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## Capabilities and Readiness for Big Data Analytics

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### Abstract

Despite some of the initial hype from marketers and consultants, the use of big data is now firmly established in many organisations worldwide. Big data analytics (BDA) is making use of huge volumes of data from a wide range of structured and unstructured sources. Surveys have however reported a number of barriers to organisational effectiveness with BDA. This research aims to determine what capabilities large organisations require to be ready for a successful BDA initiative. Drawing mainly on relevant results of two published research articles, key informed stakeholders from a large South African telecommunications company were interviewed on this topic. Thematic analysis identified the key themes and sub-themes relating to capabilities needed for the organization to be ready for effective BDA. These proved to be very similar to those given in the earlier research, although a new capability of legal compliance for data protection was now added.

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**Keywords:** Big data analytics; organisational readiness; organisational capabilities; frameworks; business analytics; thematic analysis

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## 1. Introduction

Big data and big data analytics (BDA) are seen as critical for future competitive advantage and success in many organisations worldwide. The marketing hype around these, however, initially exceeded the reality in many companies [1]. With time and experience, BDA is now delivering some good returns and transforming businesses [2-4], although results are mixed and published academic research on these is limited. A 2016 survey predicted that 60% of big data projects through to 2017 would not go beyond piloting and experimentation [1], whereas 80% of a 2017 survey of Fortune 1000 executives, mainly financial, claimed their big data investments had been successful [5]. Clearly a number of factors, not all technological, influence the effectiveness of organisations embarking on BDA initiatives [4, 6, 7]. When is a company ready to use BDA? What should they think about and assess or evaluate? This research examines the capabilities that determine an organisation's readiness to enter the BDA world successfully. The paper first sketches a short background to the issues involved, then describes the methodology used in answering the main research question. Research findings follow, before a brief discussion and conclusion.

## 2. Background

### 2.1. Big Data and Analytics

There are numerous definitions of, and perspectives on, "big data" [3]. It is generally defined by the three "V's" of volume, variety, and velocity [8], plus a selection of other V's such as value, veracity, validity, and volatility [6]. It has alternatively been defined through the data's origin, as transactions vs non-transactions and internal vs external [2, 9]. Some organisations have always had huge volumes, but have only recently started processing unstructured data such as social media, Internet of things (IoT), sensor data, geospatial data, images, audio, video etc. Big data analytics (BDA) is the extension of a continuum or evolution from decision support systems to data mining to business intelligence (BI) to predictive and prescriptive analytics [10-12]; made possible by vastly increased and cheaper processing power and storage, and instant availability of data from numerous sources. Other commonly used umbrella terms are business intelligence and analytics (BI&A) and business analytics (BA) [2]. While many business problems remain essentially the same, solutions now use newer technologies, approaches and skills such as data lakes, Hadoop, Python, machine learning and data science [4]. Some authors [13, 14] query the lack of solid research demonstrating BDA's strategic contributions and business value, and ask whether it is a fad that may disappear in five years; others mention BDA hype and disappointing results [1, 15]. But investments in the area are expected to reach \$260 billion by 2022 [16], and a recent econometric study found that BDA assets were associated with a 3-7% corporate productivity improvement [13].

### 2.2. Capabilities, Readiness, Maturity and Success

Past research has examined organisational use of analytical approaches from various angles, often with regard to BI or BI&A. Capability maturity models have been created for various areas, including BA [17]; other research has examined limited sets of capabilities for BI success [18]. Organisational readiness [19] for a system, technology or investment can be defined as those capabilities an organisation needs to possess to be ready for a successful initiative. Maturity models for BI&A, BA or BDA consider the various factors that need to be satisfied to achieve levels of maturity in that area, as opposed to readiness [20]. Typically, factors important for BI or BI&A readiness or success would also be important for BDA, but others might also be needed.

### 2.3. Frameworks and Models for this Research

Various frameworks and models have been proposed in relation to architecture, components, implementation, etc. of big data [3, 6, 21], many being largely limited to aspects of technology or data. In this research we build on two that cover broader issues, relating to BA capabilities, and requirements for organisational success with BDA.

**Business Analytics Capability Maturity Model (BACMM) and Framework (BACF):** The BACMM proposed by [17] listed 16 capabilities in four groups. These are Governance (Decision Rights, Strategic Alignment, Dynamic BA Capabilities, and Change Management); Culture (Evidence-based Management, Embeddedness,

Executive Leadership & Support, and Flexibility & Agility); Technology (Data Management, Systems Integration, Reporting & Visualisation BA Technology, and Discovery BA Technology); and People (Technology Skills, Business Skills & Knowledge, Management Skills & Knowledge, and Entrepreneurship & Innovation). After three Delphi rounds with participants, this list was later very slightly amended in their final framework BACF [22].

**Requirements for Organisational Success with BDA:** Seven key requirements for this were defined by [23] as (1) A Clear Business Need, (2) Strong, Committed Sponsorship, (3) Alignment between the Business and Analytics Strategy, (4) A Fact-Based Decision-Making Culture, (5) A Strong Data Infrastructure, (6) The Right Analytical Tools, and (7) People Skilled in the Use of Analytics.

It was felt that the capabilities required for BA should be largely similar to those needed for BDA, and that these combined with the requirements for success for BDA could serve as a useful starting point for researching the topic.

### 3. Research Methodology

Big data frameworks “fail to provide strong case studies in which they are evaluated, so their validity has not been proved” [6, p.60]. Given the limited amount of research into this area [24], this research was exploratory, interpretive, and qualitative in nature, aiming to glean new insights and understand the BDA phenomenon [25]. A combined deductive and inductive approach was used, and a case study was conducted [26, 27] on a large corporate organisation, “C1”. C1 is a South African telecommunications company, with footprints throughout Africa, servicing over 60 million customers. It was on the verge of a Big Data implementation, and ideally positioned to compare its views on capabilities and readiness to those factors identified in previous research. Its majority shareholder (C2) is one of the world’s largest international mobile communications companies.

Semi-structured interviews were held with relevant role players within the organisation. Interview questions were built up around issues from the four groups in the BACMM [17], and the BDA success requirements [23] described in Section 2.3. Questions asked varied slightly according to the interviewee’s role, with time allowed for discussion and follow-up of new issues raised. Company documents on big data policies and strategies were also examined.

Interviewee sampling was purposive, in order to gather information from key, experienced stakeholders. Participants were selected from those currently involved with the BI&A requirements development lifecycle and the BI Competency Centre (BICC), and those involved with the BDA business plan, as well as a BI&A manager and two “power” analytical users. The purpose of the study was explained to all participants prior to interviews, and they were requested to sign a consent agreement. Interviews were on a voluntary basis, with the option to withdraw from the interview at any time. Names of the organisation and interviewees were kept confidential, and replaced with aliases. The nine interviewees, with aliases to preserve anonymity, were:

- R1: a business representative who submits requirements to the BICC
- R2: a senior technical analytics specialist from the BICC
- R3: a senior more business-oriented specialist from the BICC
- R4: a manager from BI Business Liaison who co-ordinates development of BI requirements
- B1: a technical analyst involved in development of the BDA strategy and business case
- B2: a similar technical analyst also concerned with the BI&A development life cycle
- S1: an analytics “super user” from the Customer Value Management (CVM) Department
- S2: an analytics “super user” in the customer experience area
- O1: manager of the Operational Data Store with over 15 years’ involvement with C1’s BI&A

As interpretive case studies allow for flexibility in the research methods, data analysis was carried out in parallel with the data collection, enabling the researchers to adapt interviews based on new insights discovered [25]. Interviews were transcribed and thematic analysis [28] was applied with the aid of the computer aided qualitative data analysis software NVivo. Nodes / themes were defined, and iteratively themes with their subthemes emerged. In this process some new themes and subthemes not in the original sets were uncovered.

#### 4. Findings

Seven major themes emerged, with sub-themes relating to capabilities for supporting or achieving them. Six of these themes related to the key requirements for organizational success with BDA given in [23] but one totally new theme emerged during analysis. The seven emergent themes were (in no order): (1) Alignment to Company Strategy; (2) Strong, Committed Sponsorship; (3) A Fact-Based Decision-Making Culture; (4) Analytical Skills; (5) A Strong Data Infrastructure; (6) The Right Analytical Tools; (7) Legal Compliance for Data Protection (A New Theme). These are shown graphically, with the capabilities that form their subthemes, in Figure 1. This section is structured using the themes and subthemes identified, and findings are supported by limited quotes.



Fig. 1. Capabilities Emerging from Thematic Analysis

##### 4.1. Alignment to Company Strategy

**Common understanding of terminology and corporate definitions:** One challenge to achieving alignment was identified as a lack of shared knowledge between IT and business. Although a corporate definition of Big Data was found in the artefact called “Big Data Strategy document”, almost all participants had a different understanding of the term “Big Data”. Comments ranged from “*I think we’ve always had big data, whether people choose to see it or not....*” (O1) to “*it is collating and integrating structured and unstructured data into an environment that allows you to delve deeper and find other things that you would not normally find in the data.*” (S2)

**Business and Analytics Strategic Alignment:** In [23] a requirement for alignment to both the Business and Analytics strategy was defined, and it would seem that these two are very much intertwined. “*Definitely... the way we did the roadmap for the BDA strategy was to use the strategy all the way from C2’s IT strategy to C1’s IT strategy. As well as the BI strategy.*” (B1)

**A Clear Business Need:** “*in terms of alignment if we don’t align to it [business] there’s no use of them using us as a department. In terms of alignment we have to align with what the business needs...*” (R2)

In most cases aligning with business strategy and the business need would be synonymous. Here the parent company C2 currently was more motivated for BDA than C1, who inherits its strategies from C2, but sets its own budget. In this financial year, more pressing business needs by C1 had caused the BDA initiative to be put on hold.

#### 4.2. Strong, Committed Sponsorship

**Executive Leadership and Support:** BDA seems to have general endorsement from the executives in the technology divisions, with these comments: “yes, our EHOD (executive head of division) - BI division, so is his superiors” (R4), and “.. up to an ME level you could say the whole executive is supporting this.” (S2)

When asked whether or not senior management encourage the use of BI&A systems the responses were quite positive. “Within our area, yes. We are encouraged to derive insights from BI&A systems and there is a big drive to improve on this ...” (R1)

**Decision Rights:** When asked the question: “Who is responsible for making the decisions for a particular BI&A area?” the response was similar for most participants. “that is the BICC - Business Intelligence competency centre. They are up north (head office) basically directly under the CEO.” (B1). Many of the interviewees agreed that the BICC is central to the BI&A requirements of the company, and supply BI&A to the whole company. However, some areas are responsible for their own analytic requirements, developments and decisions, as stated by S2: “No, we do everything from data extraction right through to delivery and the analytics output piece as well as motivating for that into the business.”

#### 4.3. A Fact-Based Decision-Making Culture

**Evidence-based Management:** This capability relates to management decisions being made based on information produced from analytics. This seems to be happening to a degree across the organisation, in some areas more than in others. “Most management staff nowadays have dashboards built specifically for them ... BI&A has become a critical aspect of the business, in my mind the organisation is becoming data driven and more decisions are being based on data.” (R1), and “The ME of the Enterprise business unit is quite reactive, so she has a whole team of actuaries, so they do a lot of analysis on this stuff...” (R3)

**Embeddedness:** This capability relates to how embedded analytics have become in a company. Most interviewees agreed that it has become quite ingrained in many functions of the organisation. “it has become so much part of the organisation that they don’t even see it as separate you know, half the people that are actually using the stuff that comes from BI, they don’t know it comes from BI that is how embedded it is.” (O1)

“The percentage of the organisation I would say 70%. We primarily serve CBU (commercial business unit) and EBU (enterprise business unit), the finance department.” (R3)

**Entrepreneurship and Innovation:** This capability refers to individuals who use BI&A for innovation and product design as well as improving processes, thereby leading to competitive advantages. “if they do they aren’t telling us about it, but ... I believe there are but it probably isn’t being exposed to us.” (B1)

Another respondent was very positive and knew of ways the company was using their BI&A capabilities for innovation and product improvement and design. “Oh yes, we do... I was taken aback by the beautiful things that they do, they basically before any product go to launch, or even before it is signed into concept, before it gets to the final stage they do projections, they use data, they look at past usage, to predict basically...” (S1)

#### 4.4. Analytical Skills

**Technology Skills and Knowledge:** There seems to be consensus that those with technical skills also need to have a fair amount of business knowledge. “...yes technology is important when that's your role, but it is important to know where requirements are coming from, it is important to know a little bit of the background.” (R4)

Some interviewees stated that much of the technical knowledge sits with outside vendors, which could be a problem. “We’re very vendor reliant for BDA we don’t have anybody - I don’t think - in the company currently that have knowledge of Hadoop, and the other BDA stuff.” (S1)

**Business Skills and Knowledge:** The users of BI&A systems and data have a keen knowledge of their own business areas and have a basic understanding of how BI&A works. “Having an idea of how it all works should be a minimum requirement, not necessarily the code used to develop etc. .... I think what would be more important would be true understanding of the data, of how the data is structured, the relationships between them.” (R1)

**Management Skills and Knowledge:** Some managers have a basic understanding of how BI&A works, but only high-level. *“I do believe they have an understanding of it, if they don’t have the understanding they surely make sure they get an understanding.”* (B1)

#### 4.5. A Strong Data Infrastructure

**Data Management:** Data is sourced from many business units throughout the company and in many cases these have different types of databases and applications. *“the organisation is divided into enterprises, and business, and each has different type of databases, sitting at different places...”* (S1) *“Teradata is used for our Customer / Enterprise data warehouse (EDW), the Oracle Exadata is used for our operational data store.”* (B1)

*“The BI eco system is actually covered by a myriad of technologies.”* (O1), and *“it could be around 30 individual sources of information.”* (S2)

**Systems Integration:** Many of the interviewees were rather passionate about the frustrations they were having around the issues of systems integration. *“this could be a 10 hour discussion as you will always have issues integrating data, so it just depends on how you source data.”* (B1); *“to integrate various sources, if the sources aren’t in our BI eco-system it is very difficult.”* (R4)

There is a hope that Big Data will simplify the integration issues. *“... that is where the big data will enable you to pull together all the sources of information.”* (S2). Currently data virtualisation is being used in BI&A to help overcome the systems and data integration concerns: *“So the virtualisation tool is also a big data tool”* (S1)

**Dynamic BA Capabilities:** This capability relates to the continued renewal of BI&A technology resources (and licences), however it is also about ensuring that the chosen technologies allow for flexibility and easy integration with existing systems to minimise cost and complexity. *“We are big enough to do that, we’ve got the Oracle ULA (universal license agreement), we have the Cognos enterprise license can be used also for analytics.”* (O1). But: *“I think for the older BI tools, depending on the technology stack, the speed of change does not cater for the demanding changes within the business.”* (R1)

#### 4.6. The Right Analytical Tools

**Reporting and Visualisation BA Technology:** User friendly dashboards, reports, scorecards and data visualisation are essential to enable large volumes of complex data to be easily understood by decision-makers and other business users. Most interviewees were familiar with tools used throughout the organisation. *“...Tableau we’ve got a licence for it, Qlikview we have licenses for it, for visualisation.”* (B2), and *“We’ve got OBIEE, we’ve got Qlikview, we’ve got Cognos and the typical one Excel. Everybody loves to use Excel.”* (O1)

S1 was convinced that the tools will be sufficient for BDA as they were capable of reporting on the complex environment of CVM (customer value management): *“remember these are just to visualise what you have actually processed.... it’s good to see how far the visualisation reporting has come from the old traditional dashboard.”* (S1)

**Discovery BA Technology:** More sophisticated technology tools are used by advanced users to uncover new insights, but these in turn need to be presented in such a way that a user can make sense of it. Various analytical tools are already used in different areas within the organisation, including advanced analytical applications like SAS, SPSS and R. *“Current analytic tools, include Qlikview and Tableau which they can expand on we also have SAS.”* (B1), and *“We use analytical tools like SPSS, SAS using R. Then we also use SQL, for basic analysis.”* (S2)

#### 4.7. Legal Compliance with Regard to Data Protection Policies

**Third Party Agreements:** Interviewees had various opinions about third party data. Some understood it to be the likes of geospatial information, social media data integration, or just allowing a development vendor access to company customer data. It was generally agreed that C1 would have contractual agreements with any third party they would interact with, and company data would be protected through a non-disclosure agreement (NDA).

*“... so before they can conduct any of research they have to sign an NDA (non-disclosure agreements) they are not allowed to share any of our data with anybody.”* (S2)

**Data Privacy Policies:** Data privacy policies relate to the ethical use of data for analytics. All agreed that C1 abides by legal requirements on protection of personal information and uses these as guidance. *“I would assume POPI and Access to Information act would come into play here. These policies need to be adhered to as they are prescribed by law.”* (R1), and *“so we have very strict rules around the data ... like the RICA data that has the customer passport / ID numbers name, surname etc.; also from a BI perspective we only do aggregated.”* (R3)

**Legal Considerations:** This capability addresses questions like: who owns the data; what defines fair use of data; who will be held responsible when erroneous data leads to negative results, etc. There were various opinions as to who would be held legally responsible if information sourced from analytics is incorrect and has legal implications. *“think every employee should take some sort of accountability for resulting data.”* (R1), or *“the CEO takes the punch and he would probably just push that down to his management executive in charge of BI,”* (B1)

**User Access:** This pertains to the physical access users have to data, how this is managed from a technological point of view, and what sort of access users can have. Within this organisation there are systems in place to manage user access to various systems and databases. *“we have implemented hisec (high security) fields whereby you have to apply for specific access. All access to all systems are done via the ARMS process.”* (R3)

*“..if you look at the front end of the BI Portal etc. access is given by the business owners.”* (O1)

Access is also given based on the type of data. *“there's also some data that has been sectioned off like the RICA data that has the subscriber's passport / ID numbers name, surname etc.”* (R3)

#### 4.8. Change Management Capability - Did Not Fall into Any of the Major Themes

Change management skills definitely seem to be required given Big Data's potentially wide impact. *“Big data is a bit of a mind shift organisationally as well as technologically...”* (B1), and *“you know there is that standard textbook, that is how the process should be... but the reality is that it is not as rosy as the textbook says it is.”* (S1)

Flexibility and agility listed in [17] related to how adaptable personnel are in fast changing environments. Many interviewees considered technology flexibility but not the people aspect, and raised issues hindering staff adaptability. *“In most cases, personnel try to be as agile as the business demands. But sometimes the process to get stuff done or the workload on resources is the delay.”* (R1), and *“We're still using the old organisational culture to develop things.”* (S1). It was therefore felt that this overlapped with the capability of Change Management.

## 5. Discussion and Conclusion

This research set out to determine which capabilities were necessary for organisations to achieve readiness for BDA. The thematic analysis of the interview data essentially tried to uncover the key capabilities, and link them to the suggested requirements for successful BDA in [23]. The outcome was shown graphically in Figure 1, with brief related interviewee quotes being listed in the findings. The research of [17] and [23] was largely supported, but the following changes and new contributions should be noted:

The requirement of “a clear business need” in [23] was replaced by a new area of “Legal Compliance for Data Protection”, an important new contribution. Recent events and legislation on data privacy have highlighted and strengthened the need for corporate compliance with data privacy, access to, and use of data. These issues all surfaced in many of the interviews. In two 2019 publications: Watson's update [4] to [23], and the framework in [6], this aspect is now also strongly covered. “Business need” was felt to be a part of “Alignment to company strategy”.

Another contribution in our research is that Change Management emerged as an important capability separate from the seven main themes, given how it cuts across many areas and roles in both business and technology.

The authors of [17] slightly revised their original set of 16 capabilities in the BACMM, after three Delphi rounds, in their newer BACF of [22]. The main change here was to replace “flexibility and agility” with “communication” in the Culture capability area. The former was felt to overlap with change management, which they relabeled as “impact and change management” in the Governance area. Communication is often a most important capability in many aspects, and it is perhaps a shortcoming that it did not emerge separately in our research.

Another potentially useful framework has since also been proposed in the 2019 publication [6]. The Big Data IRIS (BD-IRIS) framework for implementing a big data ecosystem also has seven dimensions: data architecture, data sources, data quality, support tools, organizational, privacy and security, and methodology.

Limitations of this research are that it was carried out in one large South African telecommunications company, and further research could be done in other economic sectors, and other countries. Quantitative research could also gauge the relative importance of each of these capabilities for BDA readiness, and also for maturity in BDA.

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