paper also suggests that system dynamics contribute to understanding and managing the organizational dissent dynamics by explaining why tolerance for dissent could change and through hypothesizing the effect of dissent accumulation. In a follow-up paper, we will conduct simulation that demonstrates more concretely the suggested advantages for simulation modeling in organizational studies by Harrison et al. (2007).

Limitations and Future Research

Some limitations to this work are by design and related to the problem boundary definition, which excludes displaced dissent and the option to exit the organization. Both were excluded for the sake of simplicity and better understanding of the internal dynamics within the organization. Due to the aggregate nature of the model, there is a lack of heterogeneity among dissenters and their generated dissent (personal vs. disciplined, quality, style, volume, or frequency).

The conceptual framework brings insights to organizational dissent dynamics. However, through simulation we can explore the model behavior and understand the implications of policy scenarios for the organization and how it can move from one state to the other with an aim to maintain long-term behavior (at equilibrium) in quadrant I, a state of high responsiveness and productivity driven by an optimum level of dissent. This will be explored in another publication in a specific context.

The model in its current state is a first attempt at conceptualizing this complex dynamic phenomenon and will benefit from additional critique and inquiry by organizational scholars and practitioners with an interest in dissent to validate its structure, suggest other representative variables, add more granularity as needed, or suggest more testing scenarios.

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Chapter 5 : Modeling Organizational Dissent Dynamics in Universities[11]

Abstract

Using system dynamics modeling and computer simulation, this paper investigates how universities may evolve into high or low performance institutions by taking different approaches to dissent tolerance and processing. We adapt a conceptual model for organizational dissent dynamics (R. M. Zaini, Elmes, et al., 2016) to a generic university context. Our model provides a platform for experimentation with different dissent management policies related to growth and productivity. Simulations with the model suggest that as universities attempt to improve their performance through growth, they may devolve into low performance institutions with degrading management responsiveness and low organizational productivity. Only when organizations invest in their dissent processing capability will they engage their members productively for improving performance.

Introduction

There have been significant changes over the past ten years in the economic landscape of higher education in the United States . Public funding for universities and university education has declined; for-profit institutions have posed a disruptive threat to public and non-profit private universities and colleges; and online offerings including Massive Open Online Courses (MOOCs) allude to changing the cost structure of how courses are taught (Christensen & Eyring, 2011). Contrary to the traditional view that universities cannot be run by accountants as commercial enterprises responding only to changing markets (Rosovsky, 1990), the recent emphasis on marketing and growth of higher education institutions has led some Boards of Trustees to appoint university presidents who have a strong business background and skills at fund raising but have little or no prior academic experience (Bok, 2013). Administrative duties

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[11] A conference paper based on this chapter was presented at the 32nd International System Dynamics Conference in Delft (R. M. Zaini, Saeed, Pavlov, & Elmes, 2014)

that were previously performed on a part-time basis by the faculty have been shifted to professional administrators (Ginsberg, 2011). Universities have become administratively more complex (Marcus, 2013; Sutner, 2013), while faculty strength and power to voice dissent have declined (Mills, 2012; Readings, 1996). In addition, there have been calls to replace shared systems of university governance and do away with faculty tenure entirely (Mathewson, 2015, 2016, 2016; Mills, 2012).

Faced with tough competition and difficult economic times, professional managers at universities have often felt the need to increase revenues and cut costs in order to reach financial goals (Cosenz, 2013). With more focus on growth, financial health, accreditation, and rankings, universities have increasingly emphasized tangible objectives and performance measures (Dvorak & Busteed, 2015) tied to fundraising and the ability to attract research grants (Parker, 2014) rather than more subtle and harder to measure indicators of education quality and the research environment. Professional managers who value efficiency, hierarchy, and returns on investment often shun engaging collaboratively with faculty (Mills, 2012). Accordingly, academic administrators now are often more inclined to make unilateral decisions with only minimal if any faculty input or involvement (Bok, 2013). Few argue, however, that hard management style is not new and extends to deans and department heads (Watson, 2000).

Dissent is part of an ongoing organizational discourse that shapes a university's features and outcomes, reality, and social processes (Kassing, 2011). Historically, tenure has been a mechanism that protects professors from external pressures and ensures their academic freedom, and hence their productivity (Arnett, 2016). Tenured university professors are relatively free to think, inquire, express views, control their time, and exercise self-governance (Frost, 2015). According to Henry Rosovsky, former Dean of the faculty of Arts and Sciences at Harvard, the "two crown jewels possessed by any tenured professor at a top school: independence and security" (1990, p. 179). An empirical review of 1300 scientists found that the most effective scientists are those who pursued their own ideas, valued their freedom, and influenced decision makers (Jain et al., 2010).

Faculty governance, which can be considered as a principled form of dissent (Rosovsky, 1990), has declined as a way for faculty to voice dissent. Over the years faculty governance has developed its

own hierarchy that, especially at the top, has become more aligned with administration policy and reduced governance participation. Limiting the inclusion of faculty with dissenting voices (Hodgkinson et al., 1976) and listening to more moderate and politically-correct voices has become a modus operandi. To some extent, it has become the formal channel for communication with the administration through layers of committees dealing, most of the time, with trivial issues and giving less attention to issues related to the direction of the institution. Hence, respected faculty with bold views and deep concern about important issues became less interested to join it. This view was corroborated in a recent survey of the rank-and-file professors that found that the faculty have limited influence in campus issues which reflects either communication issues or lack of interest (Bok, 2013).

The change in tolerance for dissent in universities raises concerns on the sustainability of current performance improvements initiatives and governance policies. Those concerns can be explored through modeling and simulation using the system dynamics methodology which has been used successfully in studying complex feedback systems (Forrester, 1968; Richardson, 1999; Sterman, 2000). In order to search for policies that can leverage both the dissent tradition and productivity to maintain a high performance portfolio for the institution, we adapt a conceptual model for organizational dissent dynamics (R. M. Zaini, Elmes, et al., 2016) to a generic university context to work as a platform for experimentation with different dissent management policy scenarios. Our model captures the dynamic interactions between organizational composition, organizational dissent climate, and performance influencing and is proposed as an instrument for understanding the organizational dissent climate in universities and its implications for organizational composition and performance. Our model simulations show that performance and communication climate improve when the university invests in improving its dissent processing capability and enhances its faculty productivity. When combined with higher standards for accepting dissent and a lower volume of dissent by focusing collegially on critical issues, performance is further improved. The simulations also show that these investments take time and effort and fast returns are not to be expected. We also find that the combination of an authoritarian administration, a

dysfunctional faculty governance system, and silent faculty is likely to lead to declines in performance for the university.

In the following sections, we describe our organizational dissent model followed by a contextual depiction of its adaptation to universities. Finally, we present policy simulations, and discuss the implications for research and practice.

A Conceptual Framework for Organizational Dissent dynamics in Universities

Zaini et al. (2016) suggest a conceptual framework for the organizational dissent dynamics that reveals the dynamic interaction between the dissent expression and management, the organizational composition, and performance (See Figure 5-1). Based on theoretical and empirical information, they suggest that an organization's tolerance for dissent can change over time due to a perceived short-term productivity drop that impacts performance. This framework addresses specifically how the organizational dissent climate might be influenced by organizational composition and how the dissent climate in turn influences the composition of the organization with respect to which group influence tends to dominate (P1). It also speaks to how performance is interlinked with the organizational composition (P2) and organizational dissent climate (P3).

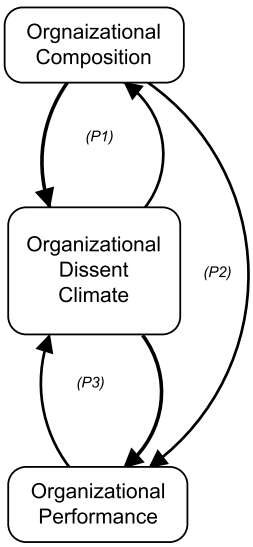

Figure 5-1: Organizational dissent dynamics conceptual framework, ref. (R. M. Zaini, Elmes, et al., 2016)

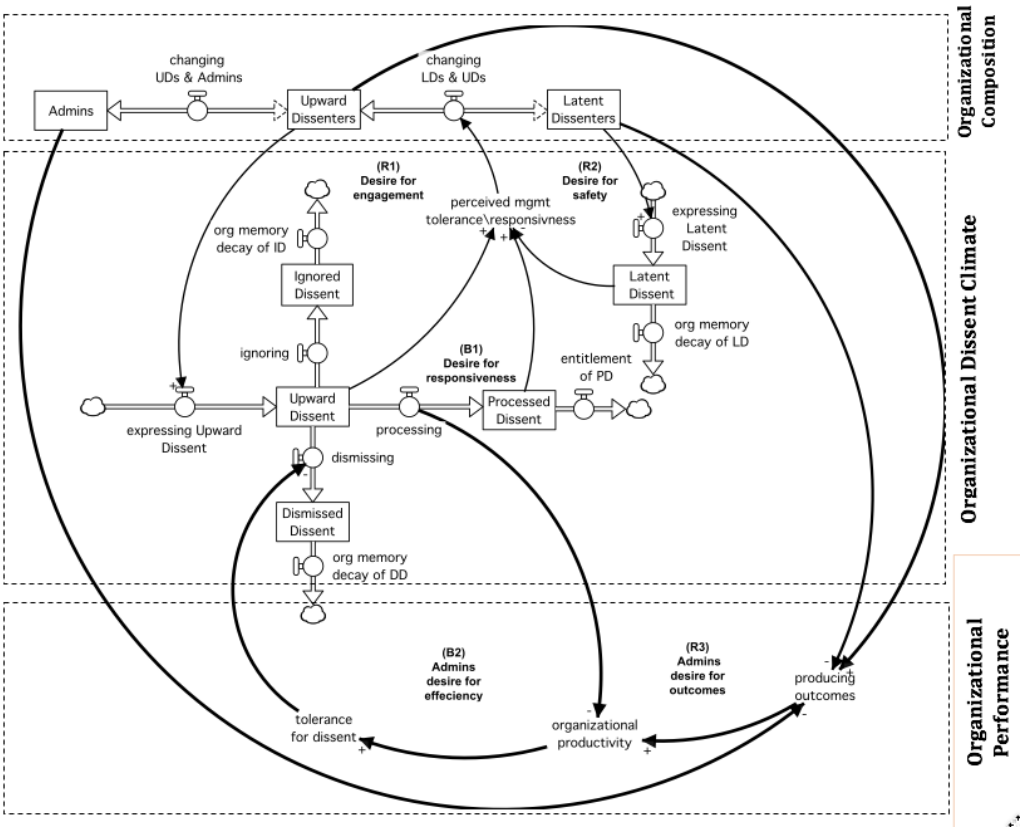

Figure 5-2: Top-level feedback structure of the model combining organizational composition, organizational dissent climate, and organizational performance from the dissent expression, ref. (R. M. Zaini, Elmes, et al., 2016).

Figure 5-2 shows the top-level feedback structure of the conceptual framework of Figure 5-1. The diagram follows the system dynamics method convention: the rectangles represent stocks, the valves symbolize flows and the circles represent intermediate computations (Richmond, 2004). The diagram represents a system of coupled differential equations that can be solved numerically using iterative techniques like Runge-Kutta forth order or Euler at successive time steps over the time period of interest to produce the simulation results (J. D. Hoffman, 2001). The model encompasses several feedback loops with additional variables that detail the conceptual framework. The desire for engagement reinforcing loop (R1) addresses the growth of dissent expression as an indicator for engagement in a dissent tolerant environment. The desire for responsiveness balancing loop (B1) highlights the need for dissent processing to sustain members' engagement. The desire for safety reinforcing loop (R2) focuses on the vicious cycle of latent dissent generated by either disgruntled or fearful members. The Admins' desire for outcomes

reinforcing loop (R3) delineates the performance aspect and how productivity drives dissent tolerance. The Admins' desire for efficiency balancing loop (B2) addresses organizational productivity and the delicate balance in resource allocation between dissent processing and outcome generation. The feedback loops will be explored in detail as they guide the interpretation of the model behavior when simulating different policy scenarios. For visual clarity, the feedback loops and their variables are simplified.

Two performance measures are defined to evaluate policy outcomes (R. M. Zaini, Elmes, et al., 2016): perceived management responsiveness that depicts the support of the dissent climate through management commitment to dissent and organizational productivity that represents the focus on efficiency. The combination of those two at different levels construct a state space that encompasses Kassing's (2011) three states in which organizations can exist with respect to dissent tolerance and performance (optimum, overloaded, underrepresented) (See Figure 5-3). Quadrant I represents high organizational productivity and high management responsiveness to dissent which corresponds to Kassing (2011) optimum dissent level and tolerance. An organization in that quadrant might be described as active, healthy and/or innovative. Quadrant II represents a state of low productivity and high responsiveness and may be described as a paralyzed or trapped organization where there is too much dissent without return. This corresponds to an overloaded organization with high levels of dissent and dissent tolerance Kassing (2011). Quadrant III is characterized by high productivity and low responsiveness; it corresponds to an industrial, machine-like organization where attention is geared towards outcomes only. Quadrant IV denotes low output and low responsiveness, which could be described as highly dysfunctional bureaucracy lacking initiative and responsiveness. Both Quadrat III and IV correspond to Kassing's (2011) underrepresented dissent referred to earlier in the paper.

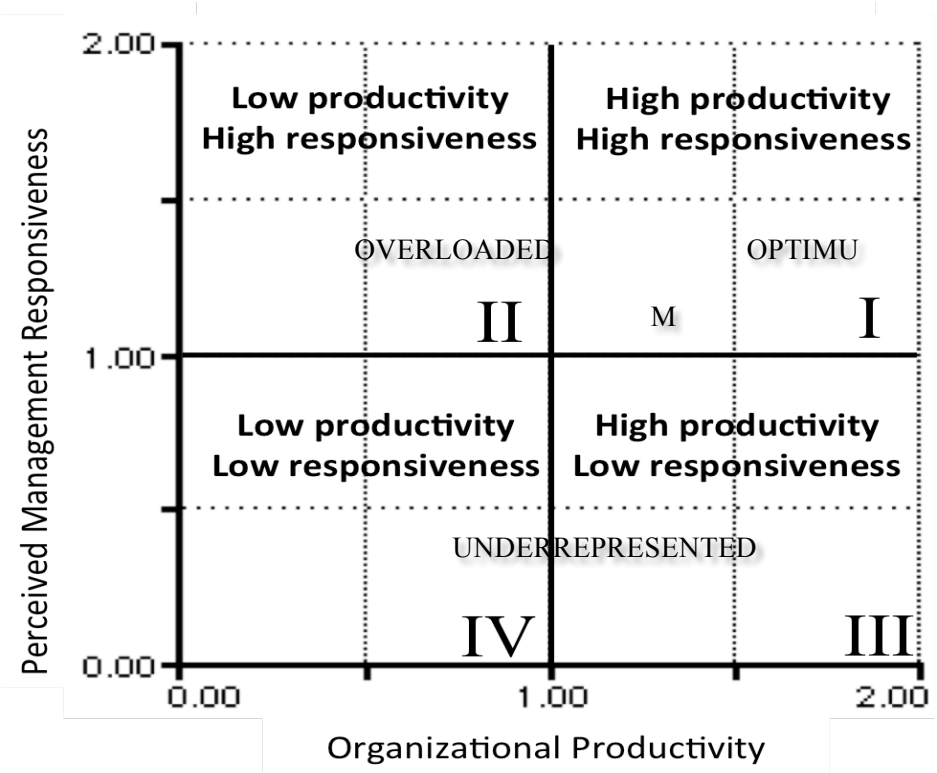

Figure 5-3: 2X2 representation for the model performance indices describing the state of an organization with respect to performance and dissent management, ref. (R. M. Zaini, Elmes, et al., 2016).

Next, we will provide an overview of the model adaption to the university context through a narrative that navigates through the conceptual framework shown in Figure 5-1 and Figure 5-2.

In a university context, Admins represent administrators, and Upward Dissenters (UDs) and Latent Dissenters (LDs) represent the faculty. Our organizational composition framework differs from the cosmopolitans and locals perspective (Gouldner, 1957, 1958) where cosmopolitan faculty members are assumed not to engage in local issues within the university and only those who are dependent on the institution for meaning and security are engaged in its internal affairs. We also depart from the classification of faculty into tenure-track, non-tenure, and adjunct that is unique to the higher education system in the U.S. All classes of faculty are aggregated into a single homogenous group in our model.

In a university faculty members are the front line productive workforce fulfilling the university's mission of "education and research". Through the exercise of voice and loyalty, faculty members influence the university, enhance productivity (Kassing, 2011), and establish norms for behavior. Shared governance and a collegial communication climate balance referent and administrative authority (Saeed,

1996) and limit the need for additional administration to control for productivity which is hard to quantify in collegial environment {Citation} . Faculty who lack formal voice, on the other hand, are usually expected to focus narrowly on their teaching, research, and advising. They might choose to exercise latent dissent by voicing their discontent to peers; this would lead to a rise in the stock of latent dissent and the number of LDs which in turn could contribute negatively to productivity outcomes (see Figure 1-1) because of distractions and wasted time (Senor & Singer, 2011).

Administrators monitor the performance of the institution and actively control resources to meet the institution's goals. While attempting to improve their institution's performance through growing student enrollment, enhancing student's college experience, or compliance to external demands, many activities are likely to require more administrators, leading to a rise in administrative influence (L. Taylor, 2015). For example, the need to reaccredit academic programs has required administrators to expend more time and effort to comply with the requirements of the accreditation boards. Often this occupies faculty with more administrative tasks and distracts them from performing their primary function of creating or updating course content, teaching, and research, thus, leading to lower productivity (Glaser, 2015). A greater number of administrative tasks might also lead to placing more faculty in supervisory roles leading to more layers of administration, or to hiring more professional administrators from the business world (Marcus, 2013). In both scenarios administrative growth will lead to an increase in the administrative influence and organizational complexity which, in turn, is likely to overburden the university with greater numbers of administrative tasks (Baty, 2014). Administrative influence through division of labor and the exercise of control could potentially help administrators devise better ways to meet with, listen to, and attend to faculty concerns as they are encouraged to speak up and participate (Jain, Triandis, & Weick, 2010) to improve decision quality (Bok, 2013) and organizational performance. Over time, this may lead to a decline in latent dissenter influence and a growth in UDs influence. In turn this may reduce the need for more administrative roles and help administrators allocate more time to academic activities improving productivity over an extended period of time.

However, with a growing emphasis on efficiency and short term output and with the variations in productivity, administrative policies may respond unfavorably to declines in productivity. For instance, when the number of annual scholarly publications per faculty (Cosenz, 2013) declines as the university's capacity to process dissent declines, this would suggest a failure of the dissent tolerance policy, a reduction in the tolerance for dissent, and/or a higher rate of dismissing dissent. In turn this would likely lead to less frequent use of voice and greater silence and control, leading to lower productivity and potentially a vicious cycle of chasing productivity improvements (see B2 loop in Figure 5-2).

Next, we will simulate the model by calibrating the model to equilibrium, and exploring different dissent management policies and discussing their implications. The complete model equations and parameter values are available upon request.

The Dynamics of Dissent Management Policies

Because our generic model pertains to theory development, it does not represent a particular case at a particular academic institution. It does suggest certain outcomes under particular conditions that could take place at different higher education institutions. We have experimented with many scenarios, which makes documenting them here rather burdensome. We present a number of these scenarios which have interesting outcomes.

In order to provide a reference point from which to start exploring different policy scenarios and understand their implications, the model is initialized in hypothetical equilibrium at the center of the diagram in Figure 5-3, where both responsiveness and productivity values are equal to one. We then Disturb the model from equilibrium to simulate the resulting dynamics through population growth of the three stocks comprising the organizational composition (AKA, the institution workforce). Seeking performance improvement, we: (a) change single organizational capabilities related to dissent management policies, and (b) change a combination of different interventions seeking to optimize the improvement of both performance indicators namely the perceived management responsiveness and organizational productivity. Each simulation below represents a particular policy intervention. Growth

scenarios are intended to promote the understanding of the model's internal dynamics. The second and third policies offer insights into the key interventions for change. The goal for all policy interventions here is to create and maintain long-term behavior (at equilibrium) in quadrant I, a state of high responsiveness and productivity driven by an optimum level of dissent.

Growing the Institution Workforce

We selected growth as strategy since this is a current prevalent theme in higher education. However, growth means different things to different people in the university. Admins want to hire more admins and part time faculty whereas tenured faculty advocate for more tenured/tenured track faculty. An increase of Admins into the university signifies an effort to add more order and efficiency through proper distribution and supervision of tasks to improve performance. An increase of UDs resembles growth in the institution's productive force (faculty with voice and voting rights) with long-term commitment. An infusion of LDs takes place when the university hires more temporary faculty with no voice or voting rights and with fewer privileges than tenured and tenure-track faculty. The initial growth in each group equals 20% of its initial units. The phase plot of the performance indicators and behavior-over-time graphs simulating the increase of each population independently is shown in Figure 5-4 below.

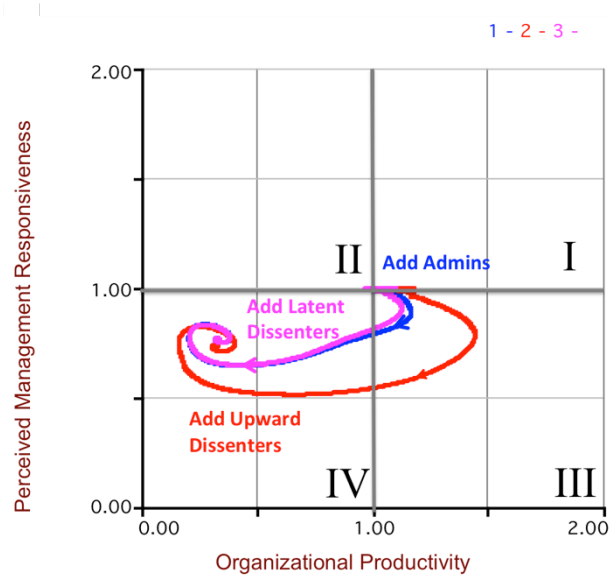

Figure 5-4: Growth scenarios simulation results showing the state space plot of each policy. The arrow signs on the curves in the state space diagram indicate the direction of the path. All curves start from the center of the plot (1,1). (1) Admin growth. (2) UD growth. (3) LD growth.

Adding Admins, UDs, or LDs results in a final equilibrium state at lower organizational productivity and perceived management responsiveness despite an initial improvement in organizational productivity (curves move to quadrant III before heading to quadrant IV). When Admins are added, they help move LDs to become UDs. This leads to an improvement in UD influence and a reduction in Admin growth rate and influence. Hence, both the productive output and the *organizational productivity* will improve (R3 loop). Adding more UDs increases the amount of upward dissent which accumulates due to the resulting drop in dissent processing as the organization reaches its capacity to process dissent. This is then likely to lead to higher dismissal and ignoring rates and less dissent processing impacted also by the initial increase in Admin influence. Together both the perceived management tolerance (R1 loop) and perceived management responsiveness (B1 loop) will decrease leading to an increase in LDs and a decrease in UDs (R2 loop). The increase in LDs will lead to an increase in their influence compared to the UD influence that fosters the growth of Admins and their influence. This, in turn, will reduce the influence of both the UDs and LDs. The fluctuation in the influence of each group affects UDs' productivity both positively and negatively.

The growth of LD influence causes a drop in productivity that will lead to the addition of more Admins and greater Admin influence. When organizational productivity drops as a result of higher Admin and LD influence, tolerance for dissent is also likely to decline leading to a higher dissent dismissal rate. This then decreases the accumulation of upward dissent but increases dismissed dissent, which reduces both the perceived management tolerance for dissent and the perceived management responsiveness. This will lead to an increase in LDs and calls for adding more Admins to chase them in an attempt to restore productivity. The cyclic behavior continues until it equilibrates at a composition comprised of high Admin influence followed by low LD and UD influence leading to an organizational state in quadrant IV at low levels of organizational productivity and perceived management responsiveness. The remaining two scenarios reach the same final state as the organization in each case hits its capacity to manage dissent and becomes trapped in an efficiency-chasing mode trying to control every aspect of its environment to boost productivity.

The summary of the growth policies and their equilibrium quadrants in the phase plot is given in Table 5-1.

Table 5-1: Simulations summary of population growth scenarios.

Policy number	Policy instrument	Rationale	Change	Simulation Outcomes
1 (Curve 1)	Increase Admins	Add more order and efficiency	+20%	Improvement in organizational productivity with a decline in perceived management responsiveness (Quadrant III) followed by a decline in both (Quadrant IV) (Underrepresented)
2 (Curve 2)	Increase UDs	Improve productivity and voice	+20%	Noticeable improvement in organizational productivity with a decline in perceived management responsiveness (Quadrant III) followed by a decline in both (Quadrant IV) (Underrepresented)
3 (Curve 3)	Increase LDs	Cost saving, less distraction	+20%	Similar to (1), improvement in organizational productivity with a decline in perceived management responsiveness (Quadrant III) followed by a decline in both (Quadrant IV) (Underrepresented)

Improving Organizational Capabilities and Attributes

Another set of simulations comprises management policies aimed at either supporting dissent climate or focusing more on efficiency without adding more personnel in any category as we did in the previous scenarios. They can be simulated through implementing changes to organizational capabilities (e.g. dissent processing) and attributes (e.g., tolerance for dissent) (Warren, 2008). Policies that support dissent climate include increasing dissent processing, tolerance for dissent, and dissent volume. The dissent climate support policies were selected because they closely match what administrators in higher education might do under conditions of rising criticism of the corporatization of higher education. For

example, Admins might work on improving their dissent processing by reducing bureaucratic layers that may have been the cause for unnecessary delays to respond to dissent. Along the same line, they might also try to be more tolerant of dissent and encourage higher dissent volume (dissent per dissenter).

Policies that focus on improving efficiency would initially increase members' productivity and decrease tolerance for dissent and dissent volume. The efficiency-focused policies are similar to what administrators are pursuing in the face of rising costs and, as their mental model may suggest, declining productivity and dissent overload (Quadrant II in Figure 5-3). They represent an attempt to increase the productivity of the members by exercising greater control and concentrating on training to improve faculty teaching and research-related skills (Cosenz, 2013).

These types of policies are implemented by changing model parameters that we have selected here to be ± 20%. The simulations for the above parameters are shown in

Figure 5-5.

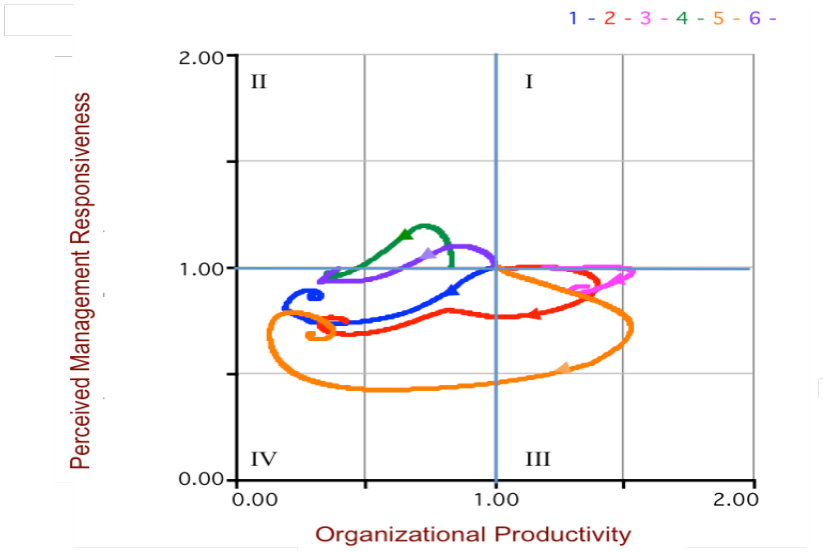

Figure 5-5 Changes in single capabilities simulation results showing the phase plot of each policy. (1) Increase tolerance for dissent. (2) Decrease tolerance for dissent. (3) Increase productivity of UDs. (4) Increase dissent processing. (5) Increase dissent per dissenter. (6) Reduce dissent per dissenter.

While all 6 scenarios

Figure 5-5 take different paths, they lead to similar final states in quadrant IV (low organizational productivity and perceived management responsiveness). Only the UD productivity improvement policy

(Curve 3) shows a different outcome by finishing in quadrant III (improved organizational productivity and low perceived management responsiveness). Initially the UD productivity improvement policy shows an increase in productivity while responsiveness remains unchanged. This improvement in organizational productivity will likely make the organization more tolerant of dissent and hence improve the dissent climate in general and UD influence in particular. However, as more UDs express their dissent, the administration's capacity to process it reaches a limit, which then leads to a decline in both the *organizational productivity* (combination of loops R3 and B2) and responsiveness to dissent (B1 loop). Under these conditions ultimately the dissent climate will suffer. The simulations suggest that Admin influence dominates the equilibrium state except for the productivity improvement policy (Curve 3) where UD influence is at a slightly higher level than both LD and Admin influence. This may explain the relative improvement in organizational productivity. It is worth noting also that improving dissent processing only (Curve 4) has a positive impact on improving responsiveness (Quadrant II) and a negative impact on productivity. Apparently, both dissent climate-supporting policies and efficiency-focused policies that rely on single-handed interventions will not accomplish the goal of moving the system toward a Quadrant 1 stable state. A summary of the results is provided in Table 5-2.

Table 5-2: Summary of simulated Policies employing changes to single capabilities and attributes

Policy number	Policy instrument	Rationale	Change	Outcomes
1 (Curve 1)	Increase tolerance for dissent	Support dissent climate	+20%	Deterioration in both organizational productivity and perceived management responsiveness (Quadrant IV) (Underrepresented)
2 (Curve 2)	Decrease tolerance to dissent	Focus on efficiency	-20%	Improvement in organizational productivity (Quadrant III) followed by deterioration in both organizational productivity and perceived management responsiveness (Quadrant IV) (Underrepresented)
3 (Curve 3)	Increase productivity of UD	Focus on efficiency	+20%	Improvement in organizational productivity with a decline in perceived management responsiveness (Quadrant III) (Underrepresented)
4 (Curve 4)	Increase processing of dissent	Support dissent climate	+ 20%	Improvement in perceived management responsiveness with a slight decrease in productivity (Quadrant II) (overloaded) followed by a decline in both organizational productivity and perceived management responsiveness (Quadrant IV) (Underrepresented)
5 (Curve 5)	Increase dissent per dissenter	Support dissent climate	+20%	Noticeable improvement in organizational productivity and a sharp decline in perceived management responsiveness (Quadrant III) (overloaded) followed by a decline in both (Quadrant IV) (Underrepresented)
6 (Curve 6)	Reduce dissent per dissenter	Focus on efficiency	-20%	Slight improvement in perceived management responsiveness with a slight decrease in productivity (Quadrant II) followed by a decline in both organizational productivity and perceived management responsiveness (Quadrant IV) (Underrepresented)

Capabilities Improvements on Multiple Fronts

As mentioned earlier, the goal of all the suggested policies here is to reach equilibrium in Quadrant I (high organizational productivity and perceived management responsiveness). Since our simulated model suggests that efforts to support dissent climate or improve efficiency by changing single capabilities and attributes does not accomplish the goal, we try here to intervene with multiple policies simultaneously for the purpose of optimizing the model behavior and moving the system towards Quadrant I. These interventions would be likely to both support the dissent climate and improve

efficiency and their rationale will be described in more detail. Despite the slight variations in their outcomes, in general, they all improve both indicators to different degrees. The simulation results are shown in Figure 5-6 and summarized in Table 5-3.

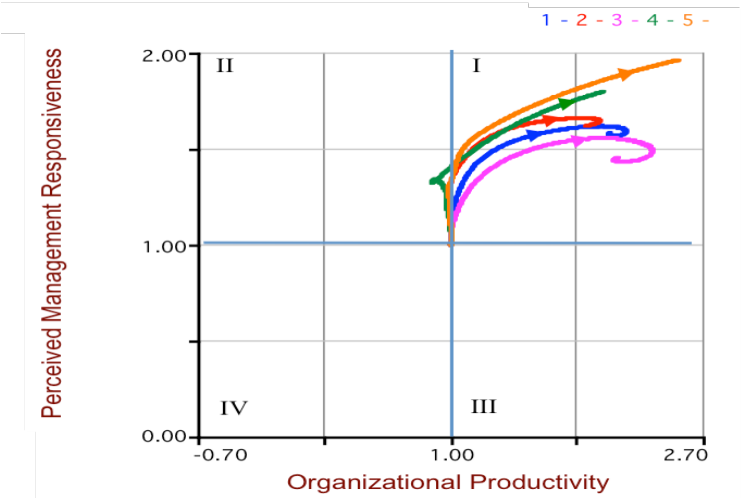

Figure 5-6: Simulation results for changes in multiple organizational capabilities and attributes showing the phase plot of each policy. (1) Increase UDs productivity + dissent processing. (2) 1 + increase dissent tolerance. (3) 1+ decrease dissent tolerance. (4) 2+ decrease dissent per dissenter. (5) 3 + decrease dissent per dissenter.

Since productivity improvement was a promising policy (Curve 3 in

Figure 5-5), we start with improvement to both faculty productivity and administration dissent processing. Both meet the Admins' desire for outcomes (R3 loop) and efficiency (B2 loop), and the faculty's desire for responsiveness (B2 loop). Curve 1 illustrates the increase of UDs productivity and the processing of dissent, which indicates that the institution is working on both fronts of skill building, that is, on skill maintenance, and on its ability to process dissent. This leads to less accumulation of upward dissent, which helps to the maintenance of productivity among UDs. A second policy (Curve 2) adds to the first one by increasing the tolerance for dissent to appeal to is members; it leads to a slight improvement in responsiveness due to the decline of dismissed dissent (B1 loop) and to a slight reduction in productivity as more effort is put into processing of dissent relative to the production of outcomes (B2 loop). Policy three (Curve 3) is a variation of the second policy by decreasing dissent tolerance in an attempt to focus on critical matters that enable proactive processing of upward dissent. This would result in a slight decline in perceived management tolerance for dissent (R1 loop) but higher gains in perceived

management responsiveness (B1 loop) and in organizational productivity (B2 loop). The forth policy adds the element of increasing dissent volume to the second policy. This might take place when the administration encourages its members to speak up about issues that concern them. Curve 4 shows an improvement in both indicators with a slight decline in productivity early on, which could deter the organization from following through on this policy. The fifth policy (Curve 5) combines the third policy with reduced dissent volume, which might take place when the organization has high dissent quality expectations. It can also take place when the focus is on only principled dissent, which would likely decrease the volume of dissent in the presence of high productivity and high dissent processing. It results in even better performance than the 4th policy as the accumulation of dissent is reduced which creates a favorable condition for the improvement of perceived management responsiveness (B1 loop) leading to higher UD influence and higher organizational productivity (combination of R3 and B2 loops) .

The outcomes from the above policies show that a variety of dissent management policies can lead to improvements in the preferable performance towards Quadrant I. In addition, at the beginning of the implementation across all policy interventions, productivity does not improve immediately and sometime declines slightly over the short term (Policy 3, Curve 3); however, in the long run, it pays dividends. This early decline may make it more challenging to maintain the commitment to implementing such policies especially when, under pressure, universities are increasingly focusing on short-term results or undergoing changes in senior leadership.

Table 5-3 Summary of policies employing changes to multiple capabilities and attributes resulting in reaching the optimum dissent Quadrant I

Policy number	Policy instrument	Rationale	Change	Outcomes
1 (Curve 1)	Increase UD productivity + dissent processing	Improve skills of both the faculty and administration	+20%	Improvement in both organizational productivity and perceived management responsiveness (Optimum)
2 (Curve 2)	1 + increase dissent tolerance	Improving skills (1) can be enhanced by more dissent tolerance	+20%	Slight improvement in both organizational productivity and perceived management responsiveness compared to (1) (Optimum)
3 (Curve 3)	1+ decrease dissent tolerance	Improving skills (1) and focusing on dissent quality by slight reduction in dissent tolerance	- 20%	Decline in both organizational productivity and perceived management responsiveness compared to (1) (Optimum)
4 (Curve 4)	2+ decrease dissent per dissenter	Improving skills and increasing dissent tolerance can be combined with focus on important current topics (decrease in dissent volume)	-20%	Slight initial dip in productivity followed by improvement in both organizational productivity and Perceived management responsiveness compared to (2) (Optimum)
5 (Curve 5)	3 + decrease dissent per dissenter	Improving skills and focus on better dissent quality and less dissent volume	-20%	Best of all, improvement in both organizational productivity and Perceived management responsiveness compared to (4) (Optimum)

Future Research and Practical Implications

The theoretical findings can be further supported by exploring empirical cases of dissent in higher education institutions and how these institutions have evolved over time with respect to dissent climate.

The model scope and complexity can also be expanded to include displaced dissent and the possibility for the organizational members to exit the organization. Admins' perceptions of effective dissent (Garner, 2014) can be also included in future work to explore other factors contributing to Admins' responses to dissent.

The insights from this work have practical implications for both the leadership and faculty in higher education. First, administrators need to be wary of feeling content with a short-term orientation that includes high dissent receptivity rather than a long-term orientation that makes dissent processing a permanent part of the institution. Second, simulations with favorable outcomes suggest that performance improves when university administrators invest in improving their dissent processing capability and enhancing faculty productivity. This has implications for how best to focus attention and invest resources into the university. Third, by working to institutionalize higher standards for dissent articulation and a lower volume of dissent (by virtue of collegial resolutions to critical faculty issues), performance may be further improved. Fourth, the simulation showed that investments into dissent management take time and effort and fast returns cannot be expected. Failure to recognize time lags could result in abandoning such polices too early and before favorable outcomes are realized. Fifth, with the short-term focus on performance improvement at many universities driven mainly by external threats and measures like national and international rankings and accreditation requirements, implementing such policies is likely to be very challenging. Sixth, the model also provides a platform for experimentation with different policy tools available to administrators in these institutions. Finally, dissenters need to be more patient as dissent processing takes time and effort and choosing to become an LDs does not improve the situation; instead, it tends to escalate administrative control and dissent intolerance. In this light UDs need to continue to engage senior leadership on substantive matters and encourage LDs to join them.

Conclusions

Based on a generic simulation model subsuming the conceptual framework provided by Kassing (2011), we have explored the dynamic interaction between the dissent expression framework and the

organizational composition to understand the effect of dissent management on dissent climate and performance in organizations and for a specific kind of organization, a university. In particular, we have looked at how an organization's tolerance for dissent changes over time, how changes to an organization's tolerance for dissent impacts performance, and how dissent expression and accumulation drive the change in the organization tolerance for dissent. We utilized system dynamics modeling and simulation methodology to explore these questions in a university context.

We have used two performance measures: support of the dissent climate through management commitment to dissent (high perceived management responsiveness) and efficiency (organizational productivity*)* (see Quadrant I in Figure 5-3). We simulated our model with different policy sets. The first set pertained to the growth of each organizational group under the same dissent tolerance and processing conditions. They all exhibited different degrees of initial improvements in organizational productivity only and a similar long-term steady state performance at low perceived management responsiveness and organizational productivity (Quadrant IV in Figure 5-4); they were also dominated by administrative influence. Then we identified clusters of organizational capabilities and attributes that were designed to foster dissent and those that were designed to improve efficiency and simulated them one at a time. Like the growth policy scenarios, they revealed a mixture of performance profiles but settled in Quadrant IV (see

Figure 5-5). Finally, we adopted policies with a focus on changing a combination of capabilities and attributes that would optimize improvement of both the perceived management responsiveness and organizational productivity, that is, create an equilibrium state in Quadrant I (see Figure 5-6).

We suggest that an academic institution may not remain stuck in one state with respect to its dissent support climate and performance. The desired change could occur over different time horizons and over different paths that are controlled by the accumulation and depletion processes. For example, some policy changes, such as adding more tenure-track faculty or administrators may generate the desired outcome instantly yet, contrary to expectations; result in unintended negative consequences over an extended period. Additionally, we have shown that an optimum state is a vast space that can be

accomplished through a host of combined policies that results in relatively similar outcomes that open the space for experimentation depending on the institution's particular conditions.

Some of the limitations to this work are by design and related to the problem boundary definition, which excluded the displaced dissent and the option to exit the organization. Due to the aggregate nature of the model, another limitation is the lack of heterogeneity among dissenters and their generated dissent.

The model is a first attempt at adapting this complex dynamic phenomenon to a generic university context and will benefit from additional critique and inquiry from the higher education community at large who can validate its findings, suggest other representative variables, add more granularity as needed, or suggest more testing scenarios.

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Chapter 6 : Conclusion

Using modeling and computer simulation, this dissertation has focused on studying two different views to organizational design and their implications for performance in the context of academic institutions. One view represents the manifest structure that includes resources (students, faculty, administration, facilities, finances, partners, donors, etc.); the other view represents the latent structure that focuses on dissent.

Chapters one and two addressed the manifest structure using two real-world cases on growth strategies. The latent structure was modeled and analyzed in chapters three and four and focused on the dynamic interplay between dissent, composition, and performance in organizations.

The dissertation has addressed the following two questions;

1. What are the tangible dynamic interdependencies constituting the manifest structure within academic institutions and their impact on performance?
2. What is the impact of the latent structures composed of intangible organizational processes, especially dissent, on performance?

A Conceptual Framework for Manifest and Latent Structures in a University from a Resource and Dissent perspective

The dissertation proposes generic system dynamics simulation models untangling the complexity of the questions. The models of the dissertation are based on three different theoretical frameworks addressing resources, dissent, and composition dynamics. They include the world-class university (Salmi, 2009), organizational dissent (Kassing, 2011), and the dynastic cycle structure (Saeed & Pavlov, 2008). They have been utilized in addition to the field work to formulate the core of the generic structures.

The findings are concisely and graphically presented in Figure 6-1. The representation shows how the manifest and latent parts of organizational design and performance are interconnected in a university. Organizational performance is also composed of a tangible and an intangible part. The manifest and latent

parts and the tangible and intangible parts are by default interconnected. There is a clear link between the manifest part of the organizational design and the tangible part of the performance. Policy decisions have clear manifestations on both sides of the causality. For instance, high revenues allow for good size budgets and hiring of faculty, enrolling students, and building facilities which in turn results in more graduates, publications, etc. At the same time, the latent part of the organizational design that includes collegial governance, voice rights, and dissent tolerance indeed has a tangible impact on performance that can enhance or slow it down. The latent part, being invisible, is often ignored, although its influence can seriously compromise performance.

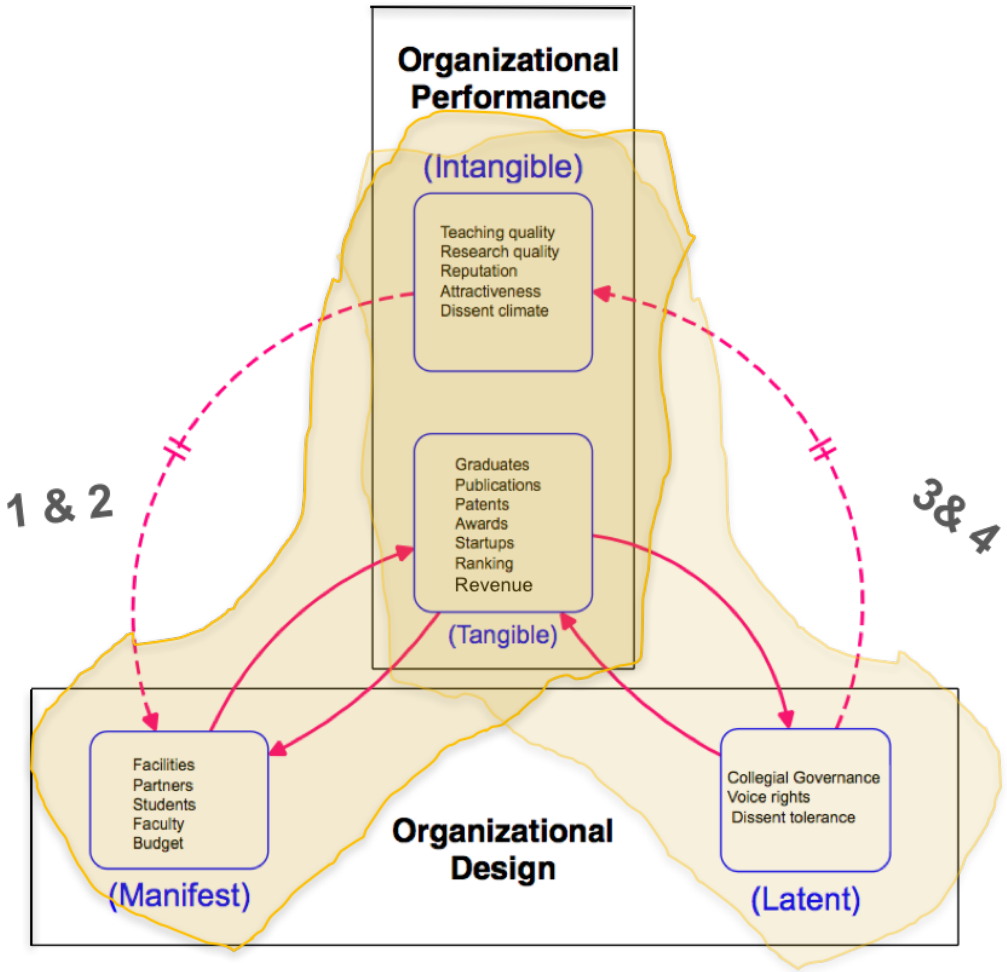

Figure 6-1: Top level representation for the manifest and latent structures in the academic institution and the dynamic interdependencies between organizational design and performance.

The latent causality shown by the dotted arrows with time delay signs (the equal sign over the dotted line) indicate the slow impact of compromising the latent part of the organizational design on the intangible performance measures like quality, reputation, and attractiveness. This intangible performance part, slowly affects the manifest part of the organizational design since faculty, students, and partners are not only driven by financial rewards, but also by the organizational environment. When the manifest organizational design part suffers, the tangible performance is quickly affected. The degradation of tangible performance will impact the latent organizational performance, leading the institution into a vicious cycle. The presence of time delays in this framework also alludes to the possibility of an oscillatory behavior that might superimpose a growth or decline pattern.

The four papers comprising the dissertation addressed segments of the above conceptual representation explicitly and implicitly and at different levels of detail. The first paper (R. M. Zaini, Pavlov, et al., 2016) looked at the manifest organizational design, the tangible, and intangible performance. The second paper (R. M. Zaini, Lyan, & Rebentisch, 2015) did the same but with more level of detail. The third and fourth papers (R. M. Zaini, Elmes, et al., 2016) focused on the latent organizational design part and addressed both the intangible and the tangible elements of performance.

Summary of Conclusions

Consolidating a list of the detailed dissertation conclusions is advantageous. The list includes:

(1) It takes a shorter time to decide about enrollment growth to mitigate the institutions' financial woes, but it takes much longer time for the latent parts of the institutional structure to adjust to this decision.

(2) Decisions made in isolation without coordination with other related decisions yield counter-intuitive outcomes. Expanding student enrollment without mitigating the impact on faculty and facilities could lead to both short term and long term implications.

(3) In the case of student enrollment growth, some results are irreversible, and will require extensive effort and extended periods of time to reverse their impact. Irreversible results can include

underutilized newly constructed facilities when enrollment declines. Examples of consequences that take a long time to reverse include reducing faculty and facilities load or restoring quality and reputation.

(4) Within the current university expansion model's assumptions (e.g., the absence of financial analysis), growing a university student body might seem like an effective short-term policy with acceptable ramifications on faculty and facility loads, but it fails to recognize the long-term impact on quality and financial health. Financial health, not currently modeled, will manifest in both the growing debt service for financing the new buildings and the operation and maintenance costs.

(5) Some well-intentioned policy interventions may solve an urgent matter, yet exacerbate others. For instance, accelerating faculty hiring to reduce faculty load could escalate faculty shortage since it would decline faculty academic experience, increase faculty attrition, and worsens the situation even further.

(6) Model efficacy can hardly extend beyond communication to influence organizational change. The presence of change agents who understand the model insights is instrumental in leading and sustaining the change efforts.

(7) The complexity of the organizational issues and the significant time delays involved until results flourish and improve the organizational performance could have an adverse effect. The negative influence would be on management commitment to policies that sustain the university development trajectory. For example, the tension between growth (a manifest performance measure) and quality (latent performance measure) is challenging to manage. Each of those measures appeals to different stakeholders and occurs in a different time horizon. A startup research university has the dilemma to meet growth targets set by its financial supporters and its commitment to quality by attracting and selecting talented students and faculty.

(8) The presence of open communication channels that encourage upward dissent improves perceived management tolerance of dissent, attracts more Latent Dissenters (LDs) to become Upward Dissenters (UDs), and generates more upward dissent. However, perceived management responsiveness to dissent will be impacted negatively when major decisions concerning the members or the direction of

the institution are made without their consultation or when their concerns are not timely and respectfully addressed. Accordingly, some employees will disengage and join the LDs, leaving the opportunity for Administrators (Admins) to act unilaterally since they interpret the silence as a sign of contentment or disinterest.

(9) In the long term, intolerance of dissent could negatively influence the organizational dissent climate by moving more UDs to become LDs, thus requiring more Admins to impose more controls to improve productivity. High Admin influence would have a negative impact on the processing of dissent because it could introduce more dissent processing delays, as the issue under consideration has to go through control routines for checks and approvals that are likely to reduce perceived management responsiveness and increase the number of LDs.

(10) Dissenters need to be more patient as dissent processing takes time and effort and choosing to become an LDs does not improve the situation; instead, it tends to escalate administrative control and dissent intolerance. In this light, UDs need to continue to engage senior leadership on substantive matters and encourage LDs to join them.

(11) Academic institutions' desired tangible change could occur over different time horizons and different paths. They may not remain stuck in one state with respect to their dissent support climate and performance. The change paths are controlled by the accumulation and depletion processes of intangibles like dissent and its outcomes. The accumulation and depletion of dissent in the organizational memory can explain why tolerance for dissent changes over time.

(12) Time delays also influence organizational composition, dissent expression, dissent accumulation, dissent decay, and performance which prevent the organization from realizing the benefits of dissent. For example, when the administration encourages its members to speak up about issues that concern them, a slight decline in productivity is experienced which could deter the organization from following through on this policy. Therefore, we suggest that an organization's tolerance for dissent can change over time due to a perceived short-term productivity drop that impacts performance. The change is

more likely to happen when the institution's focus is on short-term performance that is driven mainly by external measures like national and international rankings and accreditation requirements.

(13) Designing a performance canvas that addresses both the tangible (perceived management responsiveness to dissent) and intangible measures (organizational productivity) can provide a balanced outlook of the tangible and intangible focus in organizational design. The combination of those two measures at different levels constructs a state space that describes the states in which organizations can exist with respect to dissent tolerance and performance (optimum, overloaded, underrepresented). High organizational productivity and high management responsiveness to dissent corresponds to the optimum dissent level and tolerance. A state of low productivity and high responsiveness corresponds to an overloaded organization with high levels of dissent and dissent tolerance. High productivity and low responsiveness correspond to a state of underrepresented dissent. The canvas also suggests that an underrepresented dissent can exist in an organization with low productivity and low responsiveness.

(14) Through model simulation, the performance matrix comes to life showing how an organization moves from one state to another (optimum, overloaded, underrepresented) in response to the intervention policies. This capability makes the model an excellent platform to assess the interventions' effectiveness.

(15) Adding more administrators, tenure-track faculty, or adjunct faculty are typical improvement interventions in universities. Simulating the model with policy sets that pertained to the growth of these organizational group under the same dissent tolerance and processing conditions, exhibited different degrees of initial improvements in organizational productivity and a decline in perceived management responsiveness. Long-term steady state performance settled at low perceived management responsiveness and organizational productivity. Reaching the institution's dissent processing capacity limit and getting trapped in an efficiency-chasing mode prompting control of every aspect of its environment to boost productivity are primary drivers behind this unexpected outcome.

(16) Simulating the model with different policy sets focusing on building organizational capabilities either to improve the dissent climate or to improve efficiency, revealed a mix of performance

profiles but settled in a state of low perceived management responsiveness and organizational productivity. Improving dissent climate or dissent processing efficiency only results in conflicting goals that either overload the institution with dissent or shut it down entirely.

(17) An optimum state is attainable through a combination of interventions focusing on improving admins dissent processing capabilities and UDs productivity. Combined interventions resulted in similar favorable outcomes comprised of high perceived management responsiveness to dissent and organizational productivity. This finding calls for more experimentation with different policies contingent on the institution's particular conditions. Some policies are more accessible at one institution than others. Policies that were possible to investigate within the current model capabilities include; allocating more resources to dissent processing, improving faculty and administration productivity, setting expectations about dissent quality, or focusing on principled dissent that involve important organizational issues.

Limitations and Recommendations for Further Research

No effort was made in this dissertation to combine all aspects of the generic framework shown in Figure 1. This was intentional as I was exploring the various slices of the problem using a modular approach and focusing on clarity of the causal structure to maximize insights and keep the complexity at a manageable level (Saeed, 1992b). The work as it stands now can benefit university administrators, higher education consultants, and policy makers. They can use the models to facilitate communication and understanding through experimentation with different scenarios. The scenarios can represent the stakeholders' multiple views to the design of their organizations. Also, the presented interdependencies and assumptions constitute a set of questions that can guide what the institutions need to measure and monitor over time. These questions will facilitate exploring how strategies unfold and how the dissent climate shifts and how all this could influence the reputation and impact. The outcome of such studies will enhance the confidence and usability of the models and their value. Building a unified model can be tackled in the future with a proper degree of detail and complexity.

The models of the papers can also benefit from further advancements. The aggregate university expansion model (Zaini, Pavlov, et al., 2016) would benefit from including financials, graduate students' growth, and associated focus on research to allows for a more in-depth analysis of different growth strategies and their outcomes on the university's performance. Adding financials and linking the strategy model to the dissent model-to test the influence of financial stress on dissent tolerance - would be of interest too. Another aspect to investigate in more detail too is the death spiral dynamics arising from growth and its implications for bureaucratization, administrative control, and dissent suppression. So far this dynamic has been addressed to some extent and at an aggregate level by Saeed (1998) in a model dealing with professional competence in innovation organizations.

The startup university strategy model (Zaini et al., 2015) calls for further tightening the theoretical framework and eliminating extra details. The simplified model can then be configured in a multilevel hierarchy thus creating multiple dynamic hypotheses and their corresponding behavioral modes (Chichakly, 2016) can be developed and tested for the sake of managing complexity and gaining better insights. The current model, as it stands, can benefit from examining the impact of the various resource management and macroeconomic scenarios on a start-up university performance.

The dissent dynamics model (Zaini, Elmes, et al., 2016) scope and complexity can also be expanded to include displaced dissent (Kassing, 2011) and the option to exit the organization (Hirschman, 1970). Both were excluded for the sake of simplicity and the better understanding of the internal dynamics within the organization. Investigating their influence on the outcomes of the current model is of interest as they portray a more realistic image of the organizational scene. Addressing heterogeneity among dissenters and their generated dissent (personal vs. disciplined, quality, style, volume, or frequency) can also be explored for any significant effects on the model results. This assessment may call for a different modeling and simulation method like agent-based modeling (Railsback & Grimm, 2011). The organizational composition framework in the dissent model, when viewed in the context of universities, expects faculty to engage in upward dissent. It departs from the cosmopolitans and locals' context of Gouldner (1957, 1958), which does not expect cosmopolitan faculty members to participate in

upward dissent concerning local issues within the university. Our model does not differentiate between the nature of dissent issues but is mainly concerned with matters related to sustaining innovation. Exploring the difference between the two perspectives may be worth pursuing.

Exploring empirical cases of dissent in higher education institutions and how their dissent climate has evolved over time should be pursued to corroborate the theoretical findings of this dissertation. Two candidate cases for startup research universities include Skoltech and KAUST. As both universities grow and mature, it would be of interest to investigate the implications of dissent on several critical matters. The issues include; innovativeness, and access to the talent pool of students, faculty, and research partners. Those issues impact the growth and stature goals of these institutions. The challenge with such endeavor is the time horizon the dissent phenomena and its implications take to change the organizational climate. Examining ethnographical accounts can be useful for such research.

Modeling and Organization Design

The dissertation demonstrated that system dynamics modeling and simulation methodology could be successfully used to build generic dynamic models that can address both the tangible and intangible views to universities. The models demonstrated the complexity of organizational design by integrating different mental models, theoretical frameworks, and strategic vision representation to understand their consequences. They unveil the systemic feedback between both the manifest and latent structures and time delays that produce their effects. They also indicated strategic levers and raised additional questions that could underpin success or failure of achieving long-term strategic goals. The models' simulation outcomes are, however, contingent rather than conclusive and do not always favor any one strategic choice which should help their application to different organizational settings. The models can also be used as vehicles for communication and exchange of views around delicate organizational issues and high priority topics typically raised when making policy decisions requiring effective collaboration and organizational change. The context of the models presented in this dissertation, however, can go beyond the context of universities. For instance, the latent structure in the dissent model was based on dissent

dynamics, and since dissent is ever-present in organizations, it can be applied to a variety of organizations. Therefore, the models can be utilized to improve the understanding and management of organizations.

The dissertation took an organizational communication perspective to the university by considering dissent since it is a common phenomenon and a fundamental design element in universities. However, communication is one view of the organization and dissent is one form of communication. There are other numerous views of the university and organizations in general (Morgan, 2006) from which other latent structures can be extracted and modeled including but not limited to power, politics (Farrell & Petersen, 1982; Kaya, Aydin, & Ayhan, 2016), and values, etc.

The use of images and metaphors in organization design makes modeling an accepted fit as I suggested in the introduction. System dynamics modeling also has the power of combining views, embodying visions, and representing them in a relatable form. For example, if a new university vision is to be the MIT of Asia, MIT becomes the image that calls for analysis. The designer can then ask which qualities of MIT the university vision aspires to achieve? Then based on the answer, we can look at MIT through different perspectives, be it manifest or latent and build a model that reflects that view. Based on the model structure, a comparison can be carried out on how similar or dissimilar the vision and the specified rules and relationships for this aspiring university to the one it tries to imitate. When simulating the model afterward, the behavior that emerges from the model may not match the vision, and this can start a good discussion to identify the sources for incongruences. If the model matches the aspired vision, then modifying the assumptions, in the form of risks, might as well result in a meaningful investigation and a different set of guidelines to the designers and the modelers further explore the image and tweak the model. Another example for an organizational image is an animal. If an organization going through change picked the deer as a metaphor for their sought change, nimbleness might be identified as one of the primary image attributes. It suggests the organization can respond quickly to changes in its surrounding environment. Informed by the image, the model may need to include shorter time delays and shorter development pipelines to be able to represent accelerated responsiveness. The organizational

designers and the modelers can collaboratively work to specify the structure, the rules, and policies for the organization and interpret them in the model. Then the model can be simulated to find out whether these design specifications would eventually serve the organization vision's and explore any unintended consequences that may arise.

In addition to the value of using models to improve understanding and communication of potential organizational issues and aspiring visions, they can be an essential precursor and companion to organizational prototyping (Brown, 2009; Brown & Katz, 2011). The prototyping concept in organizations raises questions like "how do we prototype in organizational design? If the thing we are trying to create (the organization) is largely an emergent phenomenon and we are trying to specify things that we hope will produce the desired phenomena, how can we create a prototype? If we try something on a small scale, how do we know it will produce similar emergent behavior on a larger scale? Does this mean that we can't really do prototyping with organizations?" Those questions are legitimate, and the concerns are real; however, the alternative is often allocating enormous resources to build the physical infrastructure of the organization which is probably not always the best policy. Starting with a prototype and increasing the size and level of complexity over time would help in some way to mitigate the unintended consequences of instant scaling. At the same time, if models are used to inform the prototype design, they can increase the prototype success potential, the learning, and the planning of anticipated corrective actions during the execution phase.

The envisioned collaboration scenarios between organization designers and simulation modelers constitute significant contributions to both simulation modeling and organizational design and a source for collaboration between academics and practitioners in both fields. Such collaboration could potentially increase the impact of modeling and simulation to the organization studies body of scholarly articles and case studies.

Personal Reflections

Embarking on this research journey fundamentally transformed my understanding of organizations. The first two papers taught me about the necessity of working with stakeholders in producing a meaningful work in the organization. Despite being based on a theoretical framework, the dissent models, opened my eyes to the issues involved in sustaining a meaningful stakeholders' engagement. Only because it takes an extended time and tremendous effort to listen and process inputs. When running in an efficiency mode, this can be hardly a viable option.

I also discovered how much the mechanistic view to organizations influenced me. My mechanical engineering background may have played a role, but it surprised me more that this is a prevalent view that dominates the management scene through the work of some influential thought leaders. Becoming aware of the complexity and multitude of views to organizations and organization design in particular made me believe that connecting with people in organizations, listening to their observations, and attempting to grasp their points of view about the goals of their organizations is imperative for success in such an endeavor. I also became content with the presence of dissent in organizations. I see it as a natural phenomenon and a healthy one when understood and managed properly. Even organizations with clear vision and goals, their members often perceive these goals and evaluate their execution differently which is a primary reason for dissent.

Another source of dissent is issue permanence in the organizational memory which is a function of the time it takes to resolve issues or simply forget about them. Administration and faculty, management and employees have a different perception of time depending on their positions and priorities. The administration could be impatient about the time needed to submit an annual performance portfolio while a faculty member can be anxious if her letter to the dean was not answered promptly and addressed appropriately. When it comes to the administration achievements, they don't last enough in the organizational memory, but their delinquency does. Administration monitors action (flows, achieved tasks/time) and employees observe accumulations (stocks, performed tasks). Also, the time to forget is much longer than the expected time to process dissent which perpetuates discontent and hence dissent.

Organizations, I believe, need not worry about the visible signs of dissent but worry more about the lack of them thereof because dissent will not vanish but will morph into a hidden form, the latent dissent. Invisible dissent sucks the vital organizational energy and drives the organizational resources into a damage control path. Organizations need not also to overreact and label dissenters as lunatics. To the contrary, they need to utilize dissent, despite its form or content, as a source of information to study and find ways to improve their norms and structures (Elmes & Taylor, 2005).

System dynamics modeling is an analytical approach and despite its prowess in handling intangibles and thick descriptions, it inherently quantifies them into numbers and mathematical functions that lack the look and feel of the organization. Learning system dynamics modeling may have been, at first glance, a footstep towards the world of equations and numbers. However, the capability of system dynamics modeling to solicit and represent stakeholders' mental models and incorporate them into the model building process brought me to think differently about the value of modeling and models. I came to see models as means to facilitate human communication and understanding to solve problems. When people realize that they have a role in shaping their organizations, this leverages their strengths, elicit their engagement, and ease their resistance which can be a valuable but not sufficient step towards enticing change.

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Chapter 7 Appendices

Appendix A: Model Structure and Equations for Chapter 2

Appendix B: Model Structure and Equations for Chapter 3

Appendix C: Dissent Model Structure and Equations for Chapter 4 & 5