

Looking Ahead: Business Intelligence & Analytics Research in the Post-Pandemic New Normal

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Abstract

The COVID 19 black swan event has disrupted every aspect of life in unprecedented ways, causing organizations to scramble to effectively sense and respond to the tumultuous business environment. Business intelligence and analytics (BI&A) capability has gained attention as a key weapon in the arsenal needed to combat turbulent times and to adjust to the post-pandemic new normal. Post-pandemic BI&A trends point to changes in organizational priorities for BI&A infrastructure that influence the traditional view of BI&A architecture and its role within an organization. As a result, new challenges and opportunities are emerging. This paper identifies and examines twelve key post-pandemic BI&A trends from industry practice and six major research themes. It also proposes an initial set of research questions that could inspire future research in BI&A in the post-pandemic new normal.

1. Introduction

The Covid-19 pandemic has created unprecedented challenges for individuals, organizations, societies and the whole of humanity. Its disruptive impact on organizations is expected to be far-reaching. For example, a recent survey of IT leaders by IDG reported that 55 percent of the respondents delayed or cancelled at least one technology project in response to the pandemic [30].

While various challenges are likely to continue for years to come, organizations are now starting to turn their attention to the post-crisis future. For instance, the same IDG report indicates that despite cutbacks in overall IT investments, 32 percent of IT leaders accelerated or initiated business intelligence and analytics (BI&A) projects as a response to the disruption from the pandemic. This is because “[d]ata, and what we can do with data is the key to this transformation” [30:1]. Similarly, PWC’s Global Crisis Survey 2021

[51] confirmed that data-driven organizations were able to handle the crisis much better compared to others.

Focusing on the organizational context, in this paper we aim to investigate the role of BI&A in what is now collectively termed *the post-pandemic new normal*. While acknowledging very diverse and sometimes mutually inconsistent interpretations of the terms business intelligence (BI) and business analytics (BA) by different industry and research communities, we use an all-encompassing umbrella term BI&A. Following Chen et al. [10], we consider BI&A to consist of “the techniques, technologies, systems, practices, methodologies, and applications that analyze critical business data to help an enterprise better understand its business and market and make timely business decisions.” [10:1171]. This interpretation of BI&A is inclusive of different types of data, including big data (BD). Henceforth, this paper uses the all-encompassing term BI&A, when referring to BI, BA and/or BDA.

Taking a future-oriented view, our research aims to contribute to a better understanding of the role of BI&A in the post-pandemic new normal from the organizational perspective. In this paper we focus on the following specific research questions:

RQ1: What are the relevant post-pandemic BI&A-related trends described in the practitioner literature?

RQ2: What does the new post-pandemic normal look like for the BI&A discipline, in terms of new and/or existing research themes and directions?

To answer the first research question, we adopted a recently proposed BI&A framework by Phillips-Wren et al. [49] and used it to map and analyze the practitioner literature on post-pandemic trends related to BI&A.

To answer the second research question, we used the main findings from our analysis of the practitioner literature to articulate a number of broader BI&A-related research themes and position them in a wider body of multidisciplinary literature. This in turn enabled us to reflect on what does it all mean for BI&A research in the post-pandemic new normal. Our research findings

invite the BI&A research community to examine new research directions and also rethink some of the foundation concepts, including the role of the BI&A architecture framework as well as higher-level concepts such as business value of BI&A and the task-oriented nature of decision making by individual BI&A users.

The paper is organized as follows. Section 2 introduces the foundational BI&A framework. Section 3 describes our research method. The BI&A post-pandemic trends identified from the practitioner literature are discussed in Section 4. This is followed by our discussion of higher-level themes in Section 5. The final section offers concluding reflections about the BI&A field in the post-pandemic new normal.

2. Foundations

The aforementioned theoretical framework by Phillips-Wren et al. BDA [49] is an extension of the foundation BI&A framework by [67], which is well-known and widely used in the BI&A discipline. Most importantly for our research, the framework has been used by other researchers to understand the previously emerging trends, such as big data [67] or BDA [49] as well as to connect the new BI&A trends with the foundations of the BI&A discipline [48]. Figure 1 depicts the architecture framework adopted in our research, which is based on Phillips-Wren et al.'s framework. As in the original framework which the authors call a 'process-level architecture' the grey shaded components at the bottom depict the process from data sourcing up to data usage while the upper component encompasses the organizational context with all its facets.

3. Research method

A literature review of BI&A-related articles published since 2020 was conducted to identify post-pandemic BI&A trends. Consistent with the research questions, we focused on articles that are forward looking and describe trends, challenges and opportunities for BI&A in the post-pandemic new normal. Articles related to the role and use of BI&A during pandemic, such as those related to digital tracing or other applications used for organizational response to the pandemic were eliminated. Instead, the study focused on the future of BI&A practices and implementations within organizations in the post-pandemic era.

Keywords searched included business intelligence and analytics combined with the term post-pandemic trends. The literature review, which was based mostly on practitioner literature and trade press, included research reports from consultancy practices such as McKinsey and Gartner, internet articles and magazines. It led to the identification of twelve trends listed in Table 1. These trends were next mapped onto the BI&A architecture framework to indicate which components of the BI&A architecture will be impacted by the adoption of the trends. The trends were further examined in an iterative process leading to the identification of six higher level research themes and an initial set of research questions on BI&A in post-pandemic future.

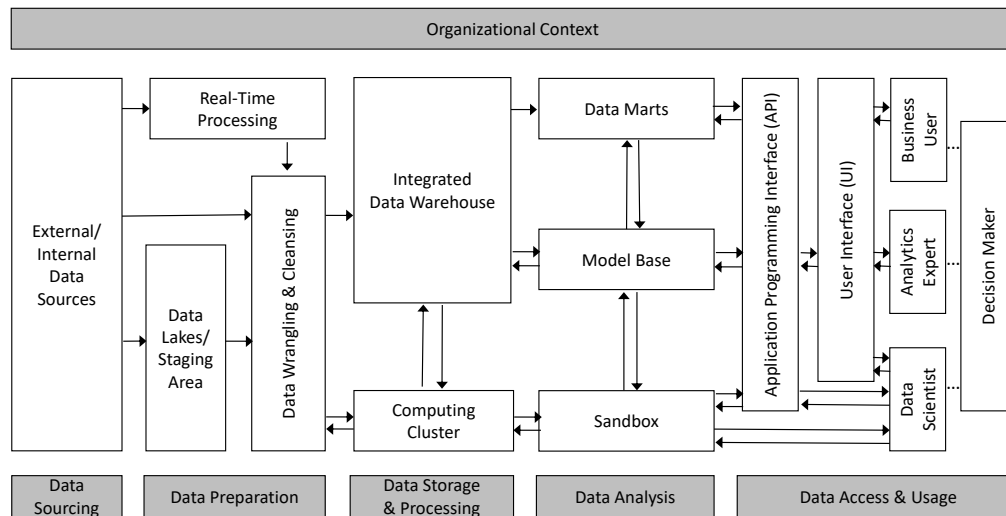


Figure 1. BI&A architecture framework (based on [48])

4. BI&A trends post-pandemic

This section offers a number of BI&A post-pandemic trends that we identified by analyzing the collected literature. The list is by no means complete but it is indicative of the current industry discourse in the BI&A space. The first two columns of Table 1 list the trends (column 1) and relate them to the components of the BI&A architecture framework (column 2).

(1) New data pipelines: Data pipelines exist to infuse different sources of data to existing BI&A storage for data driven decision making. They ingest data from data sources of interest to the organization via an extraction, transformation and loading paradigm to the data infrastructure in BI&A such as a data lake or a data warehouse [33]. However, organizations are now discovering that new data sources are needed for decision making in a rapidly changing environment. Consequently, historic data existing in BI&A data infrastructure have less value for predictive analytics [28]. According to Tom Davenport, the pandemic has hastened company adoption of external data sources as the past is no longer a guide to the future [8]. The new data sources may require the formation of new partnerships with other firms in the supply chain or third party data brokers. As a result, incorporating new data pipelines in the post-pandemic environment has become an important trend for organizations. This may require recalibration of data ingestion processes currently used in an organization such as manual, batch or real time [2].

(2) Hyperautomation: The need for faster data ingestion through automation has become ‘a condition for survival’ rather than an option for post-pandemic BI&A according to [21]. Organizations moving to accelerate digital transformation are increasing the demand for hyper-automation, an approach that enables rapid identification, vetting and automation of data and content ingestion. As a result, Gartner expects this market to reach 596 billion in 2022. Technologies that enable rapid ingestion of data through automation such as robotic process automation, low code and artificial intelligence have become a key enabler of faster decision making in organizations in the post-pandemic disruptive marketplace [52]. Data content ingestion can include tools such as signature verification tools, optical character recognition, document ingestion and conversational artificial intelligence (AI). It will enable companies to become more agile and gain cost savings by automation of manual data ingestion processes.

(3) Embedded analytics: Speed in use of analytics for decision making has taken on new meaning in the post-pandemic era. This faster data driven process is leading organizations to embed analytics into applications at most user levels [22]. It will enable

shorter information processing cycles from running data analysis to delivering actionable insights. Embedded analytics would be accessible to users ranging from customers, to frontline employees and upper management to simplify generating insights as part of their day to day operations [53]. This type of analytics requires more emphasis on a culture of self-service among analytics users now extending to customers of the organization [45]. Edge analytics, a mode of decentralized data analysis where captured data streams (typically IoT data) are analyzed within an application is one example of embedded analytics that is enabling real-time front-line decision making [24, 31].

(4) Model recalibration: The onset of the pandemic created challenges for organizations to make sense of the analytics models that had been previously honed to near perfection using historic data with AI and machine learning [28]. With the dramatic change in the economic environment came model drift as pre-pandemic data were deemed largely ineffective to predict current market changes [50]. For example, the pandemic brought about inaccurate demand projections based on historic data that led to shortages in the supply chain. Model monitoring requires a different approach that is less focused on model refinements based on existing data that is currently in production. Recalibration efforts require a holistic view that considers the accuracy of the model input data sources, model assumptions and the need for new expansive data sources [6]. In the short term organizations have begun to examine descriptive analytics as a means of assessing current conditions for decision making with a heavier emphasis placed on human judgement [8].

(5) Small and wide data: One of the main challenges for BI&A in the post-pandemic world is the deterioration in value of large amounts of historic data. In the near term, organizations are looking to small data based descriptive analysis for decision making [55]. Small data compared to big data describe data sets with less than 1000 records. With less data to feed into analytics models, organizations are turning to different approaches to analyzing small data such as real time forecasting [35]. Wide data as opposed to big data, involve the integration of a wide range of structured and unstructured disparate data sources [44]. According to Gartner, the application of analytic techniques for small data and wide data can offer useful insights reducing dependency on large data sets [23].

(6) Rapid analytic builds: In times of market uncertainty like the pandemic, analytics can provide support for urgent organizational tasks such as demand forecasting or identifying supply chain shortages. Companies, with or without an existing analytic infrastructure, have adopted rapid analytic builds to

meet urgent post-pandemic decision making needs [28]. The acceleration in building viable BI&A solutions to meet critical needs requires a different approach to BI&A implementation that is more fluid and flexible [12]. Technologies that facilitate containerization of pools of infrastructure resources to meet the need for rapid analytic workload deployment give organizations the agility to deliver insights where required [35, 54]. Principles of modularization which leverage components from multiple data, analytics and AI solutions are helping to build BI&A applications as needed [23]. Organizations are adopting this BI&A trend to be more effective in the near term [28].

(7) Cloud based analytic capabilities: Having a cloud based BI&A presence as part of an organization's BI&A infrastructure is an ongoing effort in the industry that has seen rapid growth during the pandemic. Consequently, its importance to an organization's essential BI&A infrastructure has become solidified. Many trends that were initiated in the near term in reaction to the pandemic, such as remote work, rapid analytic builds, require cloud capabilities. The Leaders Research Report by IDG [30] reveals that cloud technology enabled critical innovation during pandemic. 78 percent of survey respondents of the report (i.e., over 2000 IT leaders) indicated that they believe BI&A capability is critical to their choice of cloud solution purchase. With confirmation of its value, organizations are now more purposefully moving to adopt cloud BI&A capabilities as a means of achieving a scalable, reliable and cost effective BI&A solution [7]. Specifically, earlier hesitancy to adopt public cloud solutions such as Amazon AWS has slowly dissipated with nine out of ten companies accelerating cloud adoption, according to the 10th annual Flexera 2021 State of the Cloud Report [42]. Consequently, Gartner predicts that public cloud services will be essential for 90 percent of BI&A innovation by 2022 [15].

(8) Centralized data and tool standardization for decision making: It is generally accepted that decentralized structures and processes enable an organization to become more responsive. Greater autonomy at the front lines to take action from insights through user empowerment is touted as an important trend in post-pandemic BI&A. Henke et al. [28] suggest that enabling faster response and action requires centrally driven standardization of data and tools. Though data capture may differ across dispersed units within an organization, central standardization and common tools give the ability to gain quick insight into key organizational questions such as end to end visibility of inventory or supplier deliveries across the globe. Creating integration of key data elements that impact different functional units or geographically dispersed business units are critical in times of

disruption. Identification of these data elements and rapidly creating standardized data ingestion and data or analytics model consistency are typically tainted with new socio-technical challenges. Consequently, organizations are increasing their market responsiveness by incorporating high level standardization and common tool implementation.

(9) Operationalization of analytics: In spite of significant investments in technology, organizations are still struggling to operationalize BI&A. As Stackpole [62] recently reported: "Companies are clearly sold on analytics, but not so clear about what it means or what it takes to operationalize them" (p. 1). While organizations are taking different approaches to BI&A operationalization, it is "the exercise of incorporating analytics into enterprise decision making processes at scale, that is proving to be the most difficult" [62:1].

Moreover, by embedding BI&A into business processes (BPs), organizations achieve process improvements that are measurable [34, 63]. Process automation, efficiency, speed and cost reduction are often cited as the most important outcomes of BI&A operationalization focused on BPs.

While these are still important, the notions of 'improvement' need to be re-examined and reframed. For example, improved safety and wellbeing are now being recognized as important objectives of process improvement. BP improvement for safety and wellbeing may result in less efficient and more expensive processes. Such improvements may be temporary or 'permanent until further notice'. They often need to be implemented at a rapid speed and in response to the actual and potential health hazards. This in turn requires greater speed and agility of BI&A used to inform, support and evaluate these rapid process improvements.

(10) BI&A skills: Even before COVID 19 pandemic, there was a growing recognition of the so-called myth of 'data science unicorns' [4] – that is unrealistic expectations about the knowledge and skills of data scientists and other related professionals (e.g. data specialists, analytics experts). As Zhang [68] explains, "the data science unicorn is a somewhat mythical person who is a leader in data science, technology and business" (p. 1). Thus, their skills and knowledge were expected to include very distinct disciplines, such as statistics, mathematics, IT, AI, programming, data management, business and subject matter expertise and contextual understanding of data [4, 68]. However, such professionals exist "only rarely, if at all" [14:1].

In the post-pandemic world of the new normal, previously well-defined BI&A roles are expected to evolve, shaped by organizational needs and in response to new environmental conditions. For example, industry analysts argue that development of T-shaped skills

becomes a priority for BI&A professionals [25]. While the concept of T-shaped professionals has been discussed for decades, it has been revisited in the context of BI&A. These T-shaped “analytics professionals will require broad knowledge of the overall architecture (the top of the ‘T’) and deep knowledge in one or more specific areas (the leg of the ‘T’) – emphasizing both breadth and depth” [25: 1] of their skills and knowledge.

Another important trend related to BI&A skills is upskilling. For the future workforce, Cowell [13] argues, “upskilling in data and analytics is imperative now” (p. 1). This is due to unprecedented and accelerated changes that are expected to result in “a profound transformation in both the type and nature of future jobs” [13:1]. While this trend of upskilling started before the pandemic crisis, it got accelerated over the past two years due to massive job losses and once-in-a-generation business and societal changes.

In addition to upskilling, the post-pandemic new normal is also characterized by ‘reskilling’. For example, according to a recent industry report by McKinsey [41], organizations are now reskilling their existing workforce as a way of closing their talent gaps. This is particularly relevant for BI&A skills due to their perennial shortage that worsened during pandemic.

(11) Work in collaborative teams: Gone are the days of BI&A users working in isolation and on task-oriented decision making. Industry experts argue that in the post-pandemic new normal, organizations need to focus on building and deploying small, focused, cross-functional, multidisciplinary teams of various experts with diverse skill sets [14, 51]. Moreover, these teams need to be spread-out across and embedded in the enterprise. “Having one fast, agile team is helpful”, De

Smet et al. [59] argue, “but having many of them across an enterprise, and enabling them with the right structures, processes, and culture, makes it possible for the entire system to move faster” (p. 5). Working in multi-disciplinary teams, in turn, requires BI&A professionals to acquire new skills and capabilities [14].

(12) Dark side of BI&A: The post-pandemic new normal has intensified previously-held conversations about the unintended consequences of BI&A. In particular, harm caused by algorithmic decision making powered by analytics and AI. Society-wide datafication, algorithmic bias, discrimination, surveillance and predictive management of human lives are some of many reported consequences of the widespread use of analytics, big data and AI. While some BI&A applications are appropriate in one industry context (e.g. e-commerce) the same type of applications may have devastating effects when used in other contexts. For example, predictive analytics are widely and successfully used in marketing to predict customer churn or recommend new products. The same type of BI&A is now used in various human services, such as predictive policing, social welfare and predictive HR. The unintended consequences of these applications are now recognized as human-rights issues [36] - see for example [11, 29].

Growing concerns about the unintended harmful effects prompted new regulations to limit the use of BI&A in different contexts and for different purposes – see for example [17]. Similar regulations are expected to follow across the world. Consequently, responsible use of data, analytics and AI has already been recognized as one of the top ten trends for organizational ‘post-pandemic reset’ [20:1].

Table 1. BI&A related trends, themes and initial research questions

Trends from practitioner world	BI&A component impacted (cf. Fig. 1)	Research questions to consider	Broader research themes
(1) New data pipelines	<ul style="list-style-type: none"> Data sourcing Data preparation Data storage and processing 	<ul style="list-style-type: none"> How to identify potential new data pipelines in fast changing market conditions? What technologies and processes will support the rapid acquisition of new pipelines? 	<ul style="list-style-type: none"> Novel data perspective Digitalization New manifestations of BI&A value
(2) Hyperautomation	<ul style="list-style-type: none"> Data preparation 	<ul style="list-style-type: none"> How will existing data preparation and loading processes as well as metadata management practices need to change to enable hyperautomation? What data types, sources and/or business processes are best suited for hyperautomation? 	<ul style="list-style-type: none"> Novel data perspective Digitalization
(3) Embedded analytics	<ul style="list-style-type: none"> Data analysis Data access & usage 	<ul style="list-style-type: none"> What tools enable embedded analytics in existing applications? Which business processes are best candidates for embedded analytics? 	<ul style="list-style-type: none"> Agility & speed Digitalization New manifestations of BI&A value
(4) Model recalibration	<ul style="list-style-type: none"> Data analysis 	<ul style="list-style-type: none"> What is the process involved in model audit? How to detect model drift and need for recalibration? 	<ul style="list-style-type: none"> Agility & speed Digitalization
(5) Small and wide data	<ul style="list-style-type: none"> Data preparation Data storage & processing Data analysis Data access & usage 	<ul style="list-style-type: none"> What capabilities can an organization develop and use to build confidence in small data use cases with less data? How to identify sources of small and wide data in rapidly changing environments? 	<ul style="list-style-type: none"> Novel data perspective

(6) Rapid analytic builds	<ul style="list-style-type: none"> Data analysis Data access & usage 	<ul style="list-style-type: none"> How should governance structures be put in place to support rapid analytic builds? What type of BI&A analytic tools would support rapid builds? 	<ul style="list-style-type: none"> Agility & speed Digitalization
(7) Cloud based analytic capabilities	<ul style="list-style-type: none"> Data preparation Data storage & processing 	<ul style="list-style-type: none"> How does an organization discern what data to take to the cloud? How has organizational perception of cloud related security challenges changed in the post-pandemic new normal? 	<ul style="list-style-type: none"> Novel data perspective
(8) Centralized data and tool standardization for decision making	<ul style="list-style-type: none"> Data preparation Data storage & processing Organizational context (governance) 	<ul style="list-style-type: none"> How can centralization and standardization be achieved in the rapid pace post-pandemic new normal? How does BI&A maturity impact the implementation of this trend? 	<ul style="list-style-type: none"> Novel data perspective
(9) Operationalization of analytics	<ul style="list-style-type: none"> (Process-related) data preparation and data storage & processing Organizational context (governance extended to include governance of business processes) 	<ul style="list-style-type: none"> How to use BI&A to improve BPs for emerging post-pandemic needs (e.g. resilience, agility, safety, well-being)? What does 'improvement' of BPs mean in the post-pandemic new normal and how to measure it? 	<ul style="list-style-type: none"> Agility & speed Digitalization Collaboration of empowered decision makers New manifestations of BI&A value
(10) BI&A skills	<ul style="list-style-type: none"> Data access & usage 	<ul style="list-style-type: none"> What are effective methods and strategies for development of BI&A skills, upskilling and reskilling? What new BI&A skills and capabilities are required in the post-pandemic new normal? 	<ul style="list-style-type: none"> Collaboration of empowered decision makers Responsible deployment of BI&A in different contexts
(11) Work in collaborative teams	<ul style="list-style-type: none"> Organizational context (governance) Data access & usage (the need for data sharing) 	<ul style="list-style-type: none"> What governance process should be in place to create effective interdisciplinary collaboration? What kinds of collaboration are required for the post-pandemic new normal and how to facilitate them? 	<ul style="list-style-type: none"> Agility & speed Collaboration of empowered decision makers
(12) Dark side of BI&A	<ul style="list-style-type: none"> Organizational context (the need to consider wider organizational, industry, legislative and societal contexts) Data access & usage 	<ul style="list-style-type: none"> How to detect, prevent and mitigate harmful effects of BI&A? How to empower decision makers and organizations to develop and adopt practices that encourage the responsible use of BI&A? 	<ul style="list-style-type: none"> Responsible deployment of BI&A in different contexts Collaboration of empowered decision makers

5. Discussion: BI&A in the post-pandemic world

The following BI&A-related themes have been articulated by placing the observed BI&A practitioner trends in the context of the wider multidisciplinary academic literature. In so doing, we also identify prior streams of literature that could be helpful in addressing future BI&A research challenges in the post-pandemic normal. Table 1 relates the practitioner trends to research themes and lists initial research questions to inspire future research.

(A) Speed and agility: The ability of BI&A to facilitate organizational agility under dynamic market conditions has been studied in the pre-pandemic literature [5]. Specifically, the value of BI&A to the sensing process needed to achieve agility is touted in past literature [26]. By creating data driven insights to

identify opportunities and threats, BI&A can enhance the sensing process required to achieve organizational agility [3]. Several trends, related to enhancing the ability to sense and respond rapidly to changing market conditions, were described in very recent BI&A practitioner literature, including rapid analytic builds, recalibration of existing models for faster decision making, embedded analytics at the edge and increased cross functional collaboration. All of these trends enable quicker access to data and better insights.

Past studies suggest developing a technical BI&A infrastructure to enable sensing for organizational agility is not the main challenge for organizations attempting to adopt BI&A for agility [47]. Rather, the greater challenge lies in the social political idiosyncrasies in the organizational context that may hinder or slow reaction and action to BI&A insights. The BI&A trends that emphasize agility also suggest the

importance of organizational context and culture to enable fast reaction and action to data driven insights [66]. For example, quick cross functional collaboration for BI&A requires a shared open culture and mindset across organizational users that leads them to distribute insights and act collectively. Similarly, embedded analytics at the edge requires users in the front lines to be empowered to find and respond to insights rapidly in line with company goals. Facilitation of these actions is influenced by governance, culture and the wider socio-political context of an organization. While in the past, contextual factors were often a barrier to agility, the pandemic appears to have created momentum in the adoption of agility principles among some organizations [28]. Gartner describes the need for a ‘composable business architecture’ within the entire organization to create structural changes that would enable fluid and flexible responses to data driven insights [35].

(B) Digitalization: Digitalization has received considerable attention by academics and practitioners alike in the past few decades as an important trend that enables competitive advantage. During the pandemic, the value of digitalization became evident as organizations that were able to successfully operate during lockdown were those with greater digitalization [56]. The pandemic has hastened more organizations to engage in digitalization. According to Twilio, 79 percent of organizations state that the pandemic increased their budget for digital transformation [32]. Those who had previously merely considered incorporating digital resources to their business model have begun ramping up digitalization initiatives to better face disruptive market conditions [58]. Post-pandemic BI&A trends point to companies placing greater emphasis on automation of data collection and decision making through the increased adoption of AI and machine learning algorithms [61]. These trends enable digitalization which in turn can lead to long term digital transformation.

However, the pandemic has also revealed complications in the adoption of BI&A technologies for digitalization [18]. For examples, AI algorithms that were self-correcting and near perfect in predictive accuracy under normal market conditions failed to effectively support business operations such as the supply chain management [27]. Thus, as other BI&A trends suggest, the audit and recalibration of existing BI&A decision models and the incorporation of new data sources are needed to enable digitalization in the post-pandemic world. The BI&A ecosystem that previously created digital transformation [46] needs a modification to incorporate these new trends in light of the COVID 19 ahistorical event.

(C) Novel data perspective: Novel data trends are suggesting that existing data related BI&A practices

must evolve. As the pandemic and subsequent lockdown created ripple effects in the global economy, historic data began to lose its significance as a means of useful business insights in the near term [8]. Organizations are still attempting to find alternative solutions to compensate for the loss in relevance of existing data in organization. There is still much to be learnt about how to acquire and use data more effectively to meet decision making needs in the post-pandemic world [57]. New data pipelines may need to be combined with small and wide data to replace the historic large data sets in existing data warehouses and lakes. The more traditional means of sourcing data for BI&A require enhancement through trends such as data hyper-automation to enable more real time sensing for data driven decision making. Cloud is now a required option among other traditional options to provide BI&A capability within organizations. Concurrently, organizations are attempting to adopt standardization across tools and processes for BI&A in adopting these new trends. Moving beyond existing historic data for analytics as well as that of traditional data processing and sourcing with new BI&A trends described here, presents a novel data perspective for BI&A development in organizations.

(D) Collaboration of empowered decision-makers: Organizations are emerging from the pandemic crisis with newly-established practices of collaborative decision-making by multidisciplinary teams across functional and organizational silos [51, 59]. This in turn has several important implications for BI&A research. First, for decades there has been a focus on individual decision makers of BI&A. This focus is also evident from the BI&A foundation architecture framework, with individual decision makers in the singular roles depicted on the right of Figure 1. Yet, sharing of analytical insights among decision makers with their experiential and contextual knowledge is found to lead to a more sustainable BI&A-related competitive advantage [37].

Second, the complexity of the problem space is such that the expertise held by multidisciplinary teams is required. Prior research on cross-disciplinary collaboration offers some insights about strategies and theoretical foundations for such a collaboration, for example the role of boundary spanners and/or boundary objects [9]. In the post-pandemic new normal, the complexity of today’s BI&A environments, incomplete data, and above all, the high-stake nature of many decisions, often made under pressure, all call for further BI&A related research on collaboration in BI&A-focused multidisciplinary teams that we know very little about.

Third, the post-pandemic world requires us to re-consider who is a decision maker. While prior research

did emphasize different BI&A roles, see for example [67], the post-pandemic new normal will amplify the need to consider decision makers even further [14]. The front-line decision-makers have been long recognized as an important category of BI&A users, due to their experiential knowledge gained from their interactions with customers/patients/clients. In addition to improving their knowledge and skills, it is also important to recognize and enable their empowerment in a particular organizational context. This in turn opens a very interesting research direction focused on empowerment of decision makers using BI&A to make ethical and value-driven decisions in chaotic organizational decision-making environments [60].

(E) Responsible deployment of BI&A in different contexts: New opportunities created by BI&A in the post-pandemic new normal are often linked to improved efficiency and job automation made possible by automated algorithmic decision-making using analytics and big data. At the same time, there is a growing awareness of the associated unintended harmful effects for individuals, organizations and society at large [1, 38, 43]. When coupled with automated decision making, the consequences of BI&A, in particular predictive analytics applied to datified humans [19], go beyond commonly-discussed privacy and security [40]. The growing recognition of these harmful effects as issues of social justice [16, 36, 39] requires further research focused on new conceptual tools and theorizations in BI&A, beyond currently used ethics frameworks, principles and guidelines.

Furthermore, a number of governments and other legislators have announced new policies and measures, including new guidelines, frameworks, laws and regulations. Examples include US Government Accountability Office [64] or the most recent EU Commission's proposal for a regulation of AI systems use, which include data and advanced analytics [17].

These important developments have several important consequences for BI&A research in the post-pandemic new normal. First, they emphasize the importance of contexts, within which BI&A is deployed. These include organizational, industry, societal and even legislative contexts. Second, they highlight the need for responsible deployment of BI&A in a particular context, which may include the preventative and mitigating strategies for the unintended harmful effects of BI&A.

(F) New manifestations of BI&A value: The new post-pandemic normal also requires reflection on the notion of the value of BI&A. The term BI&A indicates its use in business for the purposes of business value creation. This value is typically manifested as improved efficiency, cost reduction and a more sustainable competitive advantage created through various BI&A

value creation mechanisms [65]. While these manifestations of value have been considered in the industry and research literature now for decades, in the post-pandemic new normal, it is necessary to consider new manifestations of BI&A value. They include, for example, organizational resilience, faster transformation to a new business model, faster adaptation to the environmental changes or simply organizational survival in the new normal. This in turn opens new research directions related to novel mechanisms of BI&A value creation in the post-pandemic new normal, or even re-thinking of the very term Business I&A.

6. Conclusions and future opportunities

Having devastated many aspects of life and society, the COVID-19 pandemic has led organizations to rethink fundamental aspects of their structure and processes needed to meet the post-pandemic new normal. Our analysis of the trends and their impact on architectural components suggest that there are potential extensions, revisions and reinterpretations that can be made to the architecture as indicated in the second column of Table 1. Moreover, the high level themes that rose from the trends suggest that BI&A architecture should become an integral part of the organizational context when facing and in the aftermath of atypical disruptive events rather than be considered as an isolated technology infrastructure. Further empirical research is required to determine which of the identified trends had occurred pre-pandemic, were intensified during pandemic or are just starting to emerge in the post-pandemic new normal.

To build resilience as well as to react and act strategically in unprecedented times, BI&A in the post-pandemic must be embedded to the organizational fabric to shape and to be shaped by organizational practices. This evolved view of BI&A suggests new research opportunities for academics to investigate the what, why and how of BI&A capability in the post-pandemic new normal.

Echoing the words of De Smet and colleagues [59], we argue that the evolved view of BI&A also requires courage and a new mind-set to come together fast. This research is our attempt to pave the way.

7. References

- [1] Alston, P., *Report of the Special rapporteur on extreme poverty and human rights*. Report. UN General Assembly. Report id A/74/493. 2019.
- [2] Amare, M.Y., and S. Simonova, "Learning analytics for higher education: proposal of big data ingestion architecture", *SHS Web of Conferences* 92, 2021.

- [3] Barlette, Y., and P. Baille, "Big data analytics in turbulent contexts: towards organizational change for enhanced agility", *Production Planning and Control*, 2020. <https://doi.org/10.1080/09537287.2020.1810755>
- [4] Baškarada, S., and A. Koronios, "Unicorn data scientist: the rarest of breeds", *Program* 51(1), 2017, pp. 65–74.
- [5] Bawack, R.E., and M.O. Ahmad, "Understanding business analytics continuance in agile information system development projects: an expectation-confirmation perspective", *Information Technology and People*, 2021. <https://doi.org/10.1108/ITP-10-2020-0681>
- [6] Berthold, M., "Data science in a post-COVID world", *VentureBeat*, 2021. <https://venturebeat.com/2021/05/01/>
- [7] Blumstein, H., "New Research: What ITDMs Want From Their Cloud Providers, Post Pandemic", *Forbes*, 4 April 2021.
- [8] Brown, S., "How COVID-19 is disrupting data analytics strategies", *MIT Sloan*, 2021. <https://mitsloan.mit.edu/>
- [9] Carlile, P.R., "Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries", *Org. Science* 15(5), 2004, pp.555–568.
- [10] Chen, H., R.H.L. Chiang, and V.C. Storey, "Business intelligence and analytics: From big data to big impact", *MIS Quarterly* 36(4), 2012, pp. 1165–1188.
- [11] Constanza-Chock, S., "Design Justice", *Cambridge: MIT Press Open*, 2020.
- [12] Costello, K., and M. Rimol, "Gartner Says Organizations Should Strive for Composability to Be Resilient.", 19 Oct. *Gartner*, 2020. <https://www.gartner.com/en/newsroom/press-release>
- [13] Cowell, M., "Upskilling in Data and Analytics is Imperative Now", *QuantHub*, 2020. <https://quanthub.com/upskilling-imperative/>
- [14] Davenport, T., "Beyond unicorns: educating, classifying and certifying business data scientists", *Harvard Data Science Review* 2(2), 2020.
- [15] Davis, J., "Top 10 Data and Analytics Trends for 2021", *InformationWeek*, 14 Nov. 2020.
- [16] Dencik, L., A. Hintz, J. Redden, and E. Treré, "Exploring Data Justice: Conceptions, Applications and Directions", *Inf. Comm. and Soc.* 22(7), 2019, pp. 873–881.
- [17] EU, "Proposal for a Regulation laying down harmonized rules on artificial intelligence", EU Commission", 2021, pp. 1–107. <https://digital-strategy.ec.europa.eu/en/library>
- [18] Faraj, S., W. Renno, and A. Bhardwaj, "Unto the breach: What the COVID-19 pandemic exposes about digitalization", *Information and Organization* 31(1), 2021.
- [19] Galliers, R.D., S. Newell, and G. Shanks, "Datafication and its human, organizational and societal effects: The strategic opportunities and challenges for algorithmic decision-making", *Journal of Strategic Information Systems* 26(3), 2017, pp. 185–190.
- [20] Gartner, "Gartner Top 10 Trends in Data and Analytics for 2020", 2020. <https://www.gartner.com/smarterwithgartner/gartner-top-10-trends-in-data-and-analytics-for-2020/>
- [21] Gartner, "Gartner Forecasts Worldwide Hyperautomation-Enabling Software Market to Reach nearly \$600 Billion by 2022", 28 April 2021. <https://www.gartner.com/en/newsroom/press-releases>.
- [22] Geoff, T., "Want Post-Pandemic Business Success? Embedded Analytics is the New Normal", *Qlik.Com.*, 2020. <https://www.qlik.com/blog/want-post-pandemic-business-success-embedded-analytics-is-the-new-normal>
- [23] Goasduff, L., "Gartner Identifies Top 10 D&A Technology Trends for 2021", 16 March *Gartner*, 2021. <https://www.gartner.com/en/newsroom/press-releases/>
- [24] Golzarjannat, A., P. Ahokangas, M. Matinmikko-Blue et al. "A business model approach to port ecosystem", *Journal of Business Models* 9(1), 2021, pp. 13–19.
- [25] Hagerty, J., "T-Shaped Skills Development is a Priority for Analytics & BI Professionals", *Oracle Analytics Advantage*, 16 July 2020.
- [26] Hassna, G., and P.B. Lowry, *Big data capability, customer agility, and organization performance: A dynamic capability perspective*, Proc of AMCIS, 2016.
- [27] Heaven, W.D., "Our weird behavior during the pandemic is messing with AI models", *MIT Technology Review*, 11 May 2020.
- [28] Henke, N., A. Puri, and T. Saleh, "Accelerating analytics to navigate COVID-19 and the next normal", *McKinsey & Company*, 2020. <https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights>
- [29] Henley, J., and R. Booth, "Welfare surveillance system violates human rights, Dutch court rules", *The Guardian*, 5 Feb 2020. <https://www.theguardian.com/technology/>
- [30] IDG IT Leaders Research Report, *Report*, 2021.
- [31] Illa, P.K., and N. Padhi, "Practical Guide to Smart Factory Transition Using IoT, Big Data and Edge Analytics", *IEEE Access* 6, 2018, pp. 55162–55170.
- [32] Koetsier, J., "97% Of Executives Say Covid-19 Sped Up Digital Transformation", *Forbes*, 2020. <https://www.forbes.com/sites/johnkoetsier/2020/09/10/>
- [33] Kozjek, D., R. Vrabčič, B. Rihtaršič, N. Lavrač, and P. Butala, "Advancing manufacturing systems with big-data analytics: A conceptual framework", *Int. J. of Computer Integrated Manufacturing* 33(2), 2020, pp. 169–188.
- [34] Lahl, D., "Intelligence Drives Better Experiences: Optimizing Business Processes in 2020", *Dataiversity*, 2020. <https://www.dataiversity.net/intelligence-drives-better-experiences-optimizing-business-processes-in-2020/>
- [35] Lawton, G., "Gartner says composable data and analytics key to digital transformation", *VentureBeat*, 2021. <https://venturebeat.com/2021/05/07/>
- [36] Marda, V., "Global information society watch 2019: artificial intelligence: human rights, social justice and development", *Association for Progressive Communications (APC), Article 19*, 2019.
- [37] Marjanovic, O., "A novel mechanism for business analytics value creation: improvement of knowledge-intensive business processes", *J. of Knowledge Management*, 2021. <https://doi.org/10.1108/JKM-09-2020-0669>
- [38] Marjanovic, O., D. Cecez-Kecmanovic, and R. Vidgen, "Algorithmic Pollution: Making the Invisible Visible", *Journal of Information Technology*, 2021. <https://doi.org/10.1177/02683962211010356>
- [39] Marjanovic, O., D. Cecez-Kecmanovic, and R. Vidgen, "Algorithmic Justice", *European Journal of Inf. Sys.* 2021. <https://doi.org/10.1080/0960085X.2021.1934130>

- [40] Markus, M.L., “Datification, Organizational Strategy, and IS Research: What’s the Score?”, *Journal of Strategic Information Systems* 26(3), 2017, pp. 233–241.
- [41] McKinsey, “Beyond hiring: How companies are reskilling to address talent gaps”, *McKinsey Insights*, 2020. <https://www.mckinsey.com/business-functions/organization/our-insights>
- [42] Miller, K., “The COVID pandemic’s lasting impact on cloud usage”, *InfoWorld*, 2021. <https://www.infoworld.com/article/3614809/>
- [43] O’Neil, C., *Weapons of Math Destruction*, NY, 2016.
- [44] Olavsrud, T., “Why businesses should focus on wide data, not big data”, *Network World*, 2015. <https://www.networkworld.com/article/2895931/>
- [45] Panetta, K., “Gartner Top Data and Analytics Trends for 2021”, <https://www.gartner.com/smarterwithgartner/>
- [46] Pappas, I.O., P. Mikalef, M.N. Giannakos, J. Krogstie, and G. Lekakos, “Big data and business analytics ecosystems: paving the way towards digital transformation and sustainable societies”, *Information Systems and e-Business Management* 16(3), 2018, pp. 479–491.
- [47] Park, Y., O.A. El Sawy, and P.C. Fiss, “The role of business intelligence and communication technologies in organizational agility: A configurational approach”, *Journal of the Association for Inf. Syst* 18(9), 2017, pp. 648–686.
- [48] Phillips-Wren, G., M. Daly, and F. Burstein, “Reconciling business intelligence, analytics and decision support systems: More data, deeper insight”, *Decision Support Systems* 146, 2021.
- [49] Phillips-Wren, G., L.S. Iyer, U. Kulkarni, and T. Ariyachandra, “Business analytics in the context of big data: A roadmap for research”, *Comm. of the Association for Information Systems* 37, 2015, pp. 448–472.
- [50] Poduska, J., “How the COVID-19 Pandemic is Accelerating the Need for Model Monitoring”, *TDWI.Org.*, 2021. <https://tdwi.org/articles/2021/03/08/>
- [51] PWC, *PWC Global Crisis Survey*, 2021.
- [52] Rashid, F.Y., “Gartner says low-code, RPA, and AI driving growth in ‘hyperautomation’”, *VentureBeat*, 2021. <https://venturebeat.com/2021/04/28/>
- [53] Rashid, F.Y., “Combining edge computing and IoT to unlock autonomous and intelligent applications”, *VentureBeat*, 2021. <https://venturebeat.com/2021/03/10/>
- [54] Robinson, D., “How AI and data analytics are driving composable infrastructure adoption in data centers”, *ComputerWeekly.Com*. 2020. <https://www.computerweekly.com/feature/How-AI-and-data-analytics-are-driving-composable-infrastructure-adoption-in-datacentres>
- [55] Roe, D., “Many Organizations Put Big Data Aside To Focus on Small Data”, *Reworked.Co.*, 2021. <https://www.reworked.co/information-management/many-organizations-put-big-data-aside-to-focus-on-small-data/>
- [56] Schrage, M., “Data, Not Digitalization, Transforms the Post-Pandemic Supply Chain”, *MIT Sloan Management Review*, 2020. <https://sloanreview.mit.edu/article/data-not-digitalization-transforms-the-post-pandemic-supply-chain/>
- [57] Sheng, J., J. Amankwah-Amoah, Z. Khan, and X. Wang, “COVID-19 Pandemic in the New Era of Big Data Analytics: Methodological Innovations and Future Research Directions”, *British Journal of Management*, 2020, pp. 1–20. <https://doi.org/10.1111/1467-8551.12441>
- [58] Shirer, M., and S. Murray, “IDC Reveals 2021 Worldwide Digital Transformation Predictions; 65% of Global GDP Digitalized by 2022, Driving Over \$6.8 Trillion of Direct DX Investments from 2020 to 2023”, *IDC*, 2020. <https://www.idc.com/getdoc.jsp?containerId=prUS46967420>
- [59] De Smet, A., D. Pachtod, C. Relyea, and B. Sternfels, “Ready, set, go: Reinventing the organization for speed in the Post-COVID-19 era”, *McKinsey*, 2020. <https://www.mckinsey.com/business-functions/organization/our-insights/ready-set-go-reinventing-the-organization-for-speed-in-the-post-covid-19-era>
- [60] Snowden, D.J., and M.E. Boone, “A Leader’s Framework for Decision Making”, *Harvard Business Review* 85(11), 2007, pp. 68–76.
- [61] Solis, B., “AI and automation are linchpins for post-pandemic business success”, *CIO*, 2021. <https://www.cio.com/article/3602812/ai-and-automation-are-linchpins-for-post-pandemic-business-success.html>
- [62] Stackpole, B., “Operationalizing Analytics is the Right Path to Value”, *CIO*, 2020. <https://www.cio.com/article/3599336/operationalizing-analytics-is-the-right-path-to-value.html>
- [63] Suer, M., “Business Processes or Analytics: What Comes First?”, *Information Management*, 2020. <https://www.reworked.co/information-management/business-processes-or-analytics-what-comes-first/>
- [64] US Government Accountability Office, “Our new science, technology assessment, and analytics team”, 2019. <https://blog.gao.gov/2019/01/29/our-new-science-technology-assessment-and-analytics-team/>
- [65] Vidgen, R., S. Shaw, and D.B. Grant, “Management challenges in creating value from business analytics”, *European J of Oper. Research* 261(2), 2017, pp. 626–639.
- [66] Wanasida, A.S., I. Bernarto, N. Sudibjo, and A. Purwanto, “The Role of Business Capabilities in Supporting Organization Agility and Performance During the COVID-19 Pandemic: An Empirical Study in Indonesia”, *Journal of Asian Finance* 8(5), 2021, pp. 897–911.
- [67] Watson, H.J., “Tutorial: Big Data Analytics: Concepts, Technologies, and Applications”, *Communications of the Association for Information Systems* 34(Article 65), 2014.
- [68] Zhang, V., “Stop searching for that data scientist unicorn”, *InfoWorld*, 2019. <https://www.infoworld.com/article/3429185/>