

Are we Capturing the True Nature of Big Data Analytics Capabilities? A Review from Concept to Construct

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Abstract

As firms increasingly rely on big data to guide decisions and manage strategic responsiveness, the need for constructing and measuring big data analytics capability (BDAC) has gone up accordingly. Though scholarly interest in BDAC is continuing to grow, however, how it is conceptualized and operationalized in empirical research remains inconsistent. This study aims to examine how BDAC constructs are specified and validated in empirical research. To this end, by following transparent and replicable procedures for search, screening, selection, and coding, the study conducted a structured review of 44 empirical studies published between 2020 and 2024. The findings indicate a diversity in conceptualization, though over two-thirds of studies have conceptualized big data analytics capabilities as a bundle of related but distinct capabilities. From measurement model specifications perspective, literature synthesis highlights that the overwhelming majority of studies have relied on reflective models, and that too with limited theoretical justification. This review contributes by eliciting prevailing methodological tensions and offering systematic guidance to assist more conceptually harmonious and analytically stronger BDAC studies. Practical implications are also discussed for researchers and practitioners seeking to develop more credible and strategically aligned analytics capability assessments. The review acknowledges the limitations with regard to shorter temporal review period and exclusion of non-SEM-based research, and calls for future research to embrace broader methodological approaches and context-sensitive modeling strategies.

Keywords: Big Data Analytic Capabilities, Formative, Reflective, Measurement Model, Misspecification

Introduction

In today's technology-driven environment, exponential growth of data generated through Internet of Things (IoT) devices, social media platforms, and enterprise systems has positioned big data analytics (BDA) as a source of competitive advantage (Sivarajah et al., 2017). Many firms have already adopted big data tools and platforms with the aim of improving their performance through increased efficiency, better customer insights, and optimised inventory. However, extant literature has reported that only one fourth of firms were able to achieve the desired outcomes from these technological initiatives (Ghasemaghaei & Calic, 2019).

Lack of success in translation of big data investment into true business value is attributed to failure to recognise the associated management practices that are necessary along with implementation and adoption of big data (Gao & Sarwar, 2022). These findings have originated a new stream of research that advocates for a transition from a purely technological emphasis to a more holistic approach of integration of organisation wide big data analytics capabilities (BDACs) (Mikalef et al., 2020). BDAC refers to a firm's capability to transform raw data into actionable insights through integration of technological infrastructure and associated human expertise, organisational routines, and governance mechanisms (Akter et al., 2016). Empirical evidence has repeatedly demonstrated strong association between big data analytics capabilities and superior decision-making, agility, innovation, and overall firm performance (Huynh et al., 2023).

Scholarly interest in BDAC is continuing to grow, however closer examination of the literature has revealed considerable heterogeneity in how it is conceptualised. Some researchers have adopted a unidimensional perspective by treating BDAC as a single integrated construct (Ciampi et al., 2021; Zhang & Yuan, 2023). In contrast, using the theoretical lens of resource based view and dynamic capability theory, considerable majority of researchers have framed it as a group of inter related but distinct resources and capabilities like data, technology, technical and managerial skills, data driven culture and organizational processes (Gupta & George, 2016; Lozada, 2022).

Despite this conceptual diversity, a central methodological concern in studying constructs like BDAC is the choice of measurement model, which defines how latent constructs are linked to their observed indicators. It determines whether indicators are seen as effects of the underlying construct (reflective models) or as causal components that together form the construct (formative models) (Coltman et al., 2008). These concerns are particularly relevant to big data analytics capabilities (BDAC) as some scholars have identified BDAC as a formative construct while other have assessed it with reflective measurements (Garmaki et al., 2023). Choosing the wrong model type, especially modeling a formative construct reflectively may artificially inflate internal consistency by forcing distinct elements to correlate, discard important indicators due to low loadings and thus compromise both theoretical and practical conclusions.

Although prior studies (Jarvis et al., 2003; Petter et al., 2007; Roy et al., 2012) have acknowledged these tensions regarding selection of correct type of measurement model, however there remains limited systematic investigation into whether BDAC constructs are being modelled in ways consistent with their conceptual foundations. To evaluate the state

of current practices and to guide future efforts toward more theoretically sound and analytically rigorous research, it is important to understand various BDAC models and the rationale behind these model selections. Against this backdrop, this study aims to assess the current state of empirical research on big data analytics capabilities from conceptualisation, operationalisation and validation perspectives. We set out the following questions to guide this review study to achieve the research objectives.

RQ1: How have BDAC constructs been conceptualised across empirical studies?

RQ2: What types of measurement models are adopted?

RQ3: To what extent have these specifications been justified?

RQ4: How rigorously have studies validated their models, and what methodological gaps persist?

This review aims to contribute to literature by providing structured insights about theory-consistent modelling practices as well as knowledge about stronger validation strategies. Additionally, to influence the credibility and utility of empirical findings, this study is intended to inform practitioners and researchers to draw closer attention to model specification choices.

Methodology

This study employed a structured review methodology by following guidelines of Snyder (2019) and Varsha P S et al (2024). The review adopts a transparent and replicable procedure, which includes systematic search, screening, coding, and synthesis of empirical studies from peer-reviewed journals.

Search Strategy

The Scopus database was chosen for the literature search because it was considered to provide extensive coverage of high-quality peer-reviewed journals in business, management, and information systems. The search strategy was informed by the problem background and exploratory readings. Thus, relevant synonyms related to big data analytics capabilities (BDAC) and structural equation modeling (SEM) were identified, whereas to capture varied terminology, proximity operators were used. The search string as described below was applied to the titles, abstracts, and keywords fields to extract peer-reviewed journal articles published between 2020 and 2024:

((("big data" pre/3 "capability") OR ("BDA" pre/3 "capability") OR ("analytic* capability"))

AND

("PLS-SEM" OR "CB-SEM" OR "Structural equation model*")

Table 1

Search Strategy

Database	Fields searched	Keywords used	Filters applied
Scopus	TITLE-ABS-KEY	"Big data", "analytics ", "capability", "BDA", "PLS-SEM", "CB-SEM", "Structural equation model"	Year: 2020–2024; Source: Journals; Subject area: Business; Language: English; Document type: Article

Screening and Selection

To ensure transparency and reproducibility, we have followed PRISMA 2020 guidelines (Page et al., 2021) for the screening and selection process (Figure 1). First, a structured search in Scopus (2020–2024; business; English; journal articles) initially identified 105 records. By evaluating BDAC relevance and use of SEM techniques, titles and abstracts were screened, and 69 studies were retained thereafter. These were then subjected to full-text review based on predefined quality criteria as described in Table 2. This full-text screening resulted in a final set of 44 articles, which were eventually included for the final literature review.

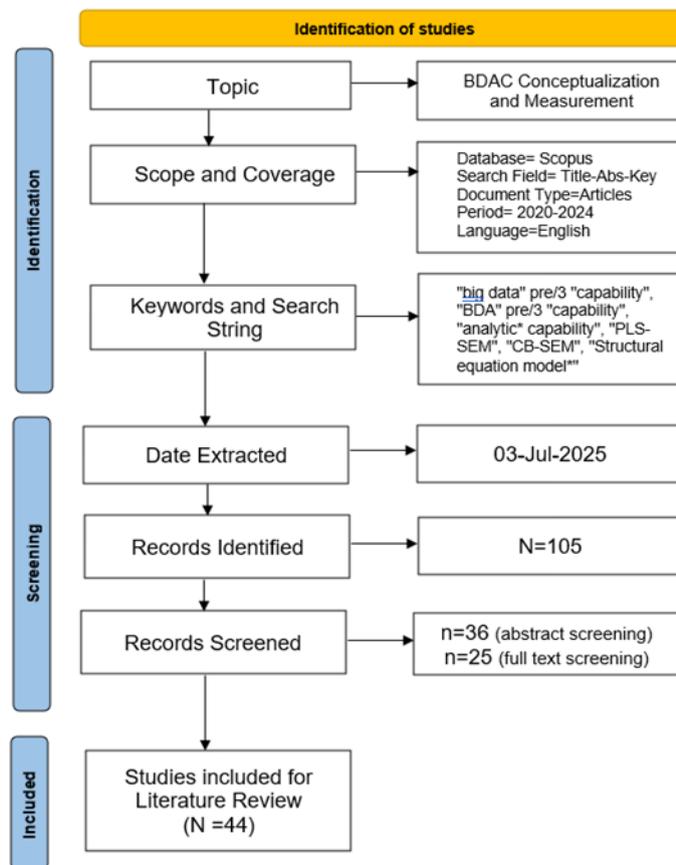


Figure 1 PRISMA diagram of literature identification, screening and selection

Table 2

Inclusion/Exclusion Criteria

Category	Inclusion criteria	Exclusion criteria
Conceptual focus	Explicitly conceptualizes BDAC as an organizational capability (single or multi-dimensional).	Studies on general big data use/adoption without capability conceptualization.
Methodological approach	Employs SEM techniques (PLS-SEM, CB-SEM, AMOS, LISREL) with explicit measurement models.	Studies using only regressions, t-tests, ANOVA, or purely ML/data mining.
Empirical scope	Involves quantitative SEM-based analysis.	Purely conceptual frameworks or qualitative-only studies.

Data Extraction and Synthesis

After screening, data were systematically extracted from 44 selected articles, using a structured coding template comprising over 20 fields that captured both methodological rigor and study context (Tranfield et al., 2003). For each of the 44 studies, bibliographic information (e.g., authorship, year, journal, DOI) and contextual characteristics (e.g., country, industry, unit of analysis, sample size) were first recorded. The conceptualization of BDAC was examined in terms of dimensionality i.e. whether it was treated as single or multidimensional construct. In the case of a multidimensional perspective, the number of dimensions along with their description was also extracted. Measurement model specifications were coded by type (reflective, formative, or hierarchical), and theoretical or empirical justification was also assessed. To assess the methodological rigour, particular attention was paid to validation practices. This included the reporting of factor loadings, AVE, CR, HTMT ratios, multicollinearity checks (e.g., VIF), and the use of advanced techniques such as CTA-PLS. Furthermore, key empirical findings were identified and recorded. This integrated coding and synthesis process enabled a critical appraisal of how BDAC is conceptualized, specified, and validated across the literature and thus highlighting prevailing practices, methodological gaps, and future opportunities for refinement.

Analysis Approach

We adopted a structured, two-stage quantitative and qualitative synthesis strategy to analyse the reviewed studies (Snyder, 2019). First, a quantitative synthesis was conducted to assess the conceptual diversity and prevalence of different measurement model types and to examine the extent to which studies provided theoretical or empirical justifications for their model specifications. We also recorded the use of validation techniques such as Cronbach's alpha, AVE, HTMT, and VIF, based on the nature of the measurement model. Next, a qualitative synthesis was undertaken to interpret patterns that went beyond frequencies. During qualitative synthesis, we critically assessed how well model specification aligned with conceptualization and theoretical underpinnings. It was especially important to look closely at how studies used the established modeling guidelines from key research works (Hafiz Hanafiah, 2020; Jarvis et al., 2003) when choosing between a formative or reflective structure. Thus, these two forms of synthesis together enabled a systematic and interpretive evaluation of measurement modeling practices within the BDAC literature.

Findings

This section presents the findings obtained as a result of analysis and synthesis after review of 44 empirical studies. Quantitative results are meant to summarise prevailing measurement practices, while qualitative findings highlight recurring conceptual and methodological tensions. Thus, these findings together present the current state of the art as well as provide the basis for guiding critical areas for improvement.

Conceptualization of BDAC: A Fragmented Landscape

Our review highlights a fragmented conceptualisation of big data analytics capabilities (BDAC). Data analysis shows that around one-third of studies (34%) treated BDAC as a unidimensional construct. In contrast, two-thirds (66%) adopted a multidimensional perspective. Studies that have used BDAC as a multidimensional construct usually identify dimensions like technology, personnel, and management. From a theoretical perspective,

most studies anchored BDAC within the resource-based or dynamic capabilities views. Only a minority of studies (11%) have incorporated alternative theoretical lenses, such as institutional theory, organisational learning, relational capital, and information processing theory. Overall, the literature demonstrates diversity in both conceptual granularity and underlying theoretical foundations.

Measurement Model Specification Practices

Our analysis shows that BDAC is predominantly specified as a reflective construct. As summarized in Table 3, 39 out of 44 studies (89%) employed reflective first-order models, with a few using reflective–reflective HCM structures (7%) or formative–reflective HCMs (5%). Notably, none of the studies specified purely formative first-order or mixed models.

Table 3
Prevalence of Measurement Model Types

Measurement Model Type	Number of Studies	% of Total
Reflective first-order	39	89%
Reflective–Reflective HCM (2nd-order)	3	7%
Formative–Reflective HCM	2	5%
Formative first-order or Mixed	0	0%

We have also collectively analysed conceptualization and measurement specification, and it was interesting to note that more than half of the studies (24 papers) described BDAC not only as multidimensional but also used first-order reflective models (Table 4). Such combinations generally raise specification-validity concerns, as warned by Petter et al (2007) and Roy et al (2012) about the risks of adopting reflective models for constructs that may be more accurately formative.

Table 4
Conceptual Dimensionality

	Unidimensional BDAC	Multidimensional BDAC
Reflective 1 st order	15	24
Reflective/HCM models	0	3
Formative/HCM models	0	2

Justification of Measurement Choices

A critical component of methodological rigor in empirical research is providing a clear theoretical or empirical rationale for selecting a measurement model. Our synthesis (Table 5) reveals that this aspect is unevenly addressed across studies on BDAC as only 12 out of 44 papers (27%) offered an explicit justification grounded in causal or domain logic. These studies have often cited seminal frameworks such as Jarvis et al. (2003) or Petter et al. (2007) to defend their reflective or formative choices. In contrast, 17 studies (39%) relied exclusively on empirical indicators and statistical validations, such as achieving high factor loadings or satisfactory average variance extracted (AVE). Over one third of studies have provided

minimal or no clear rationale for their selection of measurement specification. As summarized in Table 5, these statistics broaden the concerns of misspecification of measurement models as majority of studies have not only failed to align measurement models with theoretical grounds but also have failed to provide suitable rationale behind this crucial selection decision.

Table 5
Justification of Model Specification

Justification Provided	Number of Studies	%
Explicit theoretical rationale (e.g., causality, domain logic)	12	27%
Empirical justification only (e.g., factor analysis results)	17	39%
Minimal or no justification reported	15	34%

Validation Practices and Methodological Rigor

Across the reviewed studies, core reliability and validity checks were almost universally applied. As summarized in Table 6, all studies reported Cronbach's α and composite reliability to measure internal consistency. All studies have reported average variance extracted (AVE) to assess convergent validity. To test discriminant validity, 95% of studies used Fornell–Larcker criterion while approximately 86% additionally reported HTMT ratios. On the other hand, very thin evidence was observed regarding deeper or alternative assessments of construct validity. In studies, which have specified formative measurement models, multicollinearity assessment through VIF was only examined in 2 out of 5 studies. Similarly, to empirically test the mis-specification, none of the studies has tried to conduct confirmatory tetrad analyses (CTA-PLS) or comparable procedures. Thus, while most studies met established statistical thresholds for reliability and basic validity, advanced examinations of construct distinctiveness and model adequacy remained rare. This potentially limits the confidence in robustness of reported relationships.

Table 6
Validation Practices and Methodological Rigor

Validation Practice	# of Studies	% of Total
Cronbach's α & Composite Reliability (CR)	44	100 %
Average Variance Extracted (AVE)	44	100 %
Fornell–Larcker discriminant validity	42	95 %
HTMT ratios	38	86 %
VIF checks (formative constructs)	2	5 %
Tetrad/alternative-model checks (CTA-PLS, χ^2)	0	0 %

Misspecification Risks and Reported Issues

Out of study sample of 44 articles, none of the study has directly reported any instance of statistical misspecification. Only one study (Barbosa et al., 2024) documented an AVE below the 0.50 threshold, and one reached an HTMT value precisely at 0.90. However, a broader

concern emerges from the widespread reliance on reflective models as even in studies that theoretically depicted BDAC as comprising diverse and non-interchangeable dimensions have opted for reflective model. This practice suggests that some potential misspecifications may remain undetected—not because diagnostics were ignored, but because the chosen models inherently precluded certain risks from being examined. As such, the literature reflects strong adherence to conventional validity metrics, yet leaves open questions about deeper alignment between conceptual frameworks and empirical specifications.

Qualitative Synthesis: Recurring Tensions and Gaps

A major theme that has evolved across the reviewed literature is the disconnect between how BDAC is conceptually framed and how it is operationalized. Based on Resource Based View, many authors portray BDAC as a collection of heterogeneous resources encompassing data, technology, managerial and technical competencies and data-driven culture. Yet they proceed to measure these heterogeneous resources using reflective models and thus implicitly treat these diverse elements as interchangeable reflections of a single underlying construct. This is also mainly associated with the fact that most studies offer thin theoretical justification for their measurement models and have relied heavily on precedent rather than revisiting indicator causality or domain representativeness. Over 90 % of papers justified their approach primarily by citing earlier empirical work and thus have perpetually worsened it by further strengthening the wrong tradition of adopting reflective construct only because others have chosen it. This reliance on historical practices and lack of rigor risks embedding unexamined misspecifications into the literature.

Secondly, though most studies have relied on cross-sectional single-informant surveys for gathering data, but they have rarely examined for common method bias (CMB) using tools like marker variables or Harman's single-factor tests. Only a few studies, such as (Xu & Liu (2024) have adopted multi-source data collection to mitigate these concerns. Encouragingly, the review also reveals early signs of methodological evolutions a minority of recent studies, such as (AL-Khatib & Ramayah, 2023; Ashaari et al., 2021) have begun to experiment with more nuanced analytical approaches like multi-group analyses or hybrid SEM–ANN frameworks to capture complex relationships. However, these advances remain exceptions, with the vast majority of research still anchored in first-order reflective PLS-SEM conventions.

Discussion

The synthesis presented in previous section revealed distinct patterns of conceptualization, measurement and use of methodological rigour in BDAC research. In this section, we interpret these findings in light of ongoing debates on construct modeling and capability theory. We aim to assess what these patterns mean for advancing BDAC theory and improving empirical rigor.

Rethinking the Conceptualization–Measurement Fit

Most of the reviewed studies, acknowledged BDAC as a strategic capability that enables organizations to use data to enhance decision-making, adapt to change, and sustain competitive advantage. Approximately two-thirds of the studies (66%) conceptualized BDAC as a multi-dimensional construct encompassing technological resources (e.g., data infrastructure), human capital (e.g., analytics expertise), and organizational enablers (e.g., data governance, culture). This aligns with established theoretical perspectives such as the

Resource-Based View (RBV) and Dynamic Capabilities View (DCV), which conceptualize capabilities as systems of heterogeneous yet complementary resources. Despite describing BDAC as a composite or multifaceted capability, nearly 90% of the studies applied simple reflective first-order models. Even among studies that used higher-order models, reflective–reflective hierarchical structures were far more common than formative approaches. This pattern suggests a reliance on default modeling practices rather than a model–construct alignment based on causality or domain logic. Such inconsistencies raise important concerns about specification validity and consequently may distort path estimates, inflate relationships, and obscure the unique role of individual dimensions (Hafiz Hanafiah, 2020). In the context of BDAC, this could lead to inaccurate conclusions about which components (e.g., infrastructure vs. skills vs. culture) are truly driving organizational performance. Our review found that nearly one third of the studies provided minimal or no theoretical justification for measurement model specification and instead relied on empirical fit indicators or existing precedents. This “reflect-because-others-did” practice perpetuates unexamined assumptions and may embed misalignment into the literature.

Emerging Rigor—but Gaps Persist

Despite the dominance of reflective models, some encouraging signs of methodological maturation were evident. Almost all studies reported internal consistency and convergent validity using established metrics such as Cronbach’s alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). Discriminant validity checks (e.g., Fornell–Larcker, HTMT) were also reported in the majority of studies. However, advanced validation procedures were less commonly employed as very few studies assessed multicollinearity using Variance Inflation Factors (VIF) in formative models although this is considered as standard diagnostic for assessment of formative outer models (Hair et al., 2020). Likewise, no studies used confirmatory tetrad analysis (CTA-PLS), which is recommended for assessing whether reflective vs. formative structures are empirically supported (Cepeda et al., 2024). These omissions are notable, especially in studies that describe BDAC as a configuration of diverse and causally distinct elements.

Moreover, the reliance on single-informant, cross-sectional survey designs remains a key limitation across the field. While such designs are often practical, they restrict the ability to address common method bias, contextual variation, or temporal evolution of capabilities. Ideally, such concerns like Common Method Bias (CMB) can be assessed using statistical provisions like marker variables and Harman’s test but to a great surprise, very few studies have used these techniques. Only a small number of studies incorporated longitudinal or multisource data. Thus, this limits the generalizability and causal inferences that can be drawn, especially given the dynamic nature of BDAC as a capability that evolves over time and under varying environmental conditions.

Implications for Theory and Practice

Taken together, this study carries clear implications for future scholarship. First, researchers should strive for tighter alignment between conceptual definitions of big data analytics capabilities (BDAC) and their operational specifications i.e. if BDAC is really made up of several different parts, then using formative or hierarchical models might be more suitable. Doing this carefully can lead to more trustworthy results and clearer insights into how each part of BDAC helps organizations. From a methodological standpoint, expanding the validation toolkit by

regular usage of VIF for tests of multicollinearity in formative constructs is important. Similarly, advanced statistical method like confirmatory tetrad analyses (CTA) as well as more robust data collection methods like multi-source longitudinal designs could significantly strengthen empirical claims. Thus, richer designs would help move the literature beyond associational patterns toward more robust causal inferences. For practitioners, as most studies use simpler models, they often do not show which specific capability or resource areas — like technology upgrades versus employee training or data-focused leadership — are most critical. Therefore, harmony between research objectives and chosen measurement model further guide managers on tailoring BDAC investments to their specific strategic goals and thus can give managers sharper guidance on where to focus their efforts.

Limitations and Future Research

Like all reviews, several limitations warrant attention. First limitation is temporal scope of the review which spans only past 5 years. Secondly, only empirical studies which have used some form of structural equal modeling techniques were included in this review. Third, the review is confined to peer-reviewed journal articles indexed in Scopus within business-related disciplines, omitting relevant contributions from other domains or grey literature. Lastly, despite structured coding, interpretations of model alignment and validation rigor involve some level of subjective judgment.

More broadened review study can cater these limitations and can provide more insights on this critical area of research. Future research should adopt more methodical approach for selection of measurement models and scholars should align their choices in accordance with their study motivation, aims and objectives. Similarly regular demonstration of justification for selection of these specification choices can bring more maturity in this area of research. Moreover, to broaden the methodological lens, there is need to include mixed methods and longitudinal studies in BDAC research. There is also a need for stronger construct validation practices and usage of advance statistical measures available statistical toolkits.

Conclusion

Given the strategic importance of big data in today's data-driven environments, this review was motivated by growing interest in how big data analytics capabilities (BDAC) are defined and measured across empirical research. Literature was collected using a transparent and rigorous search, screening and selection methodological process. By synthesizing patterns across recent studies, we observed that although BDAC is often described as a multidimensional resource, most studies rely on reflective measurement models without strong justification. Moderate level methodological rigour was observed as primary validation and reliability measures have been undertaken whereas advance statistical techniques are rarely used. While our sample of 44 empirical articles offers valuable insight, it represents only a portion of the broader literature. Therefore, findings of the review should be interpreted with care. None the less, the review highlights that considering the conceptual diversity present in BDAC research, scholars should critically align measurement approaches with theoretical foundations. For practitioners, more transparent and theoretically grounded models could help them in identification of aspects of BDAC—such as infrastructure, skills, or culture—which may warrant greater investment to support strategic goals.

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