Data to Support Decision-making in American Higher Education:

Opportunities from the Perspective of the Institution,

Management, and Employee

Heather M. Messina, MPA CRA

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Dedication

This paper is dedicated to my family, Victor & Mary Gazella, who instilled in me the value of education, hard work, persistence, and grit to accomplish the goals I set for myself. To my immediate family, Michael, Cora & Aiden, who is there every step of this journey to a terminal degree, and I hope this makes you proud and see that anything is possible. To my high school English teacher, Mrs. Amy Fonash, who was influential in my career path, and who would be proud of this accomplishment. And to my exceptional mentors, past and present supervisors and professors, and amazing colleagues for their mentorship and friendship.

Abstract

Institutions of higher education have been severely affected in recent years by a number of unfavorable happenings, which include but are not limited to, a decline in matriculating high school graduates, an unstable economy, a decrease in federal and state funding, a refocus on STEM career training, stricter F-1 visa approvals for international students, and more recently, the COVID-19 pandemic. Institutions have been forced to reevaluate the way strategic decisions are made in order to face the unknowns of the future and the harsh realities that have collectively reshaped higher education (Chan & Randall, 2021, p. 13; Ueland et al., 2021, p. 128).

Since the late 2000s, researchers have explored areas of opportunity (and challenge) in using big data and data analytics to support core university functions and better decision-making. With large volumes of both academic and scientific research data, institutions of higher education have the data sets needed to benefit from the results of using data analysis tools. Adapting business intelligence techniques from industry can have the potential to alter and significantly improve existing processes of administration, teaching, scientific research, and academic service.

Many institutions of higher education are experiencing a shift in mindset and are investing in dashboards that visualize data and make it more accessible to deans, their administrative support teams, and other users across campus. As a result, a number of institutions are also exploring new employee recruitment strategies that include reskilling current staff or bringing in promising candidates and then training them in the upskills needed to perform data capture and analysis.

The institution, management, and employee perspectives highlighted in this paper, together with four theories of organizational behavior, reveal that each has a significant opportunity to impact and be part of a strategic pathway in furthering the use of data analytics to support decision-making. As it concludes, this paper refers to several opportunities and suggestions for institutional policies and next steps in order to capitalize on data analysis tools and support better strategic decision-making.

<u>Keywords</u>: institutional analytics, big data, data analytics, data science, institutions of higher education, skills gap, and decision-making.

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Introduction

Institutions of higher education have been severely affected in recent years by a number of unfavorable happenings, which include but are not limited to, a decline in matriculating high school graduates, an unstable economy, a decrease in federal and state funding, a refocus on STEM career training, stricter F-1 visa approvals for international students, and more recently, the COVID-19 pandemic. Institutions have been forced to reevaluate the way strategic decisions are made in order to face the unknowns of the future and the harsh realities that have collectively reshaped higher education (Chan & Randall, 2021, p. 13; Ueland et al., 2021, p. 128). One part of the literature considered the "manner in which organizations adapt to complex, uncertain environments by changing their information-processing capabilities, either by reducing the need for information…or by increasing the capacity for information acquisition, storage, and retrieval (via information systems)" (Dooley, 1997, p. 75).

Since the late 2000s, researchers have explored areas of opportunity and challenge of using data analytics to support core university functions, such as teaching, scientific research, and service, in order to deliver a better faculty, staff, and student experience. The objective of this literature review was to advance the field by filling a gap and presenting concise information around opportunities for the institution, management, and employee to use data to support decision-making in American institutions of higher education. The institution, management, and employee perspectives highlighted in this paper reveal that each has a significant opportunity to impact and be part of a strategic pathway in furthering the use of data analytics to support decision-making. Therefore, it is suggested that institutional policies could be established that create opportunities to capitalize on data analysis tools and support better strategic decision-making.

The term data analytics refers to looking at raw data sets (with defined columns and rows) and using statistical analysis techniques (descriptive, predictive, or prescriptive) to make conclusions about the information (themes and patterns). Big data refers to large data sets that are generated from a variety of sources, arriving in increasing volumes, and quickly accumulating. Using data to support decision-making and strategic planning is not new. Business organizations have been storing and analyzing large volumes of data since the arrival of data warehouse systems in the early 1990s. However, the availability of data and the various ways data can now be collected are ever evolving with the rise of cell phone technology, artificial intelligence and algorithms, and machine learning, to name a few. First proposed in the early 1990s and growing over the years, clustering, association, classification algorithms, regression models, predictive methods, and factor analysis have become the key approaches for data analysis (Daniel, 2015, p. 907).

Data analytics is important because it helps optimize efficiency and supports strategic decision-making. With large volumes of both academic and scientific research data, institutions of higher education have the data sets needed to benefit from the results of using data analytics tools. Adapting business intelligence techniques from industry can have the potential to alter and significantly improve existing processes of administration, teaching, scientific research, and academic service (Daniel, 2015, p. 910; Nguyen et al., 2020, p. 63). From the perspective of the institution, management, and employee, and in the context of four theories of organizational behavior, the effects of data analytics are explored and several next steps are suggested.

Literature Review

There is a growing body of literature that highlights opportunities for using big data and data analysis tools in American institutions of higher education. There is also a growing interest,

in general, in using industry as a model for exploring and unlocking the value of using data to

support decision-making in institutions of higher education. The available literature is new and

informative, providing a basis for future research and policy recommendations. Institutions of

higher education are sitting on huge amounts of valuable data stored in different departments and

software systems, waiting for the silos to be broken and the dots to be connected. With the

adaption of cloud computing infrastructure, the current situation can be transformed to make

effective and coordinated use of a wealth of data that exists and has the potential to be used to

support decision-making (Attaran et al., 2018, p. 8; Nguyen et al., 2020, p. 61).

Since the late 2000s, researchers have explored areas of opportunity and challenge of

using big data and data analysis tools to support core university functions, such as teaching,

scientific research, and service, in order to deliver a better student, faculty, and staff experience.

Information referenced throughout this literature review highlights the importance of exploring

the opportunities associated with implementing data analytics in institutions of higher education

and presents the findings for educators, administrators, and policymakers to consider (Attaran et

al., 2018, p. 1). This study has been conducted through reviewed sources of literature, including

scholarly journals, book chapters, and reports. Search engines of scholarly databases utilized in

this literature review included: Marywood University library website, Lehigh University library

website, EBSCOhost Research Databases, Wiley Online Library, and Google Scholar. Keywords

utilized in the literature review included: institutional analytics, big data, data analytics, data

science, institutions of higher education, skills gap, and decision-making.

Conducting this literature review revealed little scholarly data specifically highlighting

opportunities in American institutions of higher education to increase data analytics to support

strategic decision-making. The objective of this literature review was to advance the field by

filling a gap and presenting concise literature around opportunities for the institution, management, and employee to use data to support decision-making in American institutions of higher education. The institution, management, and employee perspectives highlighted in this literature review reveal that each has a significant opportunity to impact and be part of a strategic pathway in furthering the use of data analytics to support decision-making.

Institution Perspective

Institutions of higher education are operating in an increasingly complex and competitive environment. They are under mounting pressure to respond to national and global economic, political and social changes, such as the growing need to increase the proportion and diversification of students in certain disciplines, increase scientific research capacity and output, and ensure that the quality of learning programs is both nationally and globally relevant (Daniel, 2015, p. 904; Nguyen et al., 2020, p. 61). American institutions of higher education should recognize the importance of rapidly adapting and scaling up to new Fourth Industrial Revolution forms of education to assure the sustainability of our environment and economy, as well as to sustain the relevance of higher education as a responsive and vital component of society (Gleason, 2018, p. 225).

With large volumes of both academic and scientific research data, institutions of higher education have the data sets needed to benefit from the results of using data analytics tools. Big data and data analytics can be transformative for institutions of higher education and support better decision-making in these increasingly competitive times. Adapting business intelligence techniques from industry can have the potential to alter and significantly improve existing processes of administration, teaching, scientific research, and academic service (Daniel, 2015, p. 910; Nguyen et al., 2020, p. 63).

Business intelligence tools and data analytics are more than just methods of gathering and analyzing data. They represent a shift in mindset and adopting the role of the experimenter – a willingness to let data guide a strategic decision-making process (Attaran et al., 2018, p. 4). From an organizational perspective, it is well understood that institutional effectiveness and adaptation to change relies on the analysis of appropriate data, and today's technologies, with advances in sophistication, speed, and accuracy, enable institutions to gain insights from data that was previously unachievable (Daniel, 2015, p. 910).

Using data to support decision-making and strategic planning is not new. Business organizations have been storing and analyzing large volumes of data since the arrival of data warehouse systems in the early 1990s. However, the availability of data and the various ways data can now be collected are ever-evolving with the rise of cell phone technology, artificial intelligence and algorithms, and machine learning, to name a few. The creation and evolution of new technologies bring with them complexity in managing the volume of the collection, storage, privacy, and analysis of these datasets. First proposed in the early 1990s and growing over the years, clustering, association, classification algorithms, regression models, predictive methods, and factor analysis have become the key approaches for data analysis (Daniel, 2015, p. 907).

Descriptive analytics is the simplest of the three categories. It allows large amounts of data to be condensed into smaller, more useful pieces of information. Its purpose is to summarize what happened in the past and to uncover patterns that may offer insights into the performance or health of an organization. This enables users to monitor and manage their business processes more effectively and efficiently. In descriptive analytics, data modeling, reporting, visualization, and regression are used to collect and store data. Allowing the user access to a dashboard that

creates and presents a visual representation of information that can be used to identify trends or patterns in the data (Attaran et al., 2018, p. 4).

Predictive analytics uses current and historical data to provide insights into what will happen and why it will happen with an acceptable level of reliability. It involves the use of a variety of models and techniques to project future conditions and situations. It does not predict one possible future but rather multiple possible futures based on the decision-maker's actions. Predictive analytics can help organizations analyze historical data and facts to improve their understanding of a wide range of issues (Attaran et al., 2018, p. 3).

Prescriptive analytics goes beyond the descriptive and predictive models and shows the likely outcome of each decision. It goes a step further into the future and attempts to identify what should be done and why. Prescriptive analytics employs techniques such as decision modeling, simulation, and optimization to ascertain actions the organization could take to achieve the desired outcome. The aim is to evaluate the effect of future decisions and to present the best course of action to take in order to adjust decisions before they are actually made. This is the most valuable category of analytics and usually results in rules and recommendations for the next steps (Attaran et al., 2018, p. 4).

The decisions required for managing rapid changes in the higher education environment are multifaceted. Currently, many important and strategic decisions in American higher education are made without access to data dashboards and analytical tools. "These data can play a major part in how we understand the often-contested nature of higher education governance and so ensure that institutions are not only able to respond effectively to changes happening within and outside them but that they also remain pertinent to their purpose in the societies that they serve" (Daniel, 2015, p. 904).

A review of current literature shows that a notable opportunity exists for institutions of higher education to adopt business intelligence tools and to make use of reports by establishing data warehouses and creating data dashboards. These tools would provide an institution with the capability to make timely data-driven decisions across all departments and divisions (Daniel, 2015, p. 910). It is important to acknowledge that the literature review also revealed a number of challenges that exist within institutions of higher education that make adapting new technologies a complex undertaking. To become a data-driven organization, a university needs a thoughtfully designed analytics platform that empowers everyone to make data an integrated part of their day-to-day processes (Attaran et al., 2018, p. 9). And an institution of higher education needs an analytics solution, specifically, that can bring together disparate data in a governed environment that allows users from different departments to model, discover, communicate and distribute information easily. (Attaran et al., 2018, p. 135).

Before big data and data analysis tools can be useful to American institutions of higher education, there must be a fundamental shift in thinking. Analytics needs to be repositioned in the mindset of management professionals working in the institution. Analytics is constantly evolving; it has changed dramatically over the years and is still advancing rapidly today (Attaran et al., 2018, p. 5).

Management Perspective

Before advancements in data analytics, strategic decisions in higher education were made according to the experience of leadership and management. Data were manually collected, often in excel spreadsheets, resulting in obvious (or non-obvious) flaws. In the age of big data, and with the accessibility of business intelligence tools, it is now much more efficient to collect, store, mine, and analyze data as well as visualize, monitor, track, and predict outcomes over a

time period. The types of data generated by institutions of higher education include teaching, student, scientific research, daily management or programmatic, and other types of service to the university (Wang, 2019, p. 1).

Many institutions of higher education are finding opportunities to adopt data analysis tools that facilitate decision-making and strategic planning. They are creating dashboards that visualize data and make it more accessible to deans, their administrative support teams, and other users across campus. To identify issues and support decision-making at both the department and institutional levels, deans and administrators look for signals and patterns in areas ranging from student outcomes to financial metrics to scientific research efforts (Wolf et al., 2016, p. 2).

The literature, in general, indicates that the implementation of data analytics can have dramatic effects on the improvement of the decision-making process (Guster & Brown, 2012, p. 43; Ghasemaghaei, 2019, p. 15). A data governance structure is a critical component of adopting data analysis tools, which includes the establishment of clear ownership of the data/processes that generate the data and a clear understanding of who uses the information and the purpose of its use. These governance principles should be driven by the use of a communication model, not necessarily the technology (Guster & Brown, 2012, p. 44).

With data analytics, there is an opportunity to increase and streamline data accuracy so that planning, forecasting, and reporting mechanisms all link to the same information. The old adage "garbage in, garbage out" still applies when using sophisticated data analysis tools. Therefore, the data analysis technology platform should provide a unified and trusted view of the business, empowering all employees with insight and aligning with the organization's operational strategy (Guster & Brown, 2012, p. 44).

The accumulation of data should not be an end in itself, it should be valued as a means to an end. Therefore, there needs to be an end goal of transforming the data into useful and relevant information. This is done by getting behind the data and bringing managerial insight to the information provided (Stanton & Stanton, 2019, p. 170). In a 2018 research study by Maryam Ghasemaghaei, she hypothesized that relationships existed between data analytics use, knowledge sharing, data analytics competency, and decision-making quality. Decision-making quality refers to the correctness and accuracy of decisions for desired outcomes. Her study found that decision-making quality improves if the decision-maker has sufficient knowledge about problem variables. However, if the decision maker does not have the required knowledge about the relationships among problem variables, the quality of the decision may decrease. In this way, decision quality depends on the inputs (Ghasemaghaei, 2019, p. 15).

Ghasemaghaei (2019) found that data analytics significantly improves knowledge sharing, and knowledge sharing increases firm decision-making quality. Moreover, the impact of knowledge sharing on firm decision-making quality is at its highest when employee analytics capability is at its highest level. Most importantly, the impact of knowledge sharing on decision-making quality is not significant at low levels of analytics capability (Ghasemaghaei, 2019, pp. 19-20). In general, knowledge sharing within a firm does not necessarily enhance the quality of the decisions made in the firm. A firm's data analytics competency has a vital role in the impact of knowledge sharing on firm decision-making quality by using analytical tools (Ghasemaghaei, 2019, p. 20).

In a book edited by Nancy Gleason (2018), the author uses a lens of the Fourth Industrial Revolution to look at what is happening within institutions of higher education and why (Gleason, 2018, p. vii). The first three industrial revolutions provided evidence for profound

shifts in society, the economy, and education which resulted in the creation of co-curricular innovation and the establishment of new educational institutions (Gleason, 2018, p. 224).

A review of the literature reveals that the shelf life of any skill in the present-day working environment has become increasingly short, requiring future workers to continuously update their skills and teach themselves about new technologies and new industries that may not have existed while they were being trained for their initial degrees or roles. A further requirement for management in the Fourth Industrial Revolution would be to include a strong overlay of ethical thinking, intercultural awareness, and critical thinking to enable the thoughtful and informed application of new and developing technologies (Gleason, 2018, p. 220).

Employees in institutions of higher education need to adapt and respond to the increasing rate of change and the increasing complexity and volatility of employment (Gleason, 2018, p. 220). The study results from Ghasemaghaei (2019) reiterate the importance of training employees and developing sufficient knowledge-sharing mechanisms, and encouraging the adoption and use of data analysis tools (e.g. Tableau, Python). Future jobs that require skills to perform tasks related to data science, such as artificial intelligence (AI), machine learning, robotics, nanotechnology, 3D printing, genetics, and biotechnology, are expected to dominate in the coming decades. Employers and industries are projecting that social skills, which include persuasion, emotional intelligence, and capacity for teaching others, will also be at a premium (Gleason, 2018, p. 220).

Employee Perspective

Institutions of higher education recognize that their mission is not only focused on preparing students for an economically relevant career but also on helping train existing members of the workforce to gain the skills needed to succeed in a quickly changing workplace.

Employees need opportunities to continue to gain the skills required for a productive career, both for themselves and the institutions for which they work.

Closing the skills gap by finding or developing data science talent is a challenge, but not unattainable (Stanton & Stanton, 2019, p. 180). In a future state within the world of higher education, students, administrative staff, and faculty will never be done with their educations but instead will continue to engage in learning from their colleagues and outside experts to frequently renew and update their skills (Gleason, 2018, p. 224).

Employees, especially those who have made a career in higher education, are the best source of knowledge. In fact, knowledge resides within individuals, and in particular, in the employees that generate and apply knowledge in performing their tasks (Ghasemaghaei, 2019, p. 15). While the literature is not specifically focused on retention and voluntary turnover intentions of administrators within institutions of higher education, the literature reviewed for this paper provides a foundation for the topic. Studies have shown that, in general, higher-skilled employees are more likely to stay at an organization if their job duties include new challenges and opportunities to learn. Additionally, considerable research has shown that opportunities for career growth and professional development are crucial motivating factors for employee retention (Ghasemaghaei, 2019, p. 15).

Borrowing an example of a case study from "The Dean's Information Challenge: From Data to Dashboard" written by Wolf et al. (2016), the George Washington University is one institution that recognizes that its administrative staff has the ability to act as both artisanal decision support and as data stewards for the university. They define the business terms and appropriate data usage in a data analytics dashboard and help to create the business processes. This helps keep the staff involved in the decision-making process and provides them the

opportunity to learn new skills. The data stewards retain some of the benefits of the artisanal decision support method by ensuring the data is used in the right context, with the right business rules, and furthering the institution's mission (Wolf et al., 2016, p. 6). As a result, the central data warehouse staff spends less time gathering data and more time analyzing results and information.

Institutions of higher education need analytics professionals who have the experience, skills, knowledge, and abilities to comb through seemingly endless data to isolate the most pertinent, actionable findings. Data analytics requires professionals who are good storytellers and can translate their findings into specific strategic recommendations (Stanton & Stanton, 2019, p. 171). Among the literature, there was an acknowledgment that data analytics applied to large and complex datasets requires a new type of employee, someone who is fully grounded in a business process but who also has a breadth of analytical and personal skills (Stanton & Stanton, 2019, p. 170).

Regardless of the organizational structure for analytics (centralized, decentralized, consulting, functional, or hybrid) and assuming a company has a clear idea as to where it would like to go with analytics, the key challenge for organizations is how best to close the data analytics skills gap (Stanton & Stanton, 2019, p. 179). While traditional recruitment strategies will continue, the rapidly changing analytics marketplace will challenge organizations to find newer and more creative approaches to talent acquisition. To address this, the literature states that a number of institutions have adopted a recruitment strategy that entails bringing in promising candidates and then training them in the upskills needed to perform data analysis. This creates an opportunity and pathway for candidates to gain the skills required through non-traditional educational means such as massive open online courses (MOOCs), boot camps, and

online training leads to certificates or certifications in data analytics tools and methods (Stanton & Stanton, 2019, p. 179).

Some of the literature suggests that skills needed for data analytics and fact-based decision-making are changing job functions for existing employees within organizations more than any other skill type. Companies are viewing analytics and employees who can create and use them as essential for creating value (Stanton & Stanton, 2019, p. 171-172). Likewise, the assumption to recruit external candidates for data analytics roles may overlook bright, dedicated, and motivated individuals currently employed by the organization. Internal candidates already know the company, and the company knows them. Instead of spending time and resources to search for external candidates, a growing trend is to focus on training, reskilling and upskilling internal employees (Stanton & Stanton, 2019, p. 179).

Upskilling improves the retention of valuable employees, boosts morale, and attracts new talent. Research has shown that employees who receive development opportunities continue to make a commitment to lifelong learning and training. Companies and institutions are increasingly finding ways to upskill existing staff to achieve their strategic needs and goals rather than recruiting and having to train new staff (Stanton & Stanton, 2019, p. 179).

While precise skill sets vary among different industries, organizations, and advertised positions, it is generally agreed that the skill sets for analytics professionals fall into three broad categories: hard skills (technical skills/ competencies), soft skills (personal traits or characteristics), and credentials. Hard skills can include software development or programming, the ability to use a variety of analytical and statistical modeling tools, and a general understanding of quantitative datasets. Soft skills include the ability to communicate and present analytical insights in an understandable and compelling way, collaborate and work in teams, be

creative and innovative, and the ability to solve complex problems. Credentials include such things as work experience, certifications held, and degree(s) earned (Stanton & Stanton, 2019, p.179). Any company seeking to fill an analytics vacancy must first ask themselves what skills they are looking for.

Analysis

An in-depth literature review, as noted above, revealed four theories of organizational behavior to analyze further the opportunities of using data to support decision-making in American institutions of higher education. The four major theories revealed are Complex Adaptive Systems (CAS) Theory, Chaos Theory, Exploratory Data Analysis (EDA) Theory, and Self-Determination Theory (SDT). Institutions of higher education can easily be described as meeting the criteria for Complex Adaptive Systems (CAS) because they contain nonlinear relationships and multiple layers of hierarchical administrative and leadership networks that "seem at times to stubbornly resist transformative change while simultaneously adapting and evolving" (Ueland et al., 2021, p. 121). Adopting business intelligence or data analytics tools to institutions of higher education can have the potential to significantly improve strategic decision-making related to administrative processes, teaching, scientific research, and academic services (Daniel, 2015, p. 910).

Chaos Theory refers to one of the ways organizations manage change in response to internal and external happenings. Managing change within institutions of higher education requires capitalizing on moments of disruption, sometimes referred to as the "edge of chaos," to guide the system toward a different, more desired state. The literature, in general, indicates that the implementation of data analytics can have dramatic effects on the improvement of the decision-making process (Guster & Brown, 2012, p. 43; Ghasemaghaei, 2019, p. 15).

Next, as the name suggests, Exploratory Data Analysis (EDA) *explores* the dataset at hand by using visual representations, like dashboards, to reveal themes or patterns from the data that could provide direction or next steps. "These data can play a major part in how we understand the often-contested nature of higher education governance and so ensure that institutions are not only able to respond effectively to changes happening within and outside them but that they also remain pertinent to their purpose in the societies that they serve" (Daniel, 2015, p. 904).

Lastly, "according to Self-Determination Theory, competence is a basic psychological need that contributes to optimal human functioning and happiness. Classic theories of competence suggest that essential to the conceptualization of competence is the perception of not only "doing well" but also "doing better," that is, experiencing a sense of stretching one's limits and gaining new skills and abilities" (Yu et al., 2021, p. 1121). Considerable research has shown that opportunities for career growth and professional development are crucial motivating factors for employee retention (Ghasemaghaei, 2019, p. 15). Moreover, internal candidates and existing employees already know the company, and the company knows them. Instead of spending time and resources to search for external candidates, a growing trend is to focus on training, reskilling and upskilling internal employees (Stanton & Stanton, 2019, p. 179).

Complex Adaptive Systems (CAS) Theory

Complex Adaptive Systems (CAS) Theory provides a framework for understanding how systems of multiple, independent, and intelligent agents interact with each other in an umbrellaed and interdependent environment to create a whole that has an identity apart from its individual components (Ueland et al., 2021, p. 121). Institutions of higher education easily meet the criteria for Complex Adaptive Systems (CAS) because they contain nonlinear relationships and multiple

layers of hierarchical administrative and leadership networks that "seem at times to stubbornly resist transformative change while simultaneously adapting and evolving" (Ueland et al., 2021, p. 121). They respond to national and global economic, political and social changes, such as the growing need to increase the proportion and diversification of students in certain disciplines, increase scientific research capacity and output, and ensure that the quality of learning programs is both nationally and globally relevant (Daniel, 2015, p. 904).

A paper written by Kevin Dooley (1997) attempted to forge a unified description of complex adaptive systems from several sources and serves as a basis for explaining what is happening within institutions of higher education and why. One aspect of the literature explored the parallel between human and organizational decision-making, acknowledging that individuals are limited in their information-processing capabilities, and so too are organizations (p. 79). Therefore, relying on human judgment alone forces decision-making and action based on incomplete information and exploration of a limited number of alternatives (Dooley, 1997).

Another part of the literature considered the "manner in which organizations adapt to complex, uncertain environments by changing their information-processing capabilities, either by reducing the need for information…or by increasing the capacity for information acquisition, storage, and retrieval (via information systems)" (Dooley, 1997, p. 75).

A key characteristic of complex systems is that they are nonlinear, and recognizing that cause and effect are also nonlinear requires a different management approach. Leaders within a complex system are more likely to influence positive change when information is shared openly at all levels across the organization, including faculty, staff, and students. In this way, everyone in the institution has an opportunity to contribute to potential solutions by feeling empowered to engage in free and open dialogue. To address inefficiencies and create opportunities to improve

decision-making strategies, management must create space for knowledge sharing about best practices, emerging technologies, and other topics. Managing change within institutions of higher education requires capitalizing on moments of disruption, sometimes referred to as the "edge of chaos," to guide the system toward a different, more desired state.

Chaos Theory

It is worth noting that higher education, in general, has been severely affected in recent years by a number of unfavorable happenings, which include but are not limited to, a decline in matriculating high school graduates, an unstable economy, a decrease in federal and state funding, a refocus on STEM career training, stricter F-1 visa approvals for international students, and more recently, the COVID-19 pandemic. Institutions have been forced to reevaluate the way strategic decisions are made in order to face the unknowns of the future and the harsh realities that have collectively reshaped higher education (Chan & Randall, 2021, p. 13; Ueland et al., 2021, p. 128).

Chaos often has a negative interpretation tied to a feeling of disorganization and disruption. However, in the context of a complex system, it is the place where a shift in mindset can happen, and the effect occurs. There is a range between chaos and stability, where systems that are limited in chaos tend to be too static, and systems that are too chaotic find it difficult to self-organize and emerge from challenges. In many ways, the role of leadership within complex systems is to balance chaos and stability, creating opportunities for the exploration of new solutions while also promoting conditions that allow constancy for what the system does well (Ueland et al., 2021, p. 128).

Using Chaos Theory, Chan & Randall (2021) theorized that "while chaotic changes come and go, institutions that are entrepreneurial and innovative, market responsive, determined to

fight the turning tides, and optimistic in their outlook will not only weather the storms but will thrive at the end." An institution of higher education is somewhat living on the edge of chaos with large volumes of both academic and scientific research data. This confirms the need to acknowledge the silos and disparate amounts of data owned by multiple offices in an institution of higher education and begin to make use of the data by developing a data governance structure to make sense of the "chaos."

Exploratory Data Analysis (EDA) Theory

John Tukey coined the theory of Exploratory Data Analysis (EDA) in 1977, and his techniques for data cleaning are still relatable and significant today. It is appropriate that this theory emerged during the literature review on a topic that involves using data to support decision-making. EDA is a term to describe the act of "looking at data to see what it seems to say" (Morgenthaler, 2009, p. 33; Rao et al., 2021, p. 1457). With large volumes of both academic and scientific research data, institutions of higher education have the data sets needed to benefit from the results of using data analytics tools. What is found during an exploratory data analysis phase will help institutions establish the right questions to ask and, more importantly, what areas of data deserve further review (Morgenthaler, 2009, p. 33; Rao et al., 2021, p. 1457).

EDA aims to understand the attributes of the dataset and identify missing values or human errors in order to clean or prepare the data. This phase of data analysis begins to reveal a relationship between the variables that make it meaningful and insightful (Rao et al., 2021, p. 1460). During EDA, the dataset is first regarded as a list or batch of numbers, and the most common limitations are those imposed by the creativity or skill level of the data analyst. The list of well-known procedures to perform at this stage is the stem-and-leaf, hinges, the five-number summary, letter values, and the box plots (Morgenthaler, 2009, p. 35). Informal conclusions may

be presented in a narrative, and a graphical visualization is usually included in the initial report. Data analysis is, therefore, a creative process in which the knowledge or skillset of the data analyst plays a crucial role (Morgenthaler, 2009, p. 34).

Self-Determination Theory (SDT)

According to Self-Determination Theory (SDT), "competence is a basic psychological need that contributes to optimal human functioning and happiness. Classic theories of competence suggest that essential to the conceptualization of competence is the perception of not only "doing well" but also "doing better," that is, experiencing a sense of stretching one's limits, gaining new skills and abilities" (Yu et al., 2021, p. 1121).

Self-determination is one of the most often cited theories of human motivation. Self-determination theory depicts human beings as having three basic psychological needs which contribute to the development of their intrinsic motivation towards striving, well-being, and performance. The three basic psychological needs of SDT, namely autonomy, competence, and relatedness, are defined as universal and relevant within all people and cultures. For the purpose of this paper, there is a focus on competency or the need for competence. In this context, it is the mix of challenge and skill which enables an individual to perform a job task that is not too easy and not too difficult, and at the same time to possess skills that are necessary to do or accomplish the task (Szulawski et al., 2021, p. 3).

In a research publication titled "Is self-determination good for your effectiveness? A study of factors which influence performance within self-determination theory," by Szulawski et al. (2021), the authors argued for awareness of and attention to the incremental aspect of competence as essential to the construct of the need for competence. The results of their study showed that out of the three basic needs, competence had the strongest positive impact on

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performance, "which was partially mediated by the subjective evaluation of the levels of difficulty and intrinsic motivation" (Szulawski et al., 2021, p. 1).

In the case of institutions of higher education that are seeking skilled data analysts, the assumption to recruit external candidates for data analytics roles may overlook bright, dedicated, and motivated individuals currently employed by the organization. Instead of spending time and resources searching for external candidates, a growing trend is to focus on training, reskilling and upskilling internal employees (Stanton & Stanton, 2019, p. 179). A key step toward upskilling current employees is knowledge sharing.

Ethical Implications

Data Security and Privacy (Justice)

The perspectives highlighted in this paper, and the theories revealed throughout current literature show there is a significant opportunity to further the use of data analytics to support decision-making in American institutions of higher education. However, institutions of higher education have a lot to consider in order to ensure that institutional data (broadly defined) is used responsibly. Institutional leadership, administrators, and even students may be eager for data to be collected and to be used in new ways to support strategic decision-making. Nevertheless, excitement about new tools and methods should not overshadow the need to make sure predictive tools are deployed in a purposeful and secure manner, the right infrastructure is in place to take ownership and governance, and that it does not further entrench existing institutional inequities (Ekowo & Palmer, 2017, p. 16).

There is an obvious ethical implication of data collection, security, and privacy that should be considered. The collection and storage of large amounts of data pose a serious challenge in protecting individual privacy. Such challenges have emerged because technology

has become so advanced that laws, policies, and procedures are still catching up. "Future work will involve identifying and establishing policies that specify who is accountable for various aspects of institutional data and information, including its accuracy, accessibility, consistency, completeness, and maintenance" (Daniel, 2015, p. 917). Future work in this area will also include establishing contracts and agreements that define legal terminology and risk management for when and how data can be shared or transferred. An institution that uses data to support decision-making must make an ongoing commitment to keep up with new government laws, policies, and best practices as they are established.

A report published in 2016 titled, "The promise and peril of predictive analytics in Higher Education: A landscape analysis" provides a framework of conversation starters in order to assess whether institutional ethical standards are ready to meet current data privacy regulations. The report also examined how institutions of higher education are using predictive analytics and outlined the challenges they face in ensuring that they are doing so ethically. The framework, with regard to data security and privacy, outlines important reflection topics to consider, which include; developing a team for planning and establishing a vision for data use and how success will be measured, discussing the possibility of any unintended consequences and how they will be mitigated or addressed, and creating policies and providing regular training to technical support and other staff about how to keep data secure (Ekowo & Palmer, 2016).

Bias in Decision-making (Autonomy)

Research shows that personal biases exist when strategic decisions are made less frequently and without the support of external information such as data collection and analysis. Although personal biases exist, using institutional data dashboards has the potential to lessen the negative effects of decision-making and the actions that follow in carrying out an initiative. In

this way, to avoid bias and further entrench existing inequities, data dashboards and reports used to support decision-making should be carefully reviewed before being acted upon. Leadership and administrative staff, along with faculty, should be trained on how implicit bias combined with the limitations of data can impact how decisions are made. With the proper training, staff will be able to embrace the opportunity to use institutional data (broadly defined) to move their institutions forward (Ekowo & Palmer, 2017, p. 14). Even when institutional data, predictive models, algorithms, institutional practices, and training are as good as they can be, mistakes can be made when acting on the information (Ekowo & Palmer, 2017, p. 14).

Some research has shown that implicit bias may be heightened with predictive systems because analytics may serve to confirm bias or make implicit bias even more invisible. For example, using predictive analytics could lead to removing human judgment from decision-making. This may result in decisions that typically require holistic review becoming partly or completely automated using data alone (Ekowo & Palmer, 2017, p. 14). In other words, leadership and administrators should be aware when decisions need to consider a human aspect that the numbers don't capture.

Policy Recommendations

Since the late 2000s, researchers have explored areas of opportunity and challenge of using data analytics to support core university functions, such as teaching, scientific research, and service, in order to deliver a better faculty, staff, and student experience. The objective of this literature review was to advance the field by filling a gap and presenting concise information around opportunities for the institution, management, and employee to use data to support decision-making in American institutions of higher education. The institution, management, and employee perspectives highlighted in this paper reveal that each has a significant opportunity to

impact and be part of a strategic pathway in furthering the use of data analytics to support decision-making. Therefore, it is suggested that institutional policies could be established that create opportunities to capitalize on data analysis tools and support better strategic decision-making.

From the institution's perspective, the first recommendation is to create opportunities for a mind shift and interest in exploring priorities and possibilities through knowledge sharing. A conversation could begin if leadership makes a commitment to learning more about using data analytics in higher education and then prioritizes sharing the knowledge with their other leadership and management. The institution should do a broad review and collect qualitative current state information from key administrative areas on campus in order to determine how decisions are currently made and the leadership or management beliefs on the effectiveness of the outcomes. The next step would be to establish a committee and perform an institutional data readiness assessment. The readiness assessment tool is organized around key dimensions that experience has shown to be vital in determining whether an institution of higher education can effectively engage in data analytics tools and dashboards. The leadership in an institution of higher education should have some idea of where the organization would like to go with data analytics, and which method of data analysis (descriptive, predictive, or prescriptive) will be the most valuable. The results of the assessment intend to act as a tool for review and discussion and to help institutions determine whether observable practices help or hinder the defined end goal. Developing and pilot testing a data readiness assessment tool with a sample of institutions of higher education provides the next step in filling another gap in the literature. A data readiness assessment could reveal a model for knowing when an institution is ready to adopt data analytics tools, where it would like to go with analytics, and what is needed in order to be able to move

forward in this initiative. This is a planned topic for a Ph.D. dissertation in order to fulfill the requirements of the Strategic Leadership & Administrative Studies program at Marywood University (Spring 2023).

To become a data-driven organization, an institution of higher education needs a thoughtfully designed analytics platform that empowers everyone, at all levels of the institution, to make data capture an integrated part of their day-to-day processes. From the management perspective, the first recommendation is to centralize data capture and develop data capture policies and procedures. A data governance structure is a critical component of adopting data analysis tools, which includes the establishment of clear ownership of the data/processes that generate the data and a clear understanding of who uses the information and the purpose of its use (Guster & Brown, 2012, p. 44). Leadership should identify and establish clear guidance (both policies and procedures) that specify who is accountable for various portions or aspects of institutional data and information, including its accuracy, accessibility, consistency, completeness, and maintenance. The old adage "garbage in, garbage out" still applies when using sophisticated data analysis tools. An important step to ensuring data capture is clean and consistent is to develop a data dictionary, where the institution decides what information will be collected and how it will be defined in the data system.

From the management perspective, the next step is to consider and adopt new employee recruitment strategies. A number of institutions have adopted a recruitment strategy that entails reskilling current employees or bringing in promising candidates and then training them in the upskills needed to perform data capture and analysis. This creates an opportunity and pathway for candidates to gain the skills required through non-traditional educational means such as massive open online courses (MOOCs), boot camps, and online training leads to certificates or

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certifications in data analytics tools and methods. Jobs that require skills to perform tasks related to data science, such as artificial intelligence, machine learning, and robotics are expected to grow significantly over the next decade. Moreover, employees need opportunities to gain new skills not only for themselves for a productive career but also for the changing workplace in which they work. Overall, having the appropriate mindset and the right leaders at the table, investing in the appropriate technology, developing clear governance, policies and procedures, and creating incentives to develop employee skillsets are essential for adopting data analytics tools to institutions of higher education.

Summary

There is a growing body of literature that highlights opportunities for big data and data analytics use in American institutions of higher education. The available literature is new and informative, providing a basis for future research and policy recommendations. With the adaption of cloud computing infrastructure, the current situation can be transformed to make effective and coordinated use of a wealth of data that exists and has the potential to be used to support decision-making (Attaran et al., 2018, p. 8; Nguyen et al., 2020, p. 61).

The objective of this paper was to advance the field by filling a gap and presenting concise literature around opportunities for the institution, management, and employee to use data to support decision-making in American institutions of higher education. The institution, management, and employee perspectives highlighted in the literature review revealed that each has a significant opportunity to impact and be part of a strategic pathway in furthering the use of data analytics to support decision-making.

Data analytics can be transformative for institutions of higher education and support better decision-making in these increasingly competitive times. The literature, in general,

indicates that the implementation of data analytics can have dramatic effects on the improvement of the decision-making process (Guster & Brown, 2012, p. 43; Ghasemaghaei, 2019, p. 15). Adapting business intelligence techniques from industry can have the potential to alter and significantly improve existing processes of administration, teaching, scientific research, and academic service (Daniel, 2015, p. 910; Nguyen et al., 2020, p. 63).

Before big data and data analytics technology can be useful to American institutions of higher education, there must be a fundamental shift in thinking. Analytics needs to be repositioned in the mindset of management professionals working in the institution. Similarly, a data governance structure is a critical component of adopting data analysis tools, which includes the establishment of clear ownership of the data/processes that generate the data and a clear understanding of who uses the information and the purpose of its use.

The impact of knowledge sharing on firm decision-making quality is at its highest when employee analytics capability is at its highest level. The literature revealed that the shelf life of any skill in the present-day working environment has become increasingly short, requiring future workers to continuously update their skills and teach themselves about new technologies and new industries that may not have existed while they were being trained for their initial degrees or roles. Studies have shown that, in general, higher-skilled employees are more likely to stay at an organization if their job duties include new challenges and opportunities to learn. Institutions of higher education need analytics professionals who have the experience, skills, knowledge, and abilities to comb through seemingly endless data to isolate the most pertinent, actionable findings. Data analytics requires professionals who are good storytellers and can translate their findings into specific strategic recommendations (Stanton & Stanton, 2019, p. 171).

Institutions of higher education recognize that their mission is not only focused on preparing students for an economically relevant career but also on helping train existing members of the workforce to gain the skills needed to succeed in a quickly changing workplace. In a future state within the world of higher education, students, administrative staff, and faculty will never be done with their educations but instead will continue to engage in learning from their colleagues and outside experts to frequently renew and update their skills (Gleason, 2018, p. 224).

The literature revealed four major theories of organizational behavior to further analyze the opportunities of using data to support decision-making in American institutions of higher education. The four major theories discussed were Complex Adaptive Systems (CAS) Theory, Chaos Theory, Exploratory Data Analysis (EDA) Theory, and Self-Determination Theory (SDT). Institutions of higher education easily meet the criteria for Complex Adaptive Systems (CAS) because they contain nonlinear relationships and multiple layers of hierarchical administrative and leadership networks that "seem at times to stubbornly resist transformative change while simultaneously adapting and evolving" (Ueland et al., 2021, p. 121). Chaos often has a negative interpretation tied to a feeling of disorganization and disruption. However, in the context of a complex system, it is the place where a shift in mindset can happen, and the effect occurs. There is a range between chaos and stability, where systems that are limited in chaos tend to be too static, and systems that are too chaotic find it difficult to self-organize and emerge from challenges. In many ways, the role of leadership within complex systems is to balance chaos and stability, creating opportunities for the exploration of new solutions while also promoting conditions that allow constancy for what the system does well (Ueland et al., 2021, p. 128).

It is appropriate that Exploratory Data Analysis (EDA) theory emerged during the literature review because it has become a term to describe the act of "looking at data to see what it seems to say" (Morgenthaler, 2009, p. 33; Rao et al., 2021, p. 1457). With large volumes of both academic and scientific research data, institutions of higher education have the data sets needed to benefit from the results of using data analytics tools. For the purpose of this paper, there was a focus on competency or the need for competence within the Self-Determination Theory (SDT). In this context, it is the mix of challenge and skill which enables an individual to perform a job task that is not too easy and not too difficult, and at the same time to possess skills that are necessary to do or accomplish the task (Szulawski et al., 2021, p. 3).

The perspectives highlighted in this paper, and the theories revealed throughout current literature show there is a significant opportunity to further the use of data analytics to support decision-making in American institutions of higher education. However, institutions of higher education have a lot to consider in order to ensure that institutional data (broadly defined) is used responsibly. There is an obvious ethical implication of data collection, security, and privacy that should be considered. The collection and storage of large amounts of data pose a serious challenge in protecting individual privacy. An institution that uses data to support decision-making must make an ongoing commitment to keep abreast of new government laws, policies, and best practices as they are established.

Even when institutional data, predictive models, algorithms, institutional practices, and training are as good as they can be, mistakes can be made when acting on the information (Ekowo & Palmer, 2017, p. 14). In other words, leadership and administrators should be aware when decisions need to consider a human aspect that the numbers don't capture.

In conclusion, there are several recommendations for policies and next steps, which are to 1) create opportunities for a mind shift and interest through knowledge sharing, 2) do a broad review and collect qualitative current state information, 3) establish a committee and perform an institutional data readiness assessment, 4) discuss and define some idea of where the organization would like to go in terms of using data analytics, 5) centralize data capture and develop data capture policies and procedures, 6) ensure data capture is clean and consistent and develop a data dictionary, and 7) consider and adopt new employee recruitment strategies which include reskilling existing employees or upskilling potential employees.

About the Author

Heather M. Messina, MPA CRA is a Ph.D. candidate in the Strategic Leadership & Administrative Studies doctoral program at Marywood University, Scranton PA. She is the Assistant Director of Administration (Research) in the College of Health at Lehigh University in Bethlehem, PA. She is also the project manager for a National Science Foundation (NSF) award CCF 2200066, PI: A. Jagota 8/1/2022-1/31/2024. Mrs. Messina is an experienced research administrator with more than 12 years of experience in grant writing, research project management, pre-award proposal development, and post-award financial management. Mrs. Messina attended Marywood University for undergraduate and graduate studies. In 2008, she earned a B.A. in Communication Arts & Graphic Design, and in 2011 she earned a Master's in Public Administration. Mrs. Messina received her Certification in Research Administration (CRA) in 2012 and is an active member of the National Council for University Research Administrators (NCURA). Her research interests include using data to support decision-making in research administration in institutions of higher education, and leadership of change management and process development and improvement. She lives in Coopersburg, PA with her husband and two children.

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