Research Analytics in Higher Education: Systematic Literature Review, Synthesis, and Conceptual Framework

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ABSTRACT

As data-informed decision-making continues to evolve across multiple disciplines in higher education institutions, and as the role of research administration continues to expand from proposal submissions, compliance, and managing research and development expenditures to a profession with an active partnership with investigators to support institutional research strategy, it has become necessary to have a model that informs best practices in both strategic planning and business operations within research administration. While numerous research evaluation frameworks and assessment models have been proposed to improve the administrative processes of institutional research, data analytics has been an overlooked component, as shown in current trends and inquiries in research administration. This study proposes an approach that emphasizes the nature of data analytics to enhance the services provided by research administrators to minimize risks, maximize efficiencies, and better support researchers and other research and development (R&D) personnel in higher education. This article presents evidence-based practices to inform decision-making regarding strategic advancement in institutional research through a systematic literature review on leveraging research administration data analytics in higher education. The authors examined current examinations of how data can be effectively used in process operations and control. Importantly, they explored the critical elements of research analytics capability and suggest new perspectives on how research administration process systems might evolve into a new paradigm of data-enhanced operations and control.

Keywords: research administration, data analytics, research analytics, systematic literature review, strategic planning, business operations

Improving Research Administration with Data Analytics

The use of data analytics to inform decision-making has been a common practice in various businesses and industries in recent decades. In the higher education discipline, several types of analytics (e.g., learning analytics, predictive analytics) also have been widely adopted by public and private institutions to analyze student data, such as student enrollment, retention, and attrition for student success (Nguyen et al., 2020; Umer et al., 2021). During this same time, the research administration profession is in a period of significant change due to increased competition, accountability, and compliance requirements from federal and other sponsors of research funding. The traditional jack-of-all-trades role or *generalist* has become a more specialized advanced role, with a more recent focus on research development (Zink et al., 2022). Not only has research administration expanded its responsibilities in research support services and client-centered organizational support systems, but the role of research administration also has become increasingly instrumental to expanding institutional research portfolios. In addition, research administration as a profession has grown in its credibility, warranting respect from faculty and researchers. An important trend is the introduction of numerous graduate degrees and specialized certifications as a requirement for many research administration positions (Zink et al., 2022).

The increasingly important role that research administration plays in institutional research points to an urgent need to modernize research administration to keep up with the fast-paced transformation of the profession's diverse responsibilities and operations. The emergence of new complexities requires a clear strategy for modernizing research administration. Taking these steps would ensure effective and efficient collaborations between researchers and administrators, better assistance and faster responses to researcher needs, more manageable workloads for research administrators, more streamlined and simplified business processes, and more efficient tracking of research outcomes.

Several evaluative frameworks and assessment models have been published to address current challenges with research administrative processes, increase researcher success, and simplify work across the entire research lifecycle (Bozeman et al., 2021; Hall & Roussel, 2020; Lintz, 2008; Mullen, 2009). While the effectiveness of these proposed frameworks and models is outside the scope of this study, we acknowledge the significance of this area of research and support the continual development of research tools to enhance research productivity, improve day-to-day operations, and better support

researchers and faculty, and ensure regulations and compliance requirements are met. Alternatively, it is equally beneficial to extract useful information and generate insights from the data handled and collected by research administrators. With advances in cloud computing, artificial intelligence (AI), and machine learning, the trend toward revolutionizing business operation with data analytics seems inevitable. While data analytics has already been heavily utilized by big and small organizations, especially in business and other for-profit industries, the use of analytics and data-driven decision-making within research administration is still in its infancy (Wolf et al., 2021). Data analytics in research administration is not only an effective way of enhancing business operations and strategic planning in research, but such initiatives are arguably necessary to accommodate the development and needs of an increasingly diversified, specialized, and advanced research administration workforce.

This study calls for the implementation of a data analytics program to research, discover, and interpret patterns within the data to support improvements in research operations and inform strategic decision making. A well-supported and effective data analytics program can increase the research strengths of an institution, identify priorities for improvement in institutional research, and drive change and growth in research and development (Wolf et al., 2021).

Purpose and Objectives

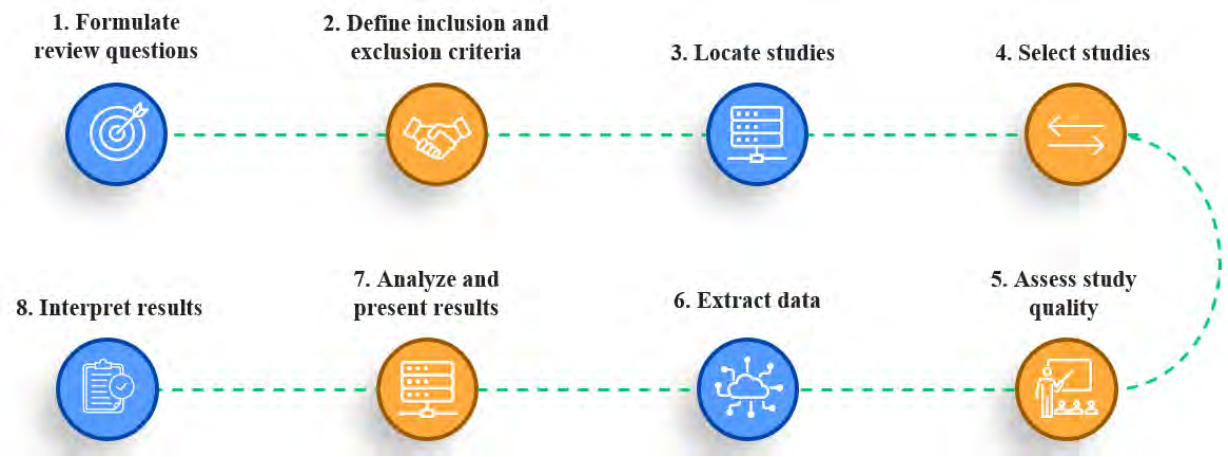
As addressed by Wolf and colleagues (2020), research analytics is in the early stages of development in some higher education institutions and non-existent in many. To date, limited empirical research has addressed the data analytics approach to enhance research administration services in the higher education domain. This study fills the gap in the literature by conducting a systematic literature review of the use of data analytics in research administration within the higher education domain. In this project, we sought to provide higher education research administration and support personnel with critical knowledge related to leveraging data analytics to make evidence-based decisions around institutional research and the research administration profession. This study also sought to identify the current state of the literature on research analytics and explore the critical elements of instituting an effective data analytics program to inform decision-making within the research administration profession based on the existing literature.

Method

The authors employed a systematic literature review on the use of data analytics in research administration as the research method to advance understanding of research analytics in higher education.

Additionally, a qualitative synthesis was developed and presented after assessing the literature evidence in the field. The review followed the standard steps of conducting a systematic review as synthesized by Lame (2019). Each step was tailored to the specific circumstances of the study (i.e., a limited number of relevant literature). Figure 1 shows the steps used throughout the literature review and data collection process.

Figure 1.
Steps to Conducting a Systematic Literature Review (Lame, 2019)



Review Questions and Criteria

The review process began by formulating specific review questions and criteria to determine which elements would be inside or outside of the scope of the study. Three review questions were specifically addressed by this study:

1. What research has been conducted on leveraging data analytics in the field of research administration for the purposes of data-informed, decision-making and improvement of business processes?
2. Based on extant literature, what are the critical elements of instituting an effective data analytics program to inform decision-making in research administration?
3. What other findings and conclusions can be drawn from existing related research?

Careful decision-making about inclusion and exclusion criteria was perhaps one of the most important steps in ensuring that the relevant literature was of good quality (Snyder, 2019). Articles included in this review came from two knowledge disciplines: institutional research and data analytics. For articles related to institutional research, only studies conducted within the United States (U.S.) context were included in the review. Since the discipline of data analytics is relatively new within research administration, the geographical criterion

was not applied to articles related to data analytics. Data analytics is a hybrid discipline between academics and business; therefore, this review included literature from both peer-reviewed academic journals and research reports from prominent organizations in the data analytics industry. These articles reported on either or both of two distinct areas: (1) the use of data analytics/ business intelligence and (2) enhancement of operations and efficiencies in research administration. Some included articles documenting the elements of data analytics maturity models from various disciplines, while others included interviews with research administrators on best practices in data governance, strategy, data quality, data analysis and expertise. Some included articles that explored different ways of improving business processes in research administration using evaluative frameworks or assessment models. Articles not written in English were excluded. Articles reporting on universities outside of the U.S. or published before 2000 were excluded to better reflect current federal funding trends and institutional cultures in the United States.

Study Selection Process

To locate and select relevant studies, reviewers developed a search strategy based on guidelines found in Lame's, Snyder's, and Page et al. 's (2019) research, considering the specific context of the present study. Keywords used in this analysis were "Data Analytics" and "Research Administration." The goal was to identify research articles that were of validated quality and fulfilled the article inclusion and exclusion criteria outlined in the previous section. The literature search process began with Boolean searches in the following online directories: Applied Social Sciences Index and Abstracts (ASSIA), Education Database (ProQuest), and ERIC (Educational Resources Information Center). An additional search also was conducted to locate theme-specific articles in the Society of Research Administrators International (SRAI)'s *Journal of Research Administration* and the National Council of University Research Administrators (NCURA)' *Research Management Review.* Per guidance by Lame (2019), a search of the "grey literature" (p. 1635), such as theses, conference proceedings, technical reports, statistical reports, and market research reports, also was conducted.

The primary reviewer followed the abovementioned strategy to determine whether the existing studies were relevant to the present research. The other reviewers and the consultants from different administrative departments or higher education reviewed the studies that the primary reviewer selected to ensure the studies' relevance. Additionally, the reviewers assessed the quality of the studies, such as discussing whether the selected studies had clear aims and whether the findings were valid. Finally, the primary reviewer decided which studies needed to be included with consideration of (dis)agreement and suggestions from the other reviewers and experts. Details of the selection process are shown in Table 1.

Table 1.
Selection of Articles, Reports, and Working Papers for the Literature Review

Types of Sources	Sources	Date Last Searched or Consulted
Journals	*Journal of Research Administration* (3)	July 10, 2023
	Administration & Society (1)	January 27, 2023
	Data Science Journal (2)	March 3, 2023
	International Journal of Information Management (1)	January 19, 2023
	IFLA Journal (1)	January 23, 2023
	Decision Support Systems (1)	February 1, 2023
	Information Engineering Express (1)	January 17, 2023
	Information Systems and E-Business Management (1)	March 9, 2023
	IEEE Transactions on Knowledge and Data Engineering (1)	July 5, 2023
	MIT Sloan Management Review (1)	February 4, 2023
	Research Management Review (1)	July 10, 2023
	The Review of Higher Education (1)	July 10, 2023
Published Maturity Models/ Business Reports	Analytics Center of Excellence (1)	December 12, 2022
	Information Security Technical Report (1)	January 10, 2023
	EAB (1)	January 17, 2023
	Gartner	December 15, 2022
	National Science Foundation	December 28, 2022
	TDWI	November 3, 2022
	Deloitte Insights (1)	November 15, 2022
Databases	ASSIA – Applied Social Sciences Index and Abstracts	May 26, 2023
	Education Database (ProQuest)	June 3, 2023
	ERIC – Educational Resources Information Center	July 9, 2023
Books	*Evidence-Based Practice: An Integrative Approach to Research, Administration, and Practice*	June 14, 2023
	Big Data Analytics	May 23, 2023
Conference Proceedings	International Conference on Engineering Design (1)	July 1, 2023
	International Conference on Information Systems (ICIS) (1)	July 1, 2023
		July 1, 2023
	INTED 2018 Conference	July 3, 2023
	Institute of Higher Education Research Projects Series (University of Georgia)	

In total, the articles included in this review involved 3 online databases, 16 journal articles, 7 data analytics maturity models/ technical/ market research reports, 2 books, and 3 papers from conference proceedings. This search resulted in business reports from the leading organizations in data analytics and research administration/ higher education, and a final search on various online directories.

Data Extraction and Analysis

Once the relevant research and studies were selected and evaluated, the primary reviewer extracted the data regarding the

information about the models, frameworks, interventions, and theories that focused on the included studies. The primary reviewer made a final decision about the extracted data after incorporating the opinions of the other reviewers. A thematic analysis was applied to explore the emergent themes of data analytics in research administration. Reviewers reached a final agreement on the overarching themes after discussions and consultations with the administration professionals from different departments. Detailed information about the overall trends, the themes, and the critical factors were synthesized in the results section and later interpreted in the discussion section.

RESULTS

The findings from the systematic literature review stemmed from the selection and analysis of 16 articles, 7 data analytics maturity models/ technical/ market research reports, 2 books, and 3 papers from conference proceedings. In the results, the authors identified the current primary utilization of data in the research administration discipline, defined "Research Analytics," and explored the themes and critical factors influencing institutions' research analytics capabilities.

Primary Uses of Data Analytics in Research Administrator

The review identified two main objectives of leveraging data analytics in research administration: using data to inform (a) strategic planning and (b) day-to-day business processes and operations.

Using Data to Inform Strategic Planning. One way to use data-informed decision-making is to look for opportunities for improvement through the data available to the institution's research administration office. The availability of high-quality and easily accessible data can answer critical questions related to strategic planning in institutional research. Examples include the following:

- Identify strengths and priorities for improvement in the institution's research agenda.
- look for ways to promote the strengths.
- come up with solutions to remedy areas that need improvement.

Wolf (2020) described one example of setting targeted research priorities at a large research-intensive institution with the use of data-informed strategy and investment. In his interview with the Society of Research Administrators International, he talked about a research-related challenge at his institution where faculty members had a limited pool of resources to start-up research programs and begin applying for external funding. One way to mitigate this challenge was to confirm institutional research strengths at the university in order to identify capacity for growth and opportunity. Using both internal and external data at hand, particular research strengths and opportunities were identified for the receipt of additional resources and dedicated support. Using information derived from institutional data (research analytics), the research development team developed a program to fund and diversify the university's research priorities that provided significant resources to support these research areas, making it possible to expand and broaden their scope.

Using Data to Inform Day-to-Day Business Processes and Operations. Apart from using data to inform strategic planning, research administration offices

also can benefit from using data to inform the efficiency of their daily work routine. Like other industries, information must be communicated in an effective and efficient manner to ensure smooth operations in the field of research administration. Lintz (2008) described several methods on which research administrators rely to communicate and handle requests coming from stakeholders whose information may travel through various channels. Other challenges such as ensuring effective, efficient, and streamlined collaborations between research administrators, faculty, business managers, and investigators are also important. In addition, research administrators play a significant role in making sure proposals are submitted in a timely manner, ensuring compliance of funded sponsored grants and contracts, and making every effort to see that pre- and post-award systems operate efficiently. Institutional collaborations extend beyond local entities (Lintz, 2008, p. 72); the increase of university-industry partnerships pose new opportunities and challenges related to efficiencies, operations, project management, and workload management within the research administration units—especially for public institutions. Research analytics uses a different type of data to generate insights into how business processes and operations can be enhanced within research administration units (Wolf, 2022). For example, grant and contract data are helpful when examining topical trends that are funded across the institution. In addition, when identifying the strengths and weaknesses in an institution's research portfolio, data from research analytics may be used to build team science, evaluate where the strengths are in terms of everyday business processes, and use analytics and data-mining tools to strengthen areas of focus, improve areas with limited resources to streamline processes and minimize risks (Wolf, 2022).

Definition of "Research Analytics"

In this review, the word "research" includes any academic activity aimed at the creation of knowledge that is conducted primarily within higher education institutions or joint partnerships between higher education institutions and other entities, such as industries, nonprofit organizations, and federal agencies. According to the Higher Education Research and Development (HERD) survey, a research and development (R&D) activity stands for the "creative and systematic work undertaken in order to increase the stock of knowledge — including knowledge of humankind, culture, and society – and to devise new applications of available knowledge" (National Science Foundation, 2021). With regard to the "analytics" component of this study, in any discipline, analytics requires the ability to collect, manage, analyze, and act on ever-increasing amounts of disparate data at the right speed and within the right time frame (Halper & Stodder, 2014, p. 5). Summarizing the pre-existing definitions of the keywords and the scope of this research, the steps for conducting this systematic literature review were guided by the definition of "research analytics" outlined below:

> *Research analytics is the science of analyzing data to make data-informed decisions for strategic planning in research and development and business processes around research administration functions. The purpose of research analytics is to identify areas that could be enhanced, troubleshoot*

current issues discovered by data and resolve them with evidence-based solutions. Information derived from research analytics can strengthen research performance, build capacity, and strengthen knowledge and discover within higher education institutions.

Factors Influencing Research Analytics Capabilities

In addition to the definition of research analytics, the authors also explored six critical elements of instituting an effective data analytics program to inform decision-making in research administration. During the exploration of critical elements of research analytics capabilities, two overarching themes emerged: Technology & Skills and Human Capital. The Technology & Skills theme is characterized by the utilization of data, provision of analytics skills, development of technology, and interactions among data, analytics, and technology. Human Capital refers to the formation of policies, standards, missions, and culture around leveraging data analytics and commitment to support data-informed decision making from senior leadership. Technology & Skills and Human Capital together unlock the opportunity to use data analytics in research administration to inform strategic planning and daily operations, and eventually revolutionize how research institutions operate and shape the future of academia.

Drawing on the guiding theories and conceptual works discussed in the literature, current scholarship suggests that the development of research analytics capabilities depends on the six factors listed below (in no particular order):

- *Data* – the sources and types of data collected and analyzed,
- *Analytics* – the analytics staffing, and tradecraft needed to generate insights from data,
- *Technology* – the availability of IT infrastructure to support an analytic initiative,
- *Governance* – the policies and standards around leveraging data analytics,
- *Culture* – data-informed, decision-making culture, and
- *Leadership* – senior leadership's commitment to support an organizational strategy around success in analytics and data-informed, decision-making.

In the next section we outline the operations of each variable of interest within the context of research administration within higher education institutions.

Data. The first proposed factor, *data*, identifies the sources, access, quality, and standardization of data and metrics, and the system of data documentation and metadata management. Articles included in this literature review posited that effective research analytics capabilities in an organization require data to be (1) sourced from a consistent data warehouse, (2) of high quality, (3) trusted throughout the institution, and (4) easily accessible.

During recent years, many companies satisfy their needs for strategic information by applying data warehouse (DW) and online analytical processing (OLAP) technologies into their structured databases (Perez et al., 2008). In the research analytics discipline, there is the potential to source the internal data used to complete research administration functions from a consistent

data warehouse that integrates data from multiple sources.

In addition to a consistent data warehouse, the quality and trustworthiness of the data are instrumental to building effective research analytics. Poor data quality, unactionable results, and nebulous recommendations are top hindrances to stakeholders' reliance on analytics to make decisions (Kune et al., 2020). Marsden and Pingry (2018) cited high-quality data inputs as necessary components for meaning replication of "erudite modeling and estimation" that create immediate value. Quality data are a necessary condition for good outcomes such as analysis or replicability (Marsden & Pingry, 2018). Marsden and Pingry (2018) pointed out that reproducibility is often compromised due to researchers and funding agencies' inexperience or unfamiliarity with adhering to appropriate data standards and data access. Therefore, another crucial requirement for effective research analytics is that analytics needs to be performed using high-quality data and data that are trusted throughout the institution. Examples of data and metrics available for research data analysis include the number of sponsored research dollars per full-time equivalent (FTE); expenditures per FTE; number of graduate students and postdoctoral students supported; number of proposals submitted; dollars requested; and number of awards (Lintz, 2008, p. 73). Examples of data and metrics that are of interest to research administrators include the number of faculty proposals versus awards won, turnaround processing time, indirect cost (IDC) recovery rate averages, and success rates per department for applications submitted to sponsors (Qureshi, 2022).

Apart from the relevance and quality of data collected by the institution, another determinant of effective research analytics is the availability and accessibility of data to research administrators at all levels. A characteristic of an optimally operating analytics program is the possibility of data democratization. Lefebvre et al (2021) defined data democratization as the enterprise's capability to motivate and empower a wider range of employees—not just data experts—to understand, find, access, use, and share data in a secure and compliant way. To give a practical example, data analytics industry leader Tableau is built on the philosophy that products should be built to expand access to data within an organization, not to centralize and control it (Fay, 2020, p. 4).

Analytics. The second proposed factor, *analytics*, identifies the development of analytics staffing and hiring to acquire the analytic skills and techniques needed to generate insights from data. Research administration, like other industries, depends on the acquisition of human capital specializing in data analytics to support an analytics initiative. Mikalef et al (2018) asserted that the capacity to utilize big data technologies and tools, and to make strategic decisions based on outcomes, is highly dependent on the skills and knowledge of the human resources. However, staffing in analytical roles, or staffing in general, has been an ongoing challenge for many organizations. Specifically in higher education, a survey study revealed that the vast majority of higher education leaders saw staffing in technical roles as a major issue (EAB, 2022). In addition, to maximize the business value of analytics, companies need employees who understand the business and can cross the communication

divide that often exists between information technology and other departments (Marsden & Pingry, 2018). Another important aspect of analytics staffing is acquiring and retaining adequate staff members with full-time data reporting and analytics responsibilities. According to Wolf et al (2020), data staff often have other responsibilities in research administration, and very few institutions have full-time data staff within their research administration units.

Apart from sourcing analytics talent, research administrators need advanced technological tools and techniques in business intelligence to successfully implement an analytics program. Translations of insights from data into powerful business decisions requires institutions to catch up with big data and data analytic tools and techniques as fundamental enablers of evidence based, data-driven predictive decisions (Seres et al., 2018, p. 9491).

Besides analytics talent and technological tools, research points to the presence and effectiveness of relevant professional development in leveraging data analytics and self-service analytics tools as additional criteria for the optimization of an analytics initiative (Lefebvre et al., 2021, p. 1). These two features support the organization in developing and achieving data democratization by enhancing employees' data analytics skills and providing them with the opportunity to conduct analyses that are appropriate for their work. Specifically regarding analytical and self-service analytical tools, according to the Analytics Center of Excellence (2020), processes and tools involved in research analytics should be regularly reviewed and revised as needed. This requirement is important in ensuring the current tools and techniques used for leveraging data are keeping abreast of the fast-paced technological changes in data analytics.

Technology. The third proposed factor, *technology*, identifies the availability of an advanced and coherent IT infrastructure to store, manage, analyze data, and support an analytic initiative and its integration into the existing environment. The technology factor also encompasses the funding and resources available to invest in an advanced and coherent IT infrastructure that supports analytics for all parts of research administration and potential users.

Research institutions rely on technological advances to enable applications of analytic techniques to gain insights from large amounts of hybrid (structured and unstructured) data (Seres et al., 2018, p. 9494). As mentioned in the *Data* section, many infrastructure projects face the challenges of developing practices and solutions for research data management which in compliance with good scientific standards make the research data discoverable, suitable, and accessible for society potential reuse (Latif et al., 2019). To mitigate these challenges, one way is to explore the possibility of cloud computing as a platform for big data analytics in view of data storage and computing requirements (Khan et al., 2018). For instance, Brandt et al (2021) developed a research data infrastructure for the material science discipline to extend and combine the features of an electronic lab notebook and a repository. The infrastructure incorporates the possibility of structured data storage and data exchange with documented and reproducible data analysis and visualization, so that researchers can be supported throughout the entire research process (Brandt et al., 2021). In the field of

research administration, some institutions have existing information systems in place to establish knowledge repositories and knowledge "banks" to facilitate the transfer of explicit knowledge. According to Lehman (2017), however, "the existing information system needs to be easy to navigate, robust, continually updated, and linked to existing work processes" (p. 61) to support an advanced knowledge management program within the profession. The IT infrastructure should also be a scalable system that can support the ever-increasing volume of data being used, and the services provided by the current data system should go beyond static reporting (i.e., the ability to customize) (Russom, 2011, p. 12). Apart from the scalability and versatility of the data system, another desirable feature is the availability of in-database analytics. According to Russom (2011), managing big data in a data warehouse is challenging when that warehouse is modeled for reports and OLAP only. Last but not least, aligning with the vision of data democratization, tools used for interaction with data should be able to support all staff with minimal training required (Analytics Center of Excellence, 2020).

Governance. The fourth proposed factor, *governance*, identifies the processes, policies, roles, and standards around data collection, access, and use to allow for effective leverage of analytics without applying too many restrictions. Data governance covers a wide array of aspects in processing data. Apart from building standard, repeatable processes; reducing costs; and increasing effectiveness through coordination of efforts and by enabling transparency of processes (Koltay, 2016, p. 304), data governance also encompasses the satisfaction of all matters of finding, cataloging, and masking data, integration of fluid data sets, delivery of built-in compliance, and leverage of advanced machine learning capabilities (Seres et al., 2018, p. 9494). Mature organizations are now recognizing the importance of information security governance—that is, how information security processes are directed and controlled both within the organization and between the organization and its business partners (Ashenden, 2008). An effective data governance strategy is critical for research administration units to ensure data are well protected due to the growing concerns and risks of information security breaches.

Data governance enables better decision-making and protects the needs of stakeholders. It helps to ensure that data are usable, accessible, and protected; reduces operational friction; and encourages the adoption of common approaches to data issues (Watts, 2020). A similar framework, the FAIR principles, was proposed by Wilkinson and colleagues – research data should be Findable, Accessible, Interoperable, and Reusable. This approach supports and strengthens data governance practices for research organizations (Wilkinson et al., 2016). An effective data governance strategy helps to avoid data inconsistencies or errors, which lead to integrity issues, poor decision-making, and a variety of organizational problems (Watts, 2020). Koltay (2016) noted that the academic sector, librarianship, as well as library and information science should pay attention to data governance, although it attracted attention mainly in the business sector. Research institutions should devise an advanced data governance strategy to

harness the potential and power of data in research administration.

Culture. The fifth proposed factor, *culture*, identifies the practices within and between departments in exploring areas where data can contribute to decision-making across the organization to improve processes, share insights, and inform action planning. Specific to the field of research administration, the *Culture* factor encompasses the extent to which data-informed decision-making is part of the culture of a research administration unit. This factor involves research administrators' perceived use and cultural acceptance of data analytics in their department or work units, the interactions between IT and institutional research offices, enterprise orientation to managing analytics, exploration, and utilization of opportunities where analytics can be leveraged to drive decision-making. It also involves the extent to which results and insights are used to inform strategic targeting, value creation, and action planning.

Research administration units that prioritize data analytics development value the effective use of data. They believe that the effective use of data is the future of research administration. Their commitment and willingness to and support for the use of data in supporting decision-making are critical factors in ensuring the successful development of a data-informed decision culture (Webber et al., 2019, p. 6). Seres et al (2018) noted that the true digital transformation of these institutions can be achieved only if the significance of the digital culture is comprehended and accepted by all organizational units, and adopted as part of their own culture (Ibid., p. 9493). In higher education, the introduction of a data-informed decision-making culture is evident in performance-based funding, institutional rating systems, and the increasing use of data mining and analytics (Hora et al., 2017, pp. 392–393). Specific to research administration, as the marketplace and funding opportunities for sponsored research become more competitive, and funders hold research entities more accountable, research administration professionals will need to learn new skills that employ the use of advanced data analytics, data science, and business intelligence tools to remain competitive and sustain research programs and growth (Wolf et al., 2021).

For a sustainable research analytics program, all employees, not just data experts, are encouraged to use data to perform their own analysis to complete job duties (Lefebvre et al., 2021, p. 2). In addition, it is important that the analytics specialist or team communicate and collaborate closely with research administrators to collect and analyze data, compile results, and present insights that are helpful for enhancing the administrative aspects of institutional research, such as general operations around pre- and post-award activities, policies, and practices around indirect rates, and supporting the investigator in navigating the complex system of sponsored research. A benefit of this collaboration is that while casual users are encouraged to perform their own analysis, data scientists have more time to act as coaches, leading to the creation of communities between technical and non-technical users (Lefebvre et al., 2021, p. 8).

Leadership. The sixth and final proposed factor, *leadership*, identifies the senior leadership's commitment to support an organizational strategy around success

in analytics, and valuing data as a strategic asset to support evidence-based decision-making. Specific to research administration, the *Leadership* factor involves senior leadership's cultural acceptance of analytics, their commitment to support the growth of data analytics capabilities across all aspects and departments of research administration to establish a data-informed decision-making culture across all levels of employees.

Research has shown that senior leaders support the following aspects of data analytics development (Webber et al., 2019, p. 6):

- value data and appropriate analytics,
- focus on key strategic priority areas to deploy analytical solutions, and
- show continued commitment to establishing a data-informed culture.

A data analytics senior leader believes that data-informed innovation adds to competitive advantage and research success. Work units under such leadership often have a strategy related to the use of data analytics; the efforts align with the business goals of the domain (Kesari, 2023). Initiatives such as the development of strategies to manage business, big data alignment, knowledge management, change management, and business process transformation in turn can impact the organizational leadership and the governance (Ong, 2016, p. 75). Apart from having a data strategy in place, involving data experts in strategic decision-making is of paramount importance to developing a data-informed culture. Specifically, senior leaders should have an established partnership with analytics professionals as a strategic partner rather than eliciting their input on an ad hoc basis. On the contrary, according to a survey report compiled by the EAB (2022) on data analytics in higher education, many institutions underutilize data professionals, often relegating them to compliance reporting and ad hoc data delivery rather than incorporating their insights into the regular decision-making process (EAB, 2022, p. 14).

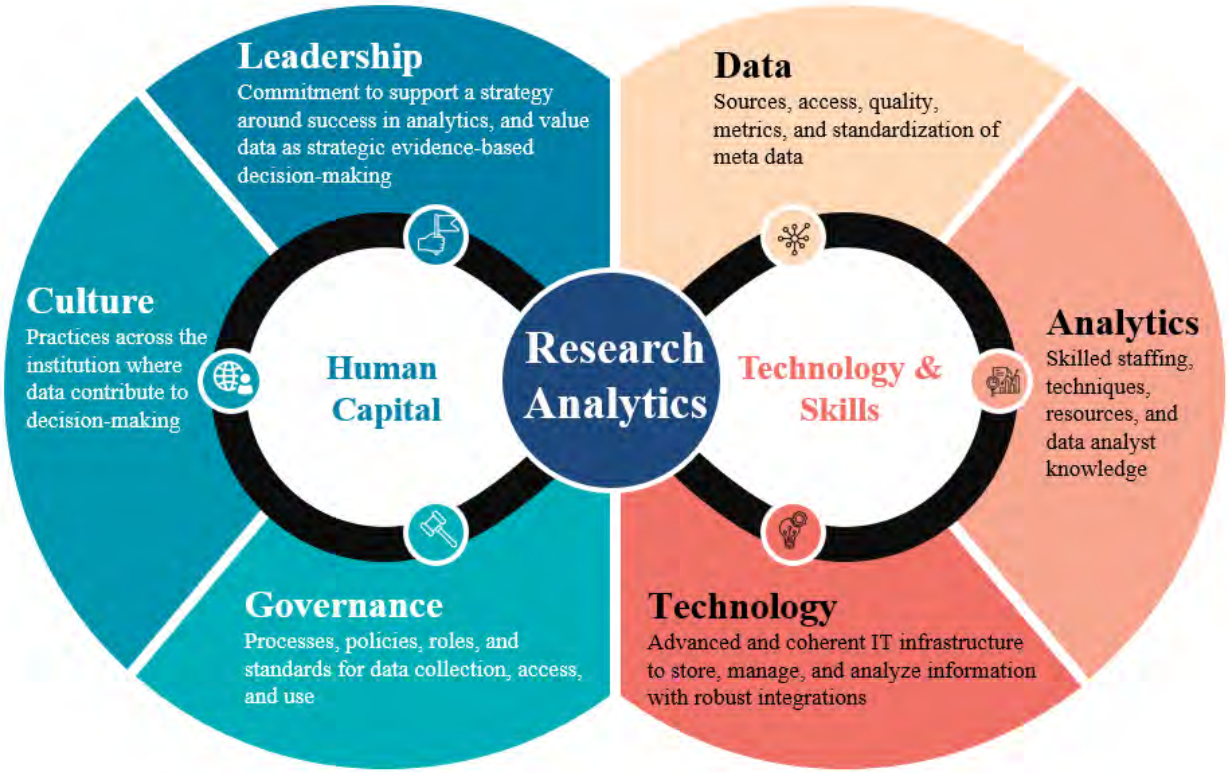
The existing literature provided additional evidence of factors in senior leadership that may hinder the development of an organization's data analytics program. For example, executives are often not digital savvy (Weill et al., 2021), which may lead to miscalculations about the condition of their organizations' data analytics development, such as a disconnect between senior leadership's perceptions of their employees' data analytics capabilities and the employees' actual capabilities (Davenport et al., 2019).

Discussion and Conceptual Framework

Existing frameworks in research administration emphasize research and evaluation rigor, such as the widely cited SCOPE research evaluation framework (International Network of Research Management Societies, 2021). Due to the recent trend toward and development of data analytics in research administration, the use of data will inevitably continue to play a critical role in informing strategic planning and daily operations. We argue that data analytics should be part of this important initiative as well. This systematic literature review builds on previous research in the area of research analytics, but hopes to overcome prior shortcomings by establishing a conceptual framework to strengthen the discipline of research

analytics development. Figure 2 shows the resultant conceptual framework titled *Research Analytics Capabilities* (RAC).

Figure 2
The Conceptual Framework of Research Analytics Capabilities (RAC)



This systematic literature review on research analytics capabilities revealed six major factors and numerous criteria that may be significantly associated with the development and optimization of a research analytics program. The inclusion of a factor or criterion in the framework was based on its relevance to the study, the degree of differentiation, and its effective operationalization. Numerous criteria beyond the scope of this review deserve further analysis and study. For instance, all factors were weighted equally in this framework based on current knowledge. We plan to conduct further studies to learn more about the relationships and differences among these factors in the near future.

This literature review has practical significance and makes important contributions to both academia and industry. Academic researchers in data analytics and/ or research administration can refer to the conceptual framework as a guide for understanding the basic tenets of developing an effective analytics program, to build on or respond to the structure and theoretical considerations underpinning this framework. This study is beneficial for research administration personnel looking for ways to inform strategic decision-making and enhance business processes.

Non-profit and industry research enterprises interested in a data analytics initiative can reference this conceptual framework to self-evaluate their organization's research analytics capabilities, or to build instruments for benchmarking analytics maturity or organizational performance.

As with any research study, there are limitations in this systematic literature review. One limitation that must be considered is the fact that due to the complex and constantly evolving nature of research analytics, the current framework may not capture all of the factors and criteria related to research analytics capabilities. Another consideration is that research analytics is a new academic discipline and, as a result, this review suffers from limited resources and previous conceptual or empirical works relevant to this study. The lack of academic knowledge in this field prompts the following recommendation for future research – that is, researchers should extend this work into all aspects of the body of knowledge concerning research analytics. The increase in academic attention to this field can improve the overall quality of research in this area and may lead to increases in strategic capacity for research within higher education.

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