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AN EMPIRICAL EXAMINATION OF THE EFFECTS OF CTO LEADERSHIP ON THE ALIGNMENT OF THE GOVERNANCE OF BIG DATA AND INFORMATION SECURITY RISK MANAGEMENT EFFECTIVENESS

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ABSTRACT

Aim/Purpose	Board of Directors seek to use their big data as a competitive advantage. Still, scholars note the complexities of corporate governance in practice related to information security risk management (ISRM) effectiveness.
Background	While the interest in ISRM and its relationship to organizational success has grown, the scholarly literature is unclear about the effects of Chief Technology Officers (CTOs) leadership styles, the alignment of the governance of big data, and ISRM effectiveness in organizations in the Western United States.
Methodology	The research method selected for this study was a quantitative, correlational research design. Data from 139 participant survey responses from Chief Technology Officers (CTOs) in the Western United States were analyzed using 3 regression models to test for mediation following Baron and Kenny's methodology.
Contribution	Previous scholarship has established the importance of leadership styles, big data governance, and ISRM effectiveness, but not in a combined understanding of the relationship between all three variables. The researchers' primary objective was to contribute valuable knowledge to the practical field of computer science by empirically validating the relationships between the CTOs

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	leadership styles, the alignment of the governance of big data, and ISRM effectiveness.
Findings	The results of the first regression model between CTOs leadership styles and ISRM effectiveness were statistically significant. The second regression model results between CTOs leadership styles and the alignment of the governance of big data were not statistically significant. The results of the third regression model between CTOs leadership styles, the alignment of the governance of big data, and ISRM effectiveness were statistically significant. The alignment of the governance of big data was a significant predictor in the model. At the same time, the predictive strength of all 3 CTOs leadership styles was diminished between the first regression model and the third regression model. The regression models indicated that the alignment of the governance of big data was a partial mediator of the relationship between CTOs leadership styles and ISRM effectiveness.
Recommendations for Practitioners	With big data growing at an exponential rate, this research may be useful in helping other practitioners think about how to test mediation with other interconnected variables related to the alignment of the governance of big data. Overall, the alignment of governance of big data being a partial mediator of the relationship between CTOs leadership styles and ISRM effectiveness suggests the significant role that the alignment of the governance of big data plays within an organization.
Recommendations for Researchers	While this exact study has not been previously conducted with these three variables with CTOs in the Western United States, overall, these results are in agreement with the literature that information security governance does not significantly mediate the relationship between IT leadership styles and ISRM. However, some of the overall findings did vary from the literature, including the predictive relationship between transactional leadership and ISRM effectiveness. With the finding of partial mediation indicated in this study, this also suggests that the alignment of the governance of big data provides a partial intervention between CTOs leadership styles and ISRM effectiveness.
Impact on Society	Big data breaches are increasing year after year, exposing sensitive information that can lead to harm to citizens. This study supports the broader scholarly consensus that to achieve ISRM effectiveness, better alignment of governance policies is essential. This research highlights the importance of higher-level governance as it relates to ISRM effectiveness, implying that ineffective governance could negatively impact both leadership and ISRM effectiveness, which could potentially cause reputational harm.
Future Research	This study raised questions about CTO leadership styles, the specific governance structures involved related to the alignment of big data and ISRM effectiveness. While the research around these variables independently is mature, there is an overall lack of mediation studies as it relates to the impact of the alignment of the governance of big data. With the lack of alignment around a universal framework, evolving frameworks could be tested in future research to see if similar results are obtained.
Keywords	big data, CTO leadership styles, information security risk management effectiveness, and digital transformation

AIM/PURPOSE

Big data is growing at an enormous pace, with 90% of the world's data created in the last 2 years alone (Jayagopal & Basser, 2019). Information technology has shifted from an isolated department to an integral component of business operations and good governance. Board of Directors seek to use their big data as a competitive advantage. Still, scholars note the complexities of corporate governance in practice related to information security risk management (ISRM) effectiveness (Okonofua et al., 2019).

Despite Von Solms and Von Solms (2009) recognition over 10 years ago that information security risk management had become the primary concern of governance, the lack of effective governance of big data in the digital age remains a growing problem. Numerous peer-reviewed research findings have demonstrated how essential high-level support is to effective information governance, yet there is still a lack of effective corporate governance (Okonofua et al., 2019). Given the critical nature of governance in aligning business priorities and the role that technology executives play in implementing big data strategies, the relationships between these factors and their influence on ISRM effectiveness in organizations based in the Western United States were of interest to this researcher. The question that interested this researcher is if the alignment of the governance of big data could mediate the relationship between Chief Technology Officer leadership styles and information security risk management effectiveness in selected organizations in the Western United States.

BACKGROUND

The study was guided by the following overarching research question: Does the alignment of big data governance mediate the relationship between CTO leadership styles and ISRM effectiveness in selected organizations in the Western United States? A definition of terms promotes a common understanding of the terminology in the study. Multiple terms and definitions can exist for describing information technology concepts, so the essential terms in the study are defined below. The definition of each of the variables included in the quantitative analysis is provided.

Big Data Governance

Big data governance includes the governance of a variety of data assets, including jobs, models, and visualizations (MapR, 2019). It is differentiated from data assets from the lack of physical separation between classes of data, creating value from combining data that has not before related, more varied and flexible processes, automation, and data that is an operational necessity and is in constant use (MapR, 2019).

Chief Technology Officer

A Chief Technology Officer is typically an executive position within an organization responsible for senior management of the company's research and development, as well as technological needs (Emsi, 2020). While exact roles can vary depending on the company (Emsi, 2020), the individuals in this study self-identified as Chief Technology Officers.

Governance

Governance is the process of interaction and decision making of individuals that have the authority to make business decisions and set information technology priorities within a company (Abubakar et al., 2019).

Information Security Risk Management (ISRM)

ISRM is the process, policies, and systems used to manage technology risks and ensure acceptable levels of an information security risk (Alguliyev et al., 2018).

Laissez-Faire Leadership Style

Laissez-faire leadership style allows reports to operate with limited oversight (Mews, 2019).

Strategic Alignment

Strategic alignment focuses on the process of linking an organization's structure and resources with its strategy and operating environment to enable higher performance (Sabherwal et al., 2019).

Transactional Leadership Style

The transactional leadership style is defined by the use of positive and negative reinforcement to motivate reports and focuses on the achievement of extrinsic rewards, avoiding risks, and accomplishment of organizational goals (Jiang et al., 2019).

Transformational Leadership Style

The transformational leadership style is characterized by when the leader uses enthusiasm and charisma to inspire reports and motivate workers by continually challenging them without micromanaging (Huertas-Valdivia et al., 2019).

RESEARCH QUESTIONS

The findings of this research can inform more modern and interconnected strategies related to the impact of CTO leadership styles, alignment of the governance of big data, and information security risk management effectiveness. The following related sub-questions supported the overarching research question and were formed based on Baron and Kenny's (1986) methodology.

> RQ1: Is there a significant predictive relationship between CTO leadership styles and ISRM effectiveness in selected organizations in the Western United States?
>
> RQ2: Is there a significant predictive relationship between CTO leadership styles and alignment of governance of big data in selected organizations in the Western United States?
>
> RQ3: In the combined regression model with CTO leadership styles, alignment of governance of big data, and ISRM effectiveness, is the effect of CTO leadership styles diminished and is the alignment of governance of big data significant?

HYPOTHESES

The following hypotheses supported the overarching question.

> H_A: The alignment of the governance of big data does mediate the relationship between CTOs leadership styles and ISRM effectiveness in selected organizations in the Western United States.

The following sub-hypotheses support the research sub-questions.

> $H1_A$: There is a significant predictive relationship between CTOs leadership styles and ISRM effectiveness in selected organizations in the Western United States.
>
> $H2_A$ There is a significant predictive relationship between CTOs leadership styles and alignment of the governance of big data in selected organizations in the Western United States.
>
> $H3_A$ In the combined regression model with CTOs leadership styles, alignment of governance of big data, and ISRM effectiveness – the effect of CTOs leadership styles is diminished and the alignment of governance of big data is significant.

METHODOLOGY

The research method selected for this study was a quantitative, correlational research design where the data was gathered and examined using numerical techniques collected through a survey to explore the effects of CTOs leadership styles and the alignment of the governance of big data on ISRM effectiveness in organizations based in the Western United States. For this study, data was collected from Chief Technology Officers (CTOs) in the Western United States. The Western United States is defined as including Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. The following inclusion criteria applied to the study: (a) participants had to work in businesses with locations in the Western United States; (b) participants were required to hold the title of Chief Technology Officer; and (c) participants were required to be between 21 and 65 years old.

The general research question of interest was if the alignment of governance of big data mediated the relationship between CTOs leadership styles and ISRM effectiveness in selected organizations in the Western United States? Figure 1 is a visual representation of the conceptual framework used in this study. The study explored a better understanding of the relationship between the alignment of the governance of big data, executive leadership styles (in particular CTOs), and ISRM effectiveness in organizations in the Western United States.

The circles shown in Figure 1 represent how an organization might currently be interacting with big data across the organization. The inter-connectedness of the circles shown in Figure 1 was of interest to this researcher. Baron and Kenny (1986) defined the processes around mediational hypotheses analysis that was leveraged for this study, which is also reflected directionally by the arrows within the research interest area shown in Figure 1 and mirrored by the process implied in the three research sub-questions. CTOs leadership styles was the independent variable, alignment of the governance of big data was the mediating variable, and ISRM effectiveness was the dependent variable. The alignment of the governance of big data was tested as a link between the independent and dependent variables. This researcher evaluated the impact of CTOs leadership styles and the alignment of the governance of big data on ISRM effectiveness in selected organizations in the Western United States.

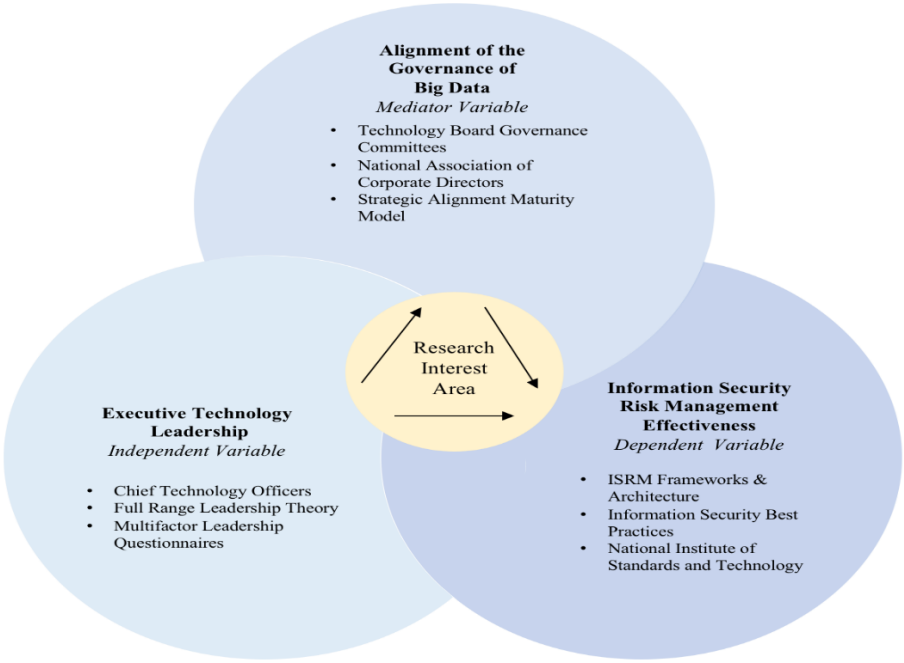

Figure 1. Visual representation of conceptual framework used in the study

Despite numerous peer-reviewed research findings that have demonstrated how essential high-level support is to effective information governance (Barlette et al., 2017), there is still a lack of effective corporate governance (Roy et al., 2016; Zukis, 2019). The relevant topics for the study included the alignment of the governance of big data, the styles of executive leadership, and the effectiveness of ISRM processes. The interest area was not how to use big data to have better governance, but rather to explore the relationships between the alignment of the governance of big data, executive leadership styles (in particular, the role of the CTOs), and ISRM effectiveness.

While during the literature review several technology executive roles were explored, the study selected the universe of Chief Technology Officers as it was deemed to be most relevant to ISRM effectiveness, and it was also not fully explored by other researchers. According to Emsi (2020), CTOs are responsible for oversight of current technology and relevant policies, as well as aligning technology-related decisions with organizational objectives. While the basic functional competencies of a CTOs are defined, with big data growing exponentially in the digital economy, there are still unknowns around executive IT leadership and its relationship with organizational success (Burrell et al., 2018). The Full Range Leadership Model developed by Bass and Avolio (1997) defines different leadership styles within the leadership competency, such as the transformational, transactional, and laissez-faire leadership styles, as well as the impact of each style. The Multifactor Leadership Questionnaire (MLQ) is one of the most widely used measures of leadership and provides specific scores for transformational, transactional, and passive-avoidant leadership styles. As it relates to the alignment of the governance of big data, a variety of governance hierarchies are explored through the lens of Luftman's (2004) strategic alignment maturity model, which addresses the alignment between potential disparate systems. In addition, ISRM effectiveness was explored through popular frameworks, architecture, and best practices, as well as through the lens of the National Institute of Standards and Technology, which created ISO27002, an international information security standard that describes best practices for information security management. Baron and Kenny's (1986) steps for mediation were leveraged across these three instruments to test the relationships between the variables to inform the overall research question.

This research aimed to understand the relationship between the independent and mediating variable and test the influence of those on the dependent variable. The steps for testing mediation defined by Baron and Kenny (1986) that applied to this study were: (a) show that the CTOs leadership styles is correlated with the alignment of the governance of big data; (b) demonstrate that ISRM effectiveness and the alignment of the governance of big data are correlated; and (c) demonstrate full mediation on the process including the effect of CTOs leadership styles on ISRM effectiveness, controlling for alignment of the governance of big data. The three instruments used to create the survey administered on the Qualtrics LLC platform were the Full Range Leadership Theory (FRLT)'s Multifactor Leadership Questionnaire (Mind Garden, 2019), Luftman's (2004) Strategic Alignment Maturity Model, and EDUCAUSE (2018) ISO27002 assessment. Edmondson and McManus (2007) found surveys that test existing constructs using statistical inference to be a good fit when the state of prior research is mature.

CONTRIBUTION

Previous scholarship has established the importance of leadership styles, big data governance, and ISRM effectiveness, but not in a combined understanding of the relationship between all three variables. The researcher's primary objective was to contribute valuable knowledge to the practical field of computer science by empirically validating the relationships between the CTOs leadership styles, the alignment of the governance of big data, and ISRM effectiveness in the Western United States. The evidence presented in the literature review indicated that researchers had not validated such relationships collectively in previous studies. Overall, the literature has verified FRLT and its explanatory power. In addition, the components of transformational leadership appear to be a good fit for the governance of big data (Hassan et al., 2019). However, with the rapidly evolving digital economy,

there remains a gap in the literature as to precisely how the alignment of the governance of big data and CTOs leadership styles relate to each other in the changing digital economy.

There are several different governance layers related to the governance of big data, and roles and responsibilities may differ depending on the organization. Strategic alignment theory has been used to help understand the alignment between different IT governance structures relative to changing priorities. Scholars continue to debate whether or not technology governance has clear roles of responsibility (Turel et al., 2019), and also emphasize that the role of an individual primarily responsible for the alignment of the governance of big data can vary by the company. As it relates to ISRM effectiveness, NIST provides some leading frameworks, architecture, and best practices. Hopkin (2018) emphasized that there is not a one-size-fits-all solution to ISRM effectiveness, which means that each company can choose various components to implement as it relates to their specific ISRM frameworks and architecture. Frameworks and architectures often need to be revised to keep up with big data security threats and changing business priorities. The board of directors and executive leadership, working within the constructs of governance structures, often determine which frameworks and architectures are deployed. A review of scholarly work suggests that the relationship between CTOs leadership styles and the alignment of the governance of big data as it relates to ISRM effectiveness in the Western United States needs to be better understood. While this research focused only on CTOs in the Western United States, future research can be extended to the rest of the United States and across the world to see if similar results are found.

INTERPRETATION OF RESEARCH SUB-QUESTION 1

The results of the regression model between CTOs leadership styles and ISRM effectiveness, as shown in Table 4, were statistically significant. These findings indicated the likelihood of a relationship between CTOs leadership styles and ISRM effectiveness caused by something other than chance. This provides evidence to reject the null hypothesis meaning that the relationship is caused by something more than chance. This finding agrees with scholarly literature that supports the relationship between leadership styles and ISRM effectiveness (Thite, 2000). Thite's (2000) research indicated that a combination of transformational and technical leadership styles showed indications of ISRM effectiveness, so the insight that the transactional leadership styles had a strong role in ISRM effectiveness varied from Thite's study findings around transformational leadership. However, this finding in the present study related to transactional leadership was in alignment with Burrell et al.'s (2018) work indicating the applicability of the transactional leadership style to the field of big data security. The finding from this study around the relationship with transactional leadership style also varied from Taft's (2017) findings that found transformational leadership style (not transactional) was most positively correlated with effective IT governance.

The results of this first regression analysis are also in agreement with Berepiki's (2018) findings indicating that transactional leadership had the strongest association with strategic alignment. However, it should be noted that, in the present study, the internal consistency for transactional leadership fell slightly below the threshold for acceptable internal consistency; therefore, the findings must be interpreted with a level of caution for this scale. Thus, readers should exercise caution when generalizing the findings of this study. In addition, there is also some debate about whether transactional and transformational leadership styles are similar or distinctive (Odumeru & Ogbonna, 2013). Odumeru and Ogbonna (2013) argued that while the two leadership styles are conceptually distinctive, there are components of transactional leadership within transformational leadership. Overall, the importance of the interpretation of Research Sub-question 1 is that the first requirement for Baron and Kenny's (1986) mediation was met.

Interpretation of Research Sub-question 2

The regression model results between CTOs leadership styles and the alignment of the governance of big data were not statistically significant. This result indicates that there was no relationship between the CTOs leadership styles and the alignment of the governance of big data, providing evidence of the plausibility of the null hypothesis, which suggests that there is nothing more than random chance at work between these two variables. This finding varies from the scholarly literature that suggests a stronger relationship between leadership styles and governance (Okonofua et al., 2019). Overall, the importance of the interpretation of Research Sub-question 2 is that the second requirement for Baron and Kenny's (1986) mediation failed. The null hypothesis for Research Sub-question 2 was not rejected. This finding might have occurred because many Committees are process-oriented, and thus the questions were process-oriented related to the alignment of the governance of big data, whereas leadership styles are more of personal characteristics.

Interpretation of Research Sub-question 3

The regression model results between the CTOs leadership styles, the alignment of the governance of big data, and ISRM effectiveness were statistically significant. This means that there is the likelihood of a relationship between the three variables caused by something other than chance. This finding provides evidence to reject the null hypothesis suggesting that the relationship is caused by something more than luck. This finding generally agrees with the scholarly literature that indicates a relationship between similar variables (Okonofua et al., 2019; Yaokumah, 2013). The null hypothesis for Research Sub-question 3 was rejected. Overall, the importance of the interpretation of Research Sub-question 3 is that both sub-question 1 and sub-question 3 met the Baron and Kenny (1986) requirements for mediation.

Interpretation Relative to Overall Research Question

The research findings indicated that the alignment of the governance of big data component was significant on its own, and the transactional leadership style was no longer significant in the mediator's presence. The mediator was significant, and the effects of the predictors from the first research questions were diminished. Therefore, governance was shown to weaken the relationship between the CTOs leadership styles and ISRM effectiveness. Governance was a significant predictor in the model, while the predictive strength of all three leadership styles was diminished between regression analysis associated with Research Sub-question 1 and Research Sub-question 3. Following the logic of Baron and Kenny's (1986) methodology, this suggests that governance is a partial mediator of the relationship between the CTOs leadership styles and ISRM effectiveness. The findings indicate that the alignment of the governance of big data is a partial link between the CTOs leadership styles and ISRM effectiveness, and the existence of the alignment of the governance of big data partially explains the relationship between CTOs leadership styles and ISRM effectiveness.

While this exact study has not been previously conducted with these three variables with CTOs in the Western United States, overall, these results are in general agreement with Okonofua et al.'s (2019) final and unexpected result that information security governance did not significantly mediate the relationship between IT leadership styles and ISRM. These findings are also generally in alignment with Davis (2017) study that found that combined strategic alignment, resource management, risk management, value delivery, and performance measurement predicted information security governance effectiveness. In addition, the relationship between transactional leadership styles and big data security effectiveness agrees with Burrell et al.'s (2018) research. This research's results are also in agreement with the recently growing number of governance accountability requirements and Yaokumah's (2013) research that indicated the importance of governance as it relates to information security effectiveness.

However, some of the overall findings did vary from some of the literature, including the finding that the transactional leadership style was a strong predictor of ISRM effectiveness. Armstrong and Sambamurthy (1999) seminal research indicating that organizations that exhibited transformational Information Technology (IT) vision (in contrast to transactional vision) had more effective executive IT leadership. Also, research by Hassan et al. (2019) indicated a strong relationship between the transformational leadership style and IT effectiveness (not the transactional leadership style). Similarly, Apollonia and Ihagh (2016) link information security outcomes with governing bodies and transformational leadership with decreased information security risks (not transactional leadership). Additionally, in disagreement with the literature review, this study also found that the alignment of the governance of big data weakened the relationship between CTOs leadership styles and ISRM effectiveness. Overall, the study's findings support the importance of both CTOs leadership styles and the alignment of the governance of big data as it relates to ISRM effectiveness.

FINDINGS

The analysis examined the relationship between the independent variable (CTOs leadership style) and the mediating variable (the alignment of the governance of big data) and tested the influence of those on the dependent variable (ISRM effectiveness). The sample consisted of 88 males (63.3%) and 51 females (36.7%). Age ranged from 21 to 63 years, with $M = 38.39$ years and $SD = 7.61$. A majority of the sample was employed in an organization with over 500 employees ($n = 73$, 52.5%). Most of the industry segments consisted of participants in the financial services sector ($n = 43$, 30.9%), the manufacturing sector ($n = 26$, 18.7%), and the engineering sector ($n = 21$, 15.1%). Frequencies and percentages for the demographical data are presented in Table 1.

Table 1. Frequencies and percentages of demographical data

DEMOGRAPHIC	*n*	%
Gender		
Male	88	63.3
Female	51	36.7
Organization size		
Under 50 employees	9	6.5
50-500 employees	57	41.0
Over 500 employees	73	52.5
Industry segment		
Agriculture	1	0.7
Construction	11	7.9
Consulting	5	3.6
Energy	5	3.6
Engineering	21	15.1
Financial services	43	30.9
Healthcare	14	10.1
Manufacturing	26	18.7
Other	13	9.4

Note. Due to rounding error, not all percentages may sum to 100.

Cronbach's alpha tests of reliability and internal consistency were interpreted using the guidelines suggested by George and Mallery (2016) where $\alpha > .9$ is Excellent, $\alpha > .8$ is Good, $\alpha > .7$ is Acceptable, $\alpha > .6$ is Questionable, $\alpha > .5$ is Poor, and $\alpha < .5$ is Unacceptable. The internal consistency for four of the five scales (transformational leadership, laissez-faire leadership, alignment of the governance of big data, and ISRM effectiveness) met the acceptable threshold. The internal consistency for transactional leadership ($\alpha = .69$) fell slightly below the threshold for acceptable internal consistency; therefore, the findings must be interpreted with a level of caution for this scale. Table 2 presents the descriptive statistics for the continuous-level variables.

Table 2. Descriptive statistics of continuous variables

COMPOSITE SCORES	*Minimum*	*Maximum*	*Mean*	*Standard Deviation*	Number of Items	α
Transformational leadership	2.65	4.80	3.86	0.42	20	.81
Transactional leadership	2.38	5.00	3.86	0.51	8	.69
Laissez-faire leadership	1.50	4.50	2.88	0.73	8	.73
Governance	1.33	6.00	4.87	1.11	3	.83
ISRM effectiveness	1.86	5.00	4.17	0.64	7	.86

To test the mediating relationship, three regression models were conducted as reflected in the three research sub-questions: (a) CTOs leadership styles as the predictor variable and ISRM effectiveness as the outcome variable; (b) CTOs leadership styles as the predictor variable and the alignment of the governance of big data as the outcome variable; and (c) CTOs leadership styles and the alignment of the governance of big data as the predictor variables and ISRM effectiveness as the outcome variable.

ANALYSIS OF RESEARCH SUB-QUESTION 1

This section presents the results of the first regression analysis.

RQ1. Is there a significant predictive relationship between CTOs leadership styles and ISRM effectiveness in selected organizations in the Western United States?

$H1_0$. There is no significant predictive relationship between CTOs leadership styles and ISRM effectiveness in selected organizations in the Western United States.

$H1_A$. There is a significant predictive relationship between CTOs leadership styles and ISRM effectiveness in selected organizations in the Western United States.

To address Research Sub-question 1, a multiple linear regression was conducted to examine whether transformational leadership, transactional leadership, and laissez-faire leadership significantly predict ISRM effectiveness. Prior to analysis, the assumption of normality, homoscedasticity, and absence of multicollinearity were tested. Normality was assessed through visual examination of a normal P-P scatterplot. The assumption of normality was met due to the data only having slight deviations following the normality trend line (see Figure 2).

A residuals scatterplot was developed to examine the homoscedasticity assumption. Due absence of a clear pattern in the residual's scatterplot, the assumption of homoscedasticity was met (see Figure 3).

Variance inflation factors (VIFs) were utilized to examine the absence of multicollinearity assumption. All three leadership variables had VIFs lower than 10, indicating that there was not a high association between the variables. Therefore, the assumption for absence of multicollinearity was met. Table 3 presents the VIFs for the three leadership styles.

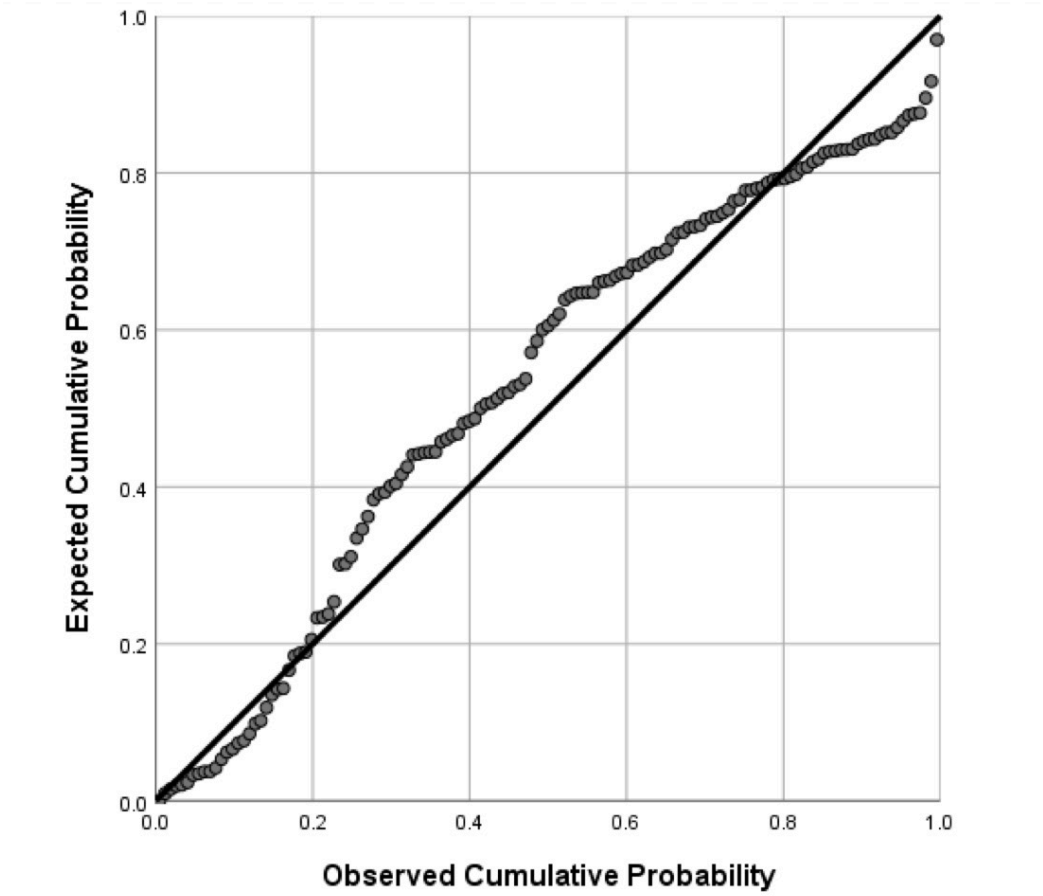

Figure 2. Normal P-P plot for leadership styles predicting ISRM effectiveness

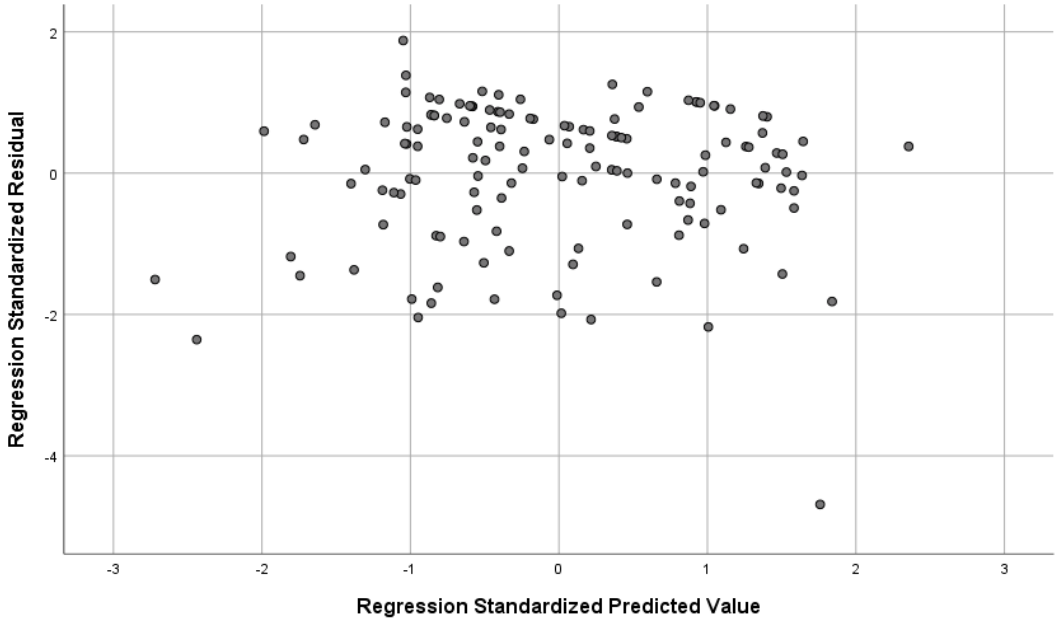

Figure 3. Residuals plot for leadership styles predicting ISRM effectiveness

Table 3. Variance inflation factors for leadership styles variables

PREDICTOR	VARIANCE INFLATION FACTOR
Transformational leadership	2.25
Transactional leadership	2.28
Laissez-faire leadership	1.06

The findings of the overall multiple linear regression were statistically significant, $F(3, 135) = 8.92$, $p < .001$, and $R^2 = .165$, suggesting that there was a significant collective relationship between transformational, transactional, laissez-faire, and ISRM effectiveness. The leadership styles variables explain 16.5% of the variance in ISRM effectiveness. Therefore, the first step of the Baron and Kenny (1986) method for mediation was met due to the three leadership styles collectively predicting ISRM effectiveness. Transactional leadership ($t = 2.28$, $p = .024$) was individually significant in the model, suggesting that with every one-unit increase in transactional leadership, ISRM effectiveness increased by approximately 0.34 units. The null hypothesis for Research Sub-question 1 was rejected. Table 4 presents the findings of the linear regression model, one of the key Baron and Kenny (1986) in testing for mediation.

Table 4. Results for multiple linear regression with transformational leadership, transactional leadership, and laissez-faire leadership predicting ISRM effectiveness

PREDICTOR	*B*	SE	β	*t*	*p*
Transformational leadership	0.25	0.18	.16	1.38	.171
Transactional leadership	0.34	0.15	.27	2.28	.024
Laissez-faire leadership	0.02	0.07	.02	0.22	.823

Note. $F(3, 135) = 8.92$, $p < .001$, $R^2 = .165$

ANALYSIS OF RESEARCH SUB-QUESTION 2

This section presents the results of the second regression analysis.

RQ2. Is there a significant predictive relationship between CTOs leadership styles and alignment of governance of big data in selected organizations in the Western United States?

$H2_0$. There is no significant predictive relationship between CTOs leadership styles and alignment of the governance of big data in selected organizations in the Western United States.

$H2_A$. There is a significant predictive relationship between CTOs leadership styles and alignment of the governance of big data in selected organizations in the Western United States.

To address Research Sub-question 2, a multiple linear regression was conducted to examine whether transformational leadership, transactional leadership, and laissez-faire leadership significant predict alignment of the governance of big data. Prior to analysis, the assumption of normality, homoscedasticity, and absence of multicollinearity were tested. The assumption of normality was met due to the data only having slight deviations following the normality trend line (see Figure 4).

A residual's scatterplot was developed to examine the homoscedasticity assumption. Due the absence of a clear pattern in the residual's scatterplot, the assumption of homoscedasticity was met (see Figure 5).

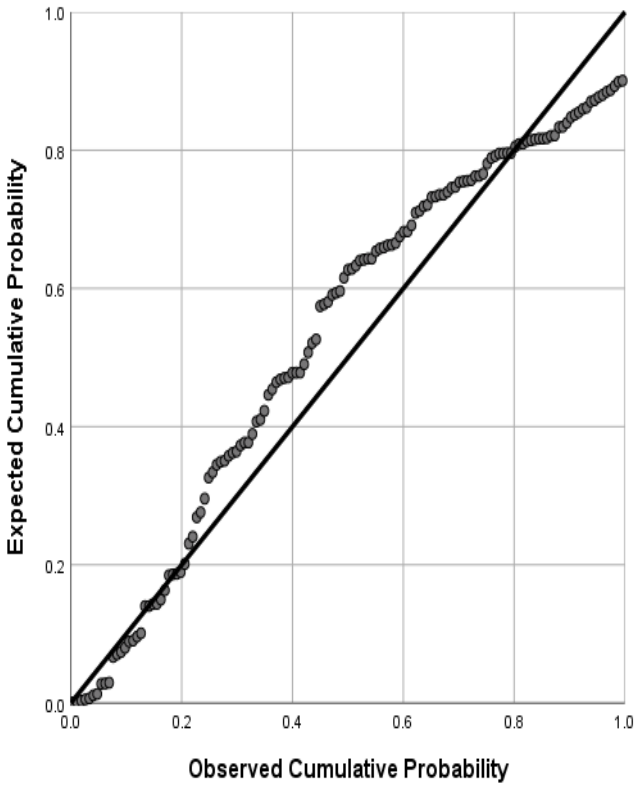

Figure 4. Normal P-P plot for leadership styles predicting governance

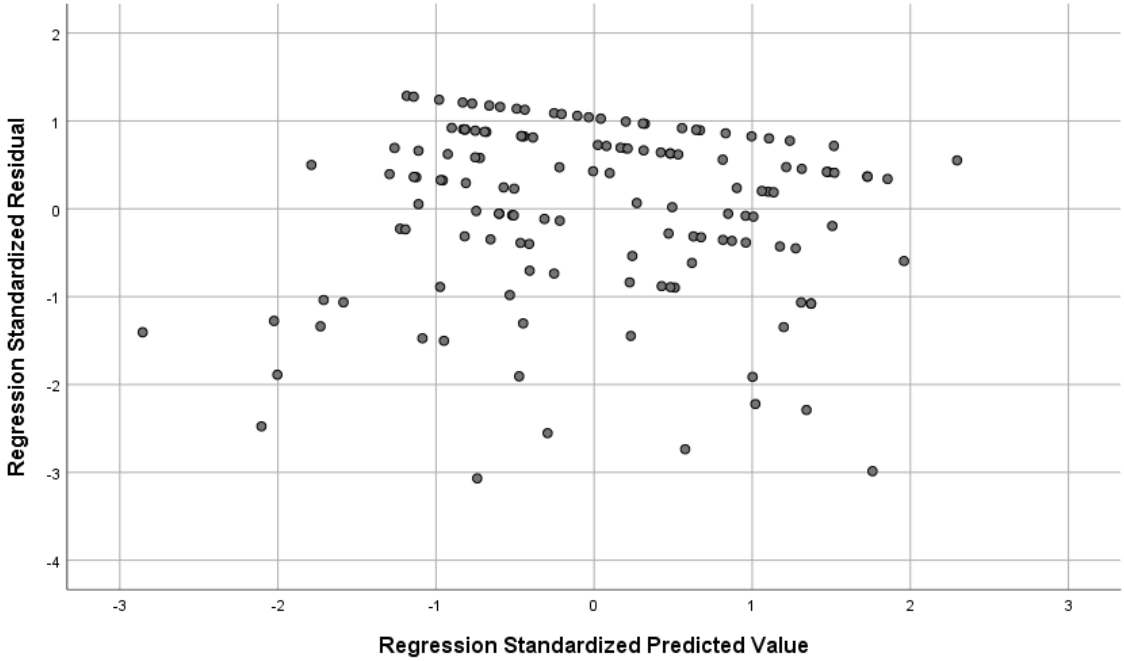

Figure 5. Residuals plot for leadership styles predicting governance

Variance inflation factors were utilized to examine the absence of multicollinearity assumption. The same predictors were examined in Research Sub-question 1, indicating that the assumption for absence of multicollinearity was met.

The findings of the overall multiple linear regression were not statistically significant, $F(3, 135) = 2.04$, $p = .111$, and $R^2 = .043$, suggesting that there was not a significant collective relationship between transformational, transactional, laissez-faire, and governance. The leadership styles variables explain 4.3% of the variance in the alignment of the governance of big data. Therefore, the second step of the Baron and Kenny (1986) method for mediation was not met due to the three CTOs leadership styles not collectively predicting the alignment of the governance of big data. The null hypothesis for Research Sub-question 2 was not rejected. Table 5 presents the findings of the multiple linear regression model.

Due to the non-significance of the findings, there is a potential of a Type II error. The achieved power was .52, which means that the probability of a Type II error was .48. Therefore, the findings may need to be interpreted with caution. However, the risk of error overall was low given the excellent sample size of survey respondents

Table 5. Results for multiple linear regression with transformational leadership, transactional leadership, and laissez-faire leadership predicting governance

PREDICTOR	*B*	SE	β	*t*	*p*
Transformational leadership	0.07	0.33	.03	0.22	.826
Transactional leadership	0.40	0.28	.19	1.47	.143
Laissez-faire leadership	0.00	0.13	.00	0.03	.977

Note. $F(3, 135) = 2.04$, $p = .111$, $R^2 = .043$

ANALYSIS OF RESEARCH SUB-QUESTION 3

This section presents the results of the third regression analysis.

RQ3. In the combined regression model with CTOs leadership styles, alignment of governance of big data, and ISRM effectiveness – is the effect of CTOs leadership styles diminished and is the alignment of governance of big data significant?

$H3_0$. In the combined regression model with CTOs leadership styles, alignment of governance of big data, and ISRM effectiveness – the effect of CTOs leadership styles is not diminished and the alignment of governance of big data is not significant.

$H3_A$. In the combined regression model with CTOs leadership styles, alignment of governance of big data, and ISRM effectiveness – the effect of CTOs leadership styles is diminished and the alignment of governance of big data is significant.

To address Research Sub-question 3, a multiple linear regression was conducted to examine whether transformational leadership, transactional leadership, laissez-faire leadership, and the alignment of the governance of big data significantly predict ISRM effectiveness. Prior to analysis, the assumption of normality, homoscedasticity, and absence of multicollinearity were tested. The assumption of normality was met due to the data only having slight deviations following the normality trend line (see Figure 6).

A residual's scatterplot was developed to examine the homoscedasticity assumption. Due the absence of a clear pattern in the residual's scatterplot, the assumption of homoscedasticity was met (see Figure 7).

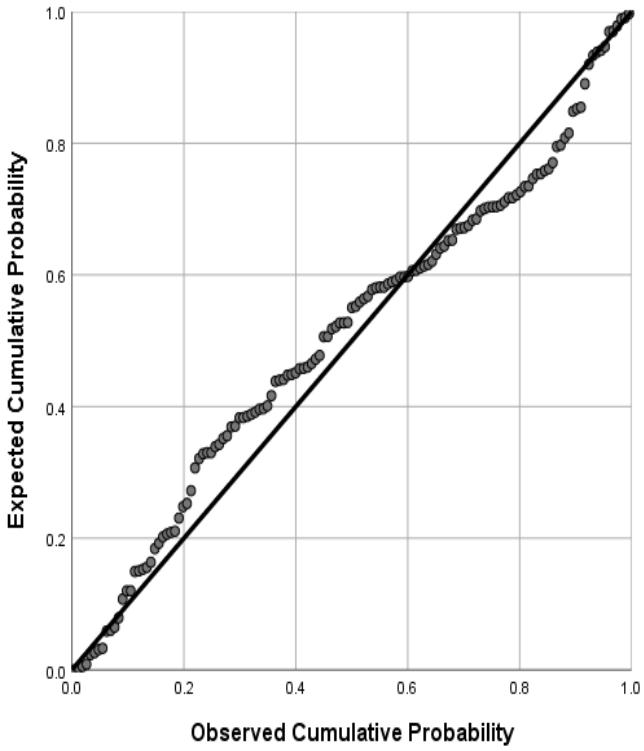

Figure 6. Normal P-P plot for leadership styles and governance predicting ISRM effectiveness

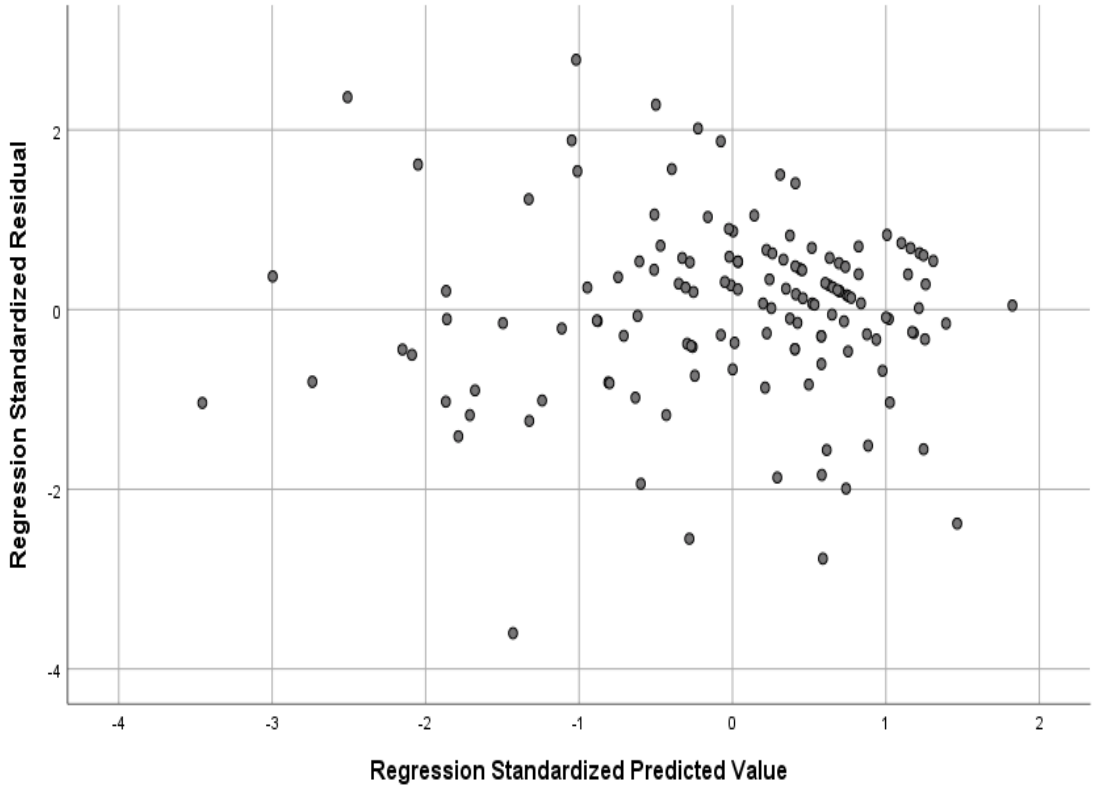

Figure 7. Residuals plot for leadership styles and governance predicting ISRM effectiveness

Variance inflation factors were utilized to examine the absence of multicollinearity assumption. All four variables had VIFs lower than 10, indicating that there was not a high association between the variables. Therefore, the assumption for absence of multicollinearity was met. Table 6 presents the VIFs for the three leadership styles.

Table 6. Variance inflation factors for leadership styles and governance variables

PREDICTOR	VIF
Transformational leadership	2.25
Transactional leadership	2.31
Laissez-faire leadership	1.06
Governance of big data	1.05

The findings of the overall multiple linear regression were statistically significant, $F(4, 134) = 31.91$, $p < .001$, and $R^2 = .488$, suggesting that there was a significant collective relationship between transformational, transactional, laissez-faire, alignment of the governance of big data, and ISRM effectiveness. The CTOs leadership styles and governance variables explain 48.8% of the variance in ISRM effectiveness. The alignment of the governance of big data ($t = 9.19$, $p < .001$) was a significant predictor in the model. Therefore, the third step of the Baron and Kenny (1986) method for mediation was met due to the mediating variable having a relationship on ISRM effectiveness. Transactional leadership ($t = 1.73$, $p = .086$), which was statistically significant in the first regression model, was no longer a significant predictor of ISRM effectiveness while in the presence of the alignment of the governance of big data (mediator). The null hypothesis for Research Sub-question 3 was rejected. The standardized beta coefficients (β) for all three leadership styles decreased between the regression model around sub-question one and the regression model around Research Sub-question 3. The null hypothesis for Research Sub-question 3 was rejected. Therefore, the Baron and Kenny (1986) method for mediation was met in this step due to all three leadership styles becoming weaker in the regression model with the alignment of the governance of big data

OVERALL RESEARCH QUESTION

Due to the results of the key steps related to the Baron and Kenny (1986) methodology, the alignment of the governance of big data can be considered a partial mediator of the relationship between CTOs leadership styles and ISRM effectiveness. Table 7 presents the findings of the multiple linear regression model.

Table 7. Results for multiple linear regression with transformational leadership, transactional leadership, and laissez-faire leadership, and governance predicting ISRM effectiveness

PREDICTOR	*B*	SE	β	*t*	*p*
Transformational leadership	0.22	0.14	.15	1.58	.118
Transactional leadership	0.20	0.12	.16	1.73	.086
Laissez-faire leadership	0.02	0.06	.02	0.26	.794
Governance of big data	0.34	0.04	.58	9.19	<.001

Note. $F(4, 134) = 31.91$, $p < .001$, $R^2 = .488$

Three survey instruments were used around CTOs leadership styles, the alignment of the governance of big data and ISRM effectiveness. In terms of the overarching research question around mediation, Baron and Kenny's (1986) methodology suggested that governance is a partial mediator of the rela-

tionship between CTOs leadership styles and ISRM effectiveness. The first regression showed collectively that the CTOs leadership styles had a significant predictive relationship with ISRM effectiveness and that the transactional leadership styles was a strong predictor with IRSM effectiveness. Therefore, CTOs leadership styles had a role in evaluating ISRM effectiveness. In terms of the research sub-question 2, collectively leadership did not have an effect on the alignment of the governance of big data. In terms of an individual basis of leadership style, the three leadership styles did not indicate a strong effect on the alignment of the governance of big data. The research findings indicated that the alignment of the governance of big data component was significant on its own and the transactional leadership was no longer significant in presence of the mediator. The mediator was found to be significant and the effects of the predictors from the first research questions were diminished. Therefore, governance was shown to weaken the relationship between CTOs leadership styles and ISRM effectiveness indicating partial mediation.

RECOMMENDATIONS FOR PRACTITIONERS

With big data growing at an exponential rate, this research may be useful in helping other practitioners think about how to test mediation with other interconnected variables related to the alignment of the governance of big data. Overall, the alignment of governance of big data being a partial mediator of the relationship between CTOs leadership styles and ISRM effectiveness suggests the significant role that the alignment of the governance of big data plays within an organization. In this study, the alignment of the governance of big data did not fully mediate the CTOs leadership styles and ISRM effectiveness, suggesting there is a need for additional mediation research around the impact of the alignment of the governance of big data.

This study also found a surprising relationship between the CTOs transactional leadership styles and ISRM effectiveness. While there are different points of emphasis across the scholarly literature, overall, the focus on ISRM effectiveness has been more associated with the transformational leadership style than the transactional leadership style. If the alignment of the governance of big data were able to affect ISRM effectiveness for only certain CTOs leadership styles, that might change, for example, how companies recruit executive technology leaders. Human resources departments that might be using transformational leadership assessments for screening might want to consider this study's results and not just limit themselves to CTOs candidates showing transformational leadership styles. However, the internal consistency for transactional leadership in this study fell slightly below the threshold for acceptable internal consistency; therefore, the findings must be interpreted with a level of caution for this scale.

RECOMMENDATIONS FOR RESEARCHERS

While this exact study has not been previously conducted with these three variables with CTOs in the Western United States, overall, these results are in agreement with Okonofua et al.'s (2019) final and unexpected result that information security governance did not significantly mediate the relationship between IT leadership styles and ISRM. These findings are also generally in alignment with Burrell et al. (2018), Davis (2017), and Yaokumah's (2013) research. However, some of the overall findings did vary from the literature, including the predictive relationship between transactional leadership and ISRM effectiveness. This study's findings were in disagreement with Armstrong and Sambamurthy (1999) seminal research, research by Hassan et al. (2019) as well as research by Apollonia and Ihagh (2016) that emphasized the role of the transformational leadership style in IT versus the transactional leadership style.

The underlying premise of this study was that the alignment of the governance of big data may explain the relationship between CTOs leadership styles and ISRM effectiveness. With the finding of partial mediation indicated in this study, this also suggests that the alignment of the governance of big data provides a partial intervention between CTOs leadership styles and ISRM effectiveness. Fu-

ture research could test mediation under different circumstances including limiting the type of governance structures or type of big data being managed to see if full mediation could be indicated in certain instances. This research could be expanded across the roles or with other similar executive technology roles to see if similar results are found. Or, a different instrument could be used to test for information security risk management effectiveness, such as the package for structural equation modeling (PLS-SEM) to compare and contrast results.

IMPACT ON SOCIETY

Big data breaches are increasing year after year, exposing sensitive information that can lead to harm to citizens. This study supports the broader scholarly consensus that to achieve ISRM effectiveness, better alignment of governance policies is essential (Okonofua et al., 2019). This research highlights the importance of higher-level governance as it relates to ISRM effectiveness, implying that ineffective governance could negatively impact both leadership and ISRM effectiveness, which could potentially cause reputational harm. Given the pressures boards feel from scandals and economic downturns and stresses related to individuals involved in severe data breaches, future research might consider the alignment of the governance of big data relative to institutional investor empowerment or activism, as well as the impact of specific legislation or regulations to minimize harm to citizens.

FUTURE RESEARCH

This study raised questions about CTOs leadership styles, the specific governance structures involved related to the alignment of big data and ISRM effectiveness. While the research around these variables independently is mature, there is an overall lack of mediation studies as it relates to the impact of the alignment of the governance of big data. The field of big data security is rapidly evolving as COBIT, NIST, and ISO27002 standards continue to evolve. With the lack of alignment around a universal framework, evolving frameworks could be tested in future research to see if similar results are obtained. Future studies could also test the mediating factor and the sub-component questions to determine if additional significant factors influence ISRM effectiveness. Different geographies, industries, or cultures could be explored with the same research methodology used by this study. A variation of this study could also include testing if similar results are achieved with a population of Chief Digital Officers, Chief Data Officers, or Chief Information Security Officers versus Chief Technology Officers.

Digital transformation in the boardroom is driven currently by varied and complex structures that exist relative to the governance of big data. As the Board of Directors responds to internal and external pressures to improve digital experiences, future research could also dig deeper into board committee charters that set standards for board membership and responsibilities and evaluate that relationship relative to executive leadership styles and ISRM effectiveness. Also, the role of the full board in retaining oversight responsibility for technology committees could be explored relative to the leadership style of the Board Chairman and ISRM effectiveness. Future research could also examine if orientation and education around big data for board members could serve as a mediator between executive leadership styles and ISRM effectiveness. Additional modifications around the current research could also include narrowing down to a subset of ISRM effectiveness such as cybersecurity or exploring the nature of the three variables in a crisis.

In terms of the alignment of the governance of big data, future research could also narrow this research study relative to companies with passive boards or certifying boards or engaged boards or intervening boards or operating boards. Another consideration that could be explored is looking at companies that monetize their big data and how that might change the relationship between CTOs leadership styles, alignment of governance of big data, and ISRM effectiveness. Regarding CTOs leadership styles, different leadership styles outside of the FRLT could also be tested to see if similar results were produced. In addition, specific components around transactional leadership could be ex-

plored to understand better the elements associated with its relationship with ISRM effectiveness. Future researchers could even better understand hiring assessments related to CTOs leadership styles and the impact that bias around the historically preferred transformational leadership might play on executive hiring.

Overall, the findings of the study highlight the importance of both the CTOs leadership styles and the alignment of the governance of big data to support ISRM effectiveness. Readers should understand that the alignment of the governance of big data did not fully mediate the relationship between the CTOs leadership styles and ISRM effectiveness, although partial mediation was indicated. This study revealed additional knowledge pertinent to the digital transformation happening in the boardroom that should stimulate new interests in field researchers concerned about CTOs leadership styles, the alignment of the governance of big data, and ISRM effectiveness.

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