

TOWARDS BIG DATA ANALYTICS EMBEDMENT IN BUSINESS OPERATIONS

Perceiving trade-offs between conflicting capabilities for embedding Big Data Analytics



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Big Data Analytics:
"fourth paradigm of science"
(Gartner, 2016)



91% of Fortune 1000 firms invested in Big Data Analytics (Kiron, 2015)

Goal:

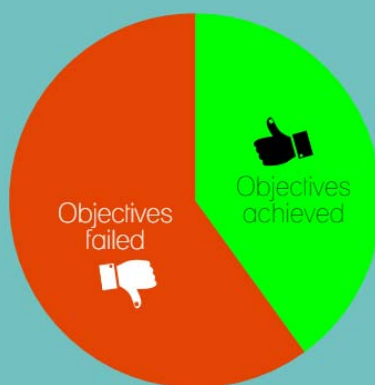
Discovering opportunities
and reducing risks

Extensive use of data
Statistical and quantitative analysis
Exploratory and predictive models
Fact-based management



To drive decisions and actions
(Davenport & Harris, 2007)

But.....,



Many firms have been
unable to get the full
potential out of their Big
Data Analytics projects



Business objective unclear



Insights not engaged in decisions



Analyses not frequently repeated

Big authors in Big Data Analytics:

A firm should embed Big Data Analytics into their business operations in order to get the full potential out of it (LaValle, 2011)

How to do that?



Define a clear objective
(e.g. to minimise the errors in production line)



Establish resources
(e.g. data, analytics tools, skills, people)



Develop capabilities
(e.g. the ability perform analytics and derive conclusions)

But, can capabilities always be combined?



In product development:



Capabilities have a 'dysfunctional flipside' that hampers the functionality of other capabilities (Leonard-Barton, 1992)

In supply-chain engineering:



Capabilities entail vulnerabilities that hamper the firm to achieve its objective (Pettit, 2008)

Capabilities can be conflicting with each other,

which means that a capability hampers another in achieving a specific objective and vice versa

For example:

Data Understandability
low

vs. Data Completeness
high

Scenario 1



Complex to visualise
Complex insights
Poor understanding
Slow conclusion derivation



Detailed insights
Complete overview
In-depth information

Scenario 2

Data Understandability
high

vs. Data Completeness
low



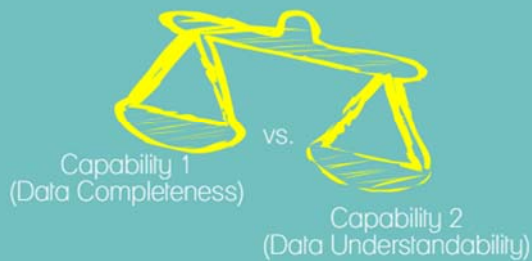
Understandable insights
Agile conclusion derivation
Easy visualisable information



Basic insights
Incomplete overview
Missing information

So, what happens when capabilities are conflicting?

A trade-off emerges.... between capabilities



A management executive should question itself:

- ? What capability has most beneficial contribution?
- ? Do the advantages of Capability 1 weigh up the disadvantages of Capability 2?

But, what happens when trade-offs are not perceived (or ignored)?

Unforeseen problems may emerge in later stages of embedding

- One of the two conflicting capabilities cannot be developed
- Investments in resources appear to be redundant
- Deadlines not achieved due to delays
- Costs may elevate
- Objectives need to be scoped down
- Final deliverable is not solving business problem
- Regulations can be unintentionally violated



How can firms perceive these trade-offs, so they can consider them in an early stage?



6 aspects need to be taken into account



1. Involve business units



2. Define objective



3. Establish resources



4. Develop capabilities



5. Assess interrelations



6. Perceive trade-offs

These 6 aspects are included in the BORCIT framework, which is designed to support executives to perceive trade-offs

1. Involve actors from different BUSINESS UNITS across the organisation



Executive Management



Operational Management



BDA Expert Team



2. Define a clear OBJECTIVE what is to be achieved



Descriptive: 'what has happened?'



Explorative: 'why has it happened?'



Predictive: 'what may happen?'



Prescriptive: 'how to prevent it from happening?'

3. Establish RESOURCES that can be deployed



Physical resources
(e.g. tools, data, dashboard, data lake)



Human resources
(e.g. skills, knowledge, experience, motivation)



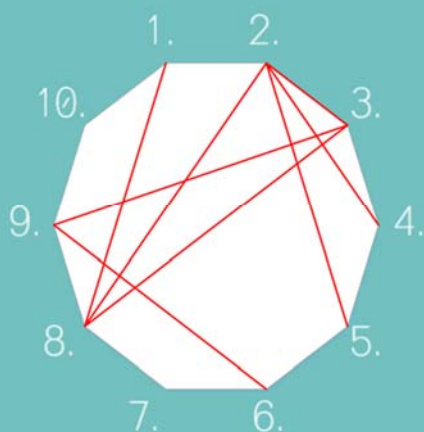
Organisational resources
(e.g. strategy, policy, org. structure, regulations)

4. Define CAPABILITIES which a firm should possess



1. Data Availability
2. Data Completeness
3. Data Understandability
4. Data Quality
5. Manageability
6. Flexibility and Autonomy
7. Interoperability
8. Security and Integrity
9. Predictability
10. Engageability

5. Assess which INTERRELATIONS between capabilities are conflicting



6. Perceive TRADE-OFFS based on their relative importance



Critical



Very difficult



Difficult



Easy



Very easy

Conclusions and recommendations



1. Add a multi-capability perspective to your embedding strategy



Because capabilities cannot always be combined, as they also can hamper each other



2. Add a multi-trade-off perspective to your embedding strategy



Because trade-offs can differ per case and need to be considered in an early stage



3. Add a multi-actor perspective to your embedding strategy



Because different business units can have a different perception of a trade-off

Contribution to the science



Current literature



This thesis



Added perspective

	Resource Based View	BORCIT framework	
Involve business units	✗	✓	Multi-actor
Define objective	✓	✓	
Establish resources	✓	✓	
Develop capabilities	✓	✓	
Assess capability interrelations	✗	✓	Multi-capability
Perceive trade-offs	✗	✓	Multi-trade-off

Case study: employment agency X

Business units involved



Supervising board



Australian management



International audit team
& KPMG team

Objective



"To optimise average lead times of the different types of timesheets completion processes used in the Australian part of the firm".

Resources to deploy



Transaction data
Data sets of employees
Data interface
Standardised analyses
BDA tool for staging,
executing and visualising



Knowledge about
timesheets processes
Knowledge about ERP
systems
BDA skills for staging,
executing and visualising
Access to Australian ERP
systems
Support from Australian
management



Privacy regulation
Data governance
Change management
plan
Time sheet proces
(re)design

Trade-offs



Supervising board



Australian management



International audit team
& KPMG team



Trends



'High' in the organisation trade-offs tend to be underperceived



'Low' in the organisation trade-offs are perceived more difficult



Trade-offs are inconsistently perceived among the business units



There is a substantive risk of erroneously considering trade-offs



Change of strategy is required to prevent unforeseen problems in later stages

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By

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in partial fulfilment of the requirements for the degree of

Master of Science

in Systems Engineering, Policy Analysis and Management
with Information Architecture specialisation track

at the Delft University of Technology,
to be defended publicly on Monday February 20, 2017 at 16:00 hours.

An electronic version of this thesis is available at <http://repository.tudelft.nl/>.

TOWARDS BIG DATA ANALYTICS EMBEDMENT IN BUSINESS OPERATIONS:

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DELIVERABLE

Date	February 6, 2017
Document	Final version
Number of pages	115 (198 with Appendix)

DEGREE

Master of Science (MSc)	Systems Engineering, Policy Analysis and Management
Specialisation track	Information Architecture
Faculty	Technology, Policy and Management (TPM)
University	Delft University of Technology
Location	Delft, The Netherlands

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FOREWORD AND ACKNOWLEDGEMENTS

In front of you lies a big stack of papers. You must be thinking “where do I start?”, “is it worth reading?” or “didn’t Maarten try to take too much hay on his fork?”. This is a Dutch saying when someone tries to do ‘too much’ with the risk of failing. It is a trade-off: when you carry too much hay on your fork, you have the risk that is too heavy to carry. On the other side, when you succeed you carried more hay within a specific amount of time, it only took you more effort. Basically, that is also the core of the subject of this thesis: trade-offs between two directions which both have its advantages and disadvantages. I want to emphasise that trade-offs occur in daily life and you occasionally consider them without even knowing that it was a trade-off. This thesis shows that a trade-off is a phenomenon that can be used as a strategic tool when used adequately. That means that you have to think a little bit further into the future, which is difficult. When you stand still for a moment and think before doing, you may prevent bad things from happening. But remember: “every advantage has its disadvantage” (Johan Cruijff). This is the message where I have written 198 pages about, but then in the context of Big Data Analytics.

I would like to thank several people that have played an important role during my studies. Starting with the people that guided me during the writing of my thesis, I would like to thank André Herdeiro Teixeira for being my first supervisor and brainstorm partner. I am sure you spent more time in supervising me than you should have. Your availability to meet up and revise my documents in progress helped me a lot. I couldn’t have done it without your input. This also applies for Haiko van der Voort. Thank you for flexibility in replacing the former second supervisor. Your expertise, new ideas and constructive feedback were eye-openers for me and are clearly visible in my thesis. Also I would like to thank Marijn Janssen for being so flexible and collaborative during the process and for supporting me so that I could write my thesis in four months instead of the occasional six months.

I would like to thank KPMG for providing me the opportunity to write my thesis in combination with an internship. In particular, I would like to thank Koen Klein Tank for providing me with endless feedback and offering me the resources for the interviews and case studies. Writing this report has been an instructive process, which was also sometimes confronting. I am more aware of my strengths now, but also I know more what my areas for improvement are.

I would like to sincerely thank my parents, Arnold and Monik, for their patience and infinite support. I am grateful for the opportunities that you provided me to study at the University of Groningen and Delft. I know I did not take the easiest route to get to this point, though I have been able to learn from you and to develop myself. Last but not least, I would like to thank my Catherine for endlessly listening to my ideas, plans and issues.

Yours sincerely,

Maarten

Amsterdam, February 5, 2017

SUMMARY

A metaphor is used to introduce the subject of this thesis. Your objective is to bike from Amsterdam to Utrecht every day to deliver a package where you use a bicycle for. Imagine that your bicycle, your muscles, eyes, arms and feet are your resources. The ability to steer, to accelerate, to brake, to lean in a direction or to evade an obstacle are your capabilities. Hence, through adequate usage of your resources you create capabilities that allows you to achieve your goal.

However, now the bicycle is being replaced by a motorbike that has a GPS system, where you have to go to Utrecht from Amsterdam with. Now, your motorbike with GPS is your main resource together with your muscles, arms, feet and eyes which you already possessed. However, you now need other capabilities in order to be able to manage your resources towards achieving your goal. For example, you will need to be able to drive faster, to steer, to lean, to break and to use the direction lights. Some of the capabilities you already possessed, but driving fast, leaning, accelerating or steering on a motorbike is different than on a bicycle. Besides, you can now take more packages with you. Therefore, you will need to make a strategy which capabilities to develop. As you want to bring the packages to Amsterdam (objective) and be in time (scope), you decide to develop the capabilities of driving fast and using the GPS system. However, after you got off from the highway, where the traffic is more complex. Because you are driving fast and at the same time using your GPS system, you missed an obstacle and crashed.

Currently, it is not clear whether you can develop and optimise all these capabilities without sacrificing other capabilities. Or do some of these capabilities conflict whereby you have to make trade-offs? If you want to focus on capabilities as accelerating and driving fast, these can conflict with the capability to use your GPS system. Or the capability to take many packages with you can conflict with your capabilities of accelerating and driving fast. Of course, it depends on the context and stage of the process; on a highway, capabilities such as acceleration would be more important than steering. But this would be different in the city centre of Utrecht or Amsterdam. Therefore, before making your strategy, you will need to perceive these trade-offs. If you try to focus on all capabilities without perceiving the trade-offs, problems may occur in a later stage whereby you have the risk of crashing.

Placing this metaphor in the context of embedding Big Data Analytics (BDA) in business operations, where instead of a motor bike, BDA is embedded, and the driver is perceived as an organisation. I want to investigate if the same problem occurs. Are there trade-offs between capabilities regarding BDA embedment? Can a framework be designed that can be used to perceive these trade-offs in an early stage?

Due to the popularity and complexity of Big Data Analytics (BDA), numerous articles have been published on defining BDA embedment strategies. What they have in common, is that they use the Resource Based View to assess how firm's resources must be managed in order to develop capabilities that are essential to successfully embed BDA in business operations. However, in practice, when defining BDA embedment strategies, in different areas within the organisation, capabilities can conflict with each other that need to be traded off. When these trade-offs are not perceived, as a consequence problems can occur in later stages of embedding BDA, which are expensive and time intensive to resolve. Questions emerge on how to perceive these trade-offs between conflicting interrelated capabilities. The Resource Based View on itself cannot be used to perceive these trade-offs. Through literature review and case studies, capabilities important for BDA embedment are established and interrelations between them are assessed. The BORCIT framework is designed - throughout this thesis based on empirical research - that facilitates the Executive Management of firms to perceive trade-offs in an early stage so that these can be considered before starting to embed BDA.

Unsuccessful BDA embedment is mainly caused by six aspects. First aspect is that the developed 'BDA solution' is not engaged in decision-making or supporting the tasks of **business units** in the firm. When they are not involved in the development of the solution, this can cause the misalignment of expectations and interests. Second aspect of failing BDA embedment is that the **objective** is not clear that needs to be achieved by embedding BDA. As can be reasoned, when many data sources are involved from several systems of the organisation, the BDA solution can become very complex and difficult to engage in decisions. Third aspect of failing BDA embedment is that the **resources** of BDA are not known, planned or managed adequately. Many firms are unable to deploy the expensive

BDA resources, because of their complexity. Fourth aspect of failing BDA embedment is that the firm does not know where it should be capable of in order to achieve a specified objective. These so called **capabilities** tell where a firm is capable of by managing and deploying its resources. Fifth aspect of failing of BDA embedment is that a firm does not know what **interrelations** capabilities have on each other. When this is unknown, it is unclear whether capabilities solely bring benefits or also entail difficulties with respect to a specified objective. Sixth and last aspect of failing BDA embedment is that a firm does not consider conflicting interrelations whereby **trade-offs** are implicitly ignored. When these consequences are not considered, they can lead to unexpected negativities leading to the emergence of problems. Especially in late process stages, problems are very expensive due to the investments that are already made.

These six aspects are incorporated in the designed BORCIT framework. Executive Managers of firms can use it to perceive trade-offs. Because, when trade-offs are not perceived they cannot be considered. As a consequence, problems can occur in later stages of the project leading to the failure of objectives. This thesis addresses six aspects are that give explanation about the success of embedding BDA to perceive these trade-offs. These aspects are taken into account in the framework that facilitates based on literature and empirical research. There are six phases that need to be walked through.

1. involving people from different business units from the organisation
2. defining a clear objective what is to be achieved by embedding BDA
3. determining what trade-offs can be deployed
4. defining capabilities that tell where the firm should be capable of in order to achieve the objective
5. assess which interrelations between capabilities are conflicting
6. perceiving and considering trade-offs by allocating relative importance of each pair of capabilities.

Application of the BORCIT framework demonstrates how firms can perceive trade-offs more complete between conflicting capabilities when embedding BDA in their organisation. This is done for two case studies: an employment agency and a dairy producer. In both case studies, the majority of the trade-offs is underestimated, which can be caused by the fact that the Executive Management is not completely informed about the fact the (e.g. organisational and technological) complexities of the project. In addition, also the majority of the trade-offs are perceived inconsistently, which can be caused by the fact that the Executive Management does not completely perceives the consequences of the trade-off. Because of this, unforeseen problems may occur. Three examples of unforeseen problems are briefly discussed below, comparable with the 'crash' of the metaphor.

First example, when the different perceptions on a trade-off are not taken into account, the expectations of a solution deliverable are not aligned. The business problem can become obscure because the business units are not involved, objectives are not commonly defined, resources are not delivered throughout the organisation or the BDA solution is not accepted or engaged in decision-making and business operations.

Second example, when the trade-offs are erroneously considered without consulting other compliance business units, sanctions can backfire the project. The firm can become non-complaint because laws are not obeyed, regulations are not followed, the firm's policy is unclear or not taken into account, and privacy and security can be breached.

Third example, when challenges and issues on the work floor (operational level) are not perceived when considering trade-offs, the process of embedding BDA can be plagued with technical complexities. Data may contain errors and inconsistencies, data may not be available real-time, data quality is lacking, or information overload may occur due to the large data volumes.

To consistently and more completely perceive trade-offs, involvement of the Operational Management, and the BDA Expert Team is of high importance when defining strategy for embedding BDA in the business operations of both cases.

Key-words: *Big Data Analytics, Resources, Innovation Adoption, Business Intelligence, Capabilities, Trade-offs, Resource Based View*

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TERMINOLOGY

As the subject of this thesis tends to be abstract and complex, an overview is presented in Table 1 of the terms used.

Term	Description
Aspect	This is the term used for the factors of successful/failing definition of capabilities for BDA embedment. There are six aspects: 1. Business units involved, 2. Objective of embedding BDA, 3. Resources management, 4. Capabilities development, 5. Interrelations between capabilities, 6. Trade-offs between conflicting interrelated capabilities.
Trade-off	The exchange of one thing for another of more or less equal value, especially to effect a compromise (Dictionary.com, 2016b). A trade-off between conflicting interrelated capabilities implies that a choice must be made between two outputs both entailing advantages and disadvantages.
<u>Perceived trade-off</u>	How trade-offs are seen in difficulty based on the relative difference in importance of two conflicting capabilities. When two conflicting capabilities are seen as same important, it is perceived as a critical trade-off. When one is much more important, it is perceived as a (very) easy trade-off.
Under-perceive	Perceiving a trade-off easier than the other business units.
Inconsistently perceive	Perceiving a trade-off distinctively than the other business units.
Resource	A source of supply, support, or aid, especially one that can be readily drawn upon when needed (Dictionary.com, 2016a). BDA resources are skills, data governance, analyses, models, data warehouse, knowledge, analytical tools etc., which can be used to perform BDA activities.
Objective	A specific result that a person or system aims to achieve within a time frame and with available resources (Dictionary, 2016). It is the goal that has to be achieved by embedding BDA in business operations.
Capability	The quality of being capable or the ability to undergo or be affected by a treatment or action (Dictionary.com, 2016a). The ability of a firm (or business unit) to perform actions that use BDA resources in order to achieve an objective.
Interrelation	The impact or consequence that a capability has on another capability whereby, in principle, there are three options.
Conflicting interrelation	Conflicting interrelations meaning that one capability has a negative influence on another capability.
Complementing interrelation	Complementing interrelations meaning that one capability has a positive influence on another capability.
Neutral interrelation	Neutral interrelations meaning that there is no influence from one capability on another capability.
Business unit	A organisational area, taken from the Organisational Model that, that has its own goal and is responsible for its performance (Mintzberg, 1979). In technological projects, such as embedding BDA, three of these business units are affected: the technical staff, strategic board and the middle-line management (Steenhuisen, 2009).
BDA solution	A solution to the objective that is created by BDA resources and capabilities.
Big Data Analytics (BDA)	Big data analytics is the process of examining large data sets to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful business information (Target, 2016).
Mintzberg's Organisational Model	An overview of the organisation of a firm wherein the different business units are situated with different hierarchical levels and goals.
Resource Based View	A view to perceive a strategy of a firm whereby a relation is established between resources and capabilities to create strategic advantage.
Design Space	The space within the scope for designing components that satisfy the requirements.
Morphological chart	A method to create design components that satisfy the requirements.
Design Science	Design Science is a scientific study of systematic designing originally introduced by R. Buckminster Fuller (Papanek et al., 1972).
Exploration interviews	Round 1 interviews of this thesis whose findings are used as requirements of the BORCIT framework design.
Evaluation interviews	Round 2 interviews of this thesis wherein the BORCIT framework is applied to a specific case study in order to evaluate its performance.
BORCIT framework	The framework that is designed in this research to overcome the research problem and achieve the research objective by addressing the knowledge gap. It is a framework that facilitates executive managers of firms to achieve an objective by embedding BDA in the firms business operations.

Analytic Hierarchy Process	Analytic Hierarchy Process is used as a method for the interviews of round 2. It is a general theory of measurement, which can be used to derive ratio scale from both discrete and continuous paired comparisons (Saaty, 1987).
Executive Management	'Strategic board' business unit on Mintzberg's Organisational Model in the context of embedding BDA.
Operational Management	'Middle-line management' business unit on Mintzberg's Organisational Model in the context of embedding BDA.
BDA Expert Team	'Technical staff' business unit on Mintzberg's Organisational Model in the context of embedding BDA.

Table 1: Terminology of this master's thesis

I. Initial problem

1. INTRODUCTION

This is the first chapter of this thesis, which is located in the first phase of the Design Science cycle as can be seen in Figure 1. The first Design Science phase focuses on introducing the problem and defining the research objective by addressing the 'knowledge gap' based on literature.

In this chapter, subjects are discussed including:

- Introduction
- Research problem
- Research objective
- Research questions
- Scope
- Relevance of this thesis
- Outline of this thesis
- Summary and example

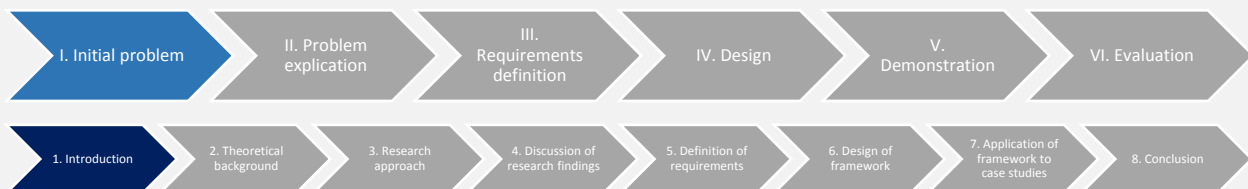


Figure 1: First chapter of this thesis in the first Design Science phase.

1.1. INTRODUCTION

Situation: Big Data Analytics (BDA) has increased extreme popularity over the last years and is expecting to become more important in businesses (Buhl *et al.*, 2013; Chen *et al.*, 2012; Kowalczyk *et al.*, 2014; LaValle *et al.*, 2011). It is seen as one of the most emerging trends of promising, innovative and revolutionary technologies for both business and academic ends, and even it is described as the “fourth paradigm of science” (Akter *et al.*, 2016; Gartner, 2016; Gobble, 2013; Keller *et al.*, 2012). As they drive organisational innovation, competition and productivity they can increase firms’ overall performance (Loebbecke *et al.*, 2015; McAfee *et al.*, 2012).

The Resource Based View is common used in literature to explain the potential of BDA, which states that physical, human and organisational resources in firms create capabilities. With the increasing of data *Volume* with high *Variety*, *Veracity* and an enormous *Velocity*, data as a resource has become easily available for business means opening up opportunities for creating Value (Buhl *et al.*, 2013; Chen *et al.*, 2012; Kwon *et al.*, 2014). According to a recent study BDA contributes around 10% of the growth for 56% of firms in the United States (Columbus, 2014). In 2013, around 6% of the firms of Fortune 1000 decided to invest in BDA projects, whereas now more than 91% have invested (Kiron *et al.*, 2014).

Nonetheless, these convincing and promising numbers are two-flanked and henceforth have a dark side. Various reports claim that the majority of BDA projects do not reach their objectives due to technological, organisational or human complications (Buhl *et al.*, 2013; Clavier *et al.*, 2012; Grant, 2016; Gupta *et al.*, 2016; Hannula *et al.*, 2003; Olszak, 2016). For this reason, they are neither frequently repeated nor engaged in supporting of decisions and operations (Braganza *et al.*, 2017). Many organisations have not been able to effectively embed BDA in their organisation whereby the full potential of BDA is not fulfilled (Atre, 2008; Chaudhary, 2004; Gupta *et al.*, 2016; Isik *et al.*, 2011; Olszak, 2016; Ross *et al.*, 2013; Schick *et al.*, 2011; Watson *et al.*, 2007).

The Resource Based View is a tool that supports firms in defining what resources and capabilities are important to achieve their objective (Barney, 1991). Embedding BDA in business operations of organisations is a costly, challenging and complex process whereas it is necessary for firms to define where they need to be capable to achieve their objectives (Gupta *et al.*, 2016; Kowalczyk *et al.*, 2014; Ross *et al.*, 2013). These capabilities are created when BDA resources are deployed and managed adequately.

Complication: However, current literature does not take into consideration that capabilities can also have a negative effect on other parts of the project of embedding BDA. In other domains, including product development and supply chain management, literature asserts that capabilities can have dysfunctional downsides or entail vulnerabilities that hamper a firm in achieving their objectives (Leonard-Barton, 1992; Pettit, 2008). In such cases, trade-offs between capabilities should be considered whereby their advantages and disadvantages are taken into account. As in current literature (using the Resource Based View) these trade-offs between capabilities of embedding BDA are neither known nor considered, a clear ‘knowledge gap’ is detected. The risk of not perceiving or erroneously considering trade-offs in engineering projects, is that in a later stage unforeseen can problems emerge. Solving these problems is more expensive (due to former investments) and intensive, with as a consequence that objectives become unfeasible (Nicholas *et al.*, 2008).

Question: This thesis aims to bridge this ‘knowledge gap’ whereby the following question emerges:

How can firms perceive trade-offs between capabilities that need to be considered to successfully embed Big Data Analytics into their business operations?

Approach: Through empirical study and literature research, six aspects of failing BDA embedment are investigated in order to perceive the trade-offs between conflicting capabilities. Business units from across the organisation that need to be involved are determined to get a more complete perception of the trade-offs. Resources and capabilities are determined that are important for embedding BDA in business operations, and it is examined if there are conflicting interrelations between them. A list of trade-offs between conflicting capabilities is established that need to be perceived before starting to embed BDA. Based on the research findings, an actionable framework is designed that facilitates Executive Managers of firms to perceive these trade-offs. This framework is applied to two case studies and evaluated afterwards.

1.2. RESEARCH PROBLEM

1.2.1. PROBLEM EXPLORATION

IN ORDER TO EMBED BDA, FIRMS NEED TO DEFINE CAPABILITIES

BDA projects do not fulfil their potential due to organisational, human and technological complexities (Clavier *et al.*, 2012; Hannula *et al.*, 2003; Olszak, 2016). For this reason, BDA insights are neither frequently created nor engaged in supporting decisions and operations (Braganza *et al.*, 2017). Many firms are not able to effectively embed BDA in their business operations (Atre, 2008; Chaudhary, 2004; Gupta *et al.*, 2016; Isik *et al.*, 2011; Olszak, 2016; Ross *et al.*, 2013; Schick *et al.*, 2011; Watson *et al.*, 2007).

In order to embed BDA in their business operations, firms should develop a set of capabilities (LaValle *et al.*, 2011). A capability is described as 'the quality of being capable' or 'the ability to undergo or be affected by a treatment or action' (Dictionary.com, 2016a). In the context of this thesis it is defined as 'the ability of a firm (or business unit) to perform actions that use BDA resources in order to achieve an objective'. According to the Resource Based View, firms create capabilities through adequate management of the organisational, human and physical resources as visualised in Figure 2 (Barney, 1991; Kwon *et al.*, 2014; Lieberman *et al.*, 1998; Wernerfelt, 1984). Many firms do not know what capabilities they should develop in order to embed BDA (A. Bharadwaj *et al.*, 2013; A. S. Bharadwaj, 2000; Grant, 2016; Gupta *et al.*, 2016; LaValle *et al.*, 2011).

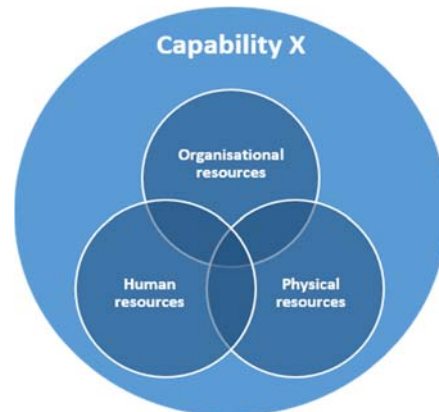


Figure 2: Visual interpretation of the relation between a capability and organisational, human and physical resources of the Resource Based View

CAPABILITIES CANNOT ALWAYS BE COMBINED

Current literature does not speak about the negative effects of capabilities of BDA which can hamper the process of embedding it in business operations. However, in other domains than BDA, articles are published about the negative effects that capabilities can entail. In product development, Leonard-Barton (1992) speaks about the 'dysfunctional flipside' of capabilities, which have a negative effect on other parts of the project. When these are not considered, an objective can become hollow and unrealistic. In supply-chain management Pettit *et al.* (2008) mention that each capability can entail several vulnerabilities that hamper the firm to achieve its objective. However, neither Leonard-Barton nor Pettit *et al.* discuss what these conflicting interrelations entail for the domain of BDA. Therefore, this is researched in this thesis.

The Resource Based View does not take interrelations between capabilities within the same strategy into consideration, which in principle can be complementing, neutral or conflicting. Figure 3 visualises this phenomenon with 'gears rotating within an engine of a car'. Whereas gears rotating in the correct direction produce power, whereas rotating in the wrong direction would cause friction. It can be claimed that capabilities do not conflict on a high level (Executive Management), however, on a lower level (BDA Expert Team or Operational Management) this is more likely as during implementation capabilities are more specific than during the defining of the strategy of embedding BDA.

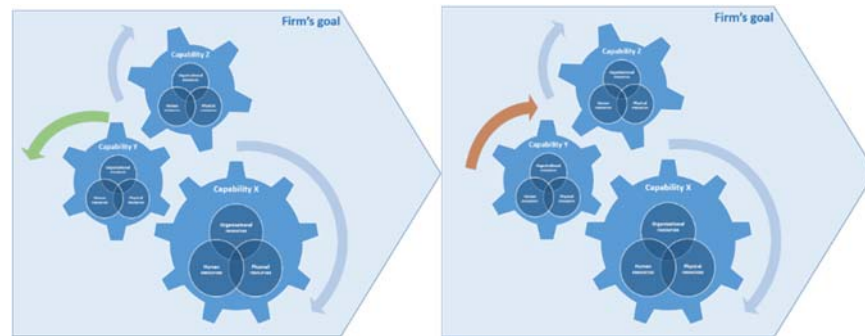


Figure 3: **Complementing** (left) and **conflicting** (right) interrelations between capabilities plotted in a visual interpretation of the Resource Based View

THERE IS NO MULTI-ACTOR PERSPECTIVE

In the current literature that uses the Resource Based View, the implicit assumption is made that capabilities can be defined from one perspective (e.g. Executive Management). However, thereby it does not consider the perspectives of other business units from the firm that are involved in the process of embedding BDA.

By mapping these business units with Mintzberg's Organisational Model (1979) as depicted in Figure 4, it can be seen that three different business units are involved: the Executive Management (strategic board), the Operational Management (middle-line management) and the BDA Expert Team (technical staff). When BDA is not engaged to support operations and decisions of business units, it is not embedded in the organisation. Frequently, problems lie in the misalignment of the expectations, perceptions and interests of these three different business units (Steenhuisen, 2009).

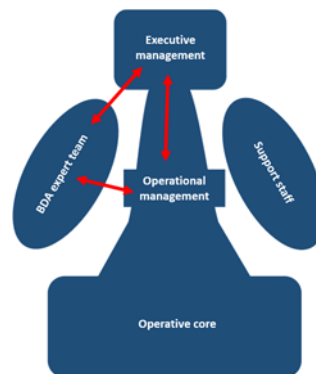


Figure 4: The business units that interact with each other when embedding BDA

TRADE-OFFS ARE NOT PERCEIVED

As discussed above, the fact that the current literature on embedding BDA using the Resource Based View, 1. does not take into account that capabilities cannot always be combined and 2. assumes that capabilities can be defined from a single-actor perspective. This can result in the fact that trade-offs are not perceived. Unforeseen problems can then emerge in later stages of embedding BDA. Solutions of these late problems can cause large delays and are more expensive due to the former investments that have been made (Nicholas et al., 2008). Hence, firms need to perceive these trade-offs in order to consider them. The advantages have to be weighed up the disadvantages of capabilities.

In Figure 5, a trade-off between two conflicting capabilities is schematically visualised. There are two capabilities: capability A and capability B, which have a conflicting interrelation with each other. When capability A is highly developed, this is at the expense of capability B. Vice versa, when capability B is highly developed, this is at the expense of capability A. In this (simplified) example, there are two directions that can be chosen, which lead to two different outcomes:

- Choice A: direction towards capability A (Figure 5):

- o Highly developed capability A which brings advantages A
- o Low developed capability B which entails disadvantages B
- Choice B: direction towards capability B (Figure 5):
 - o Highly developed capability B which brings advantages B
 - o Low developed capability A which entails disadvantages A

Hence, there are two outputs where a firm has to choose between. Depending on what advantages and what disadvantages each output entails, the firm has to consider a trade-off. However, this is dependent on what objective the firm wants to achieve by embedding BDA.

- For instance, a hospital is likely to prioritise capabilities as Security and Integrity and understandability more than a car manufacturer, who is likely to prioritise capabilities as Autonomy and Flexibility.

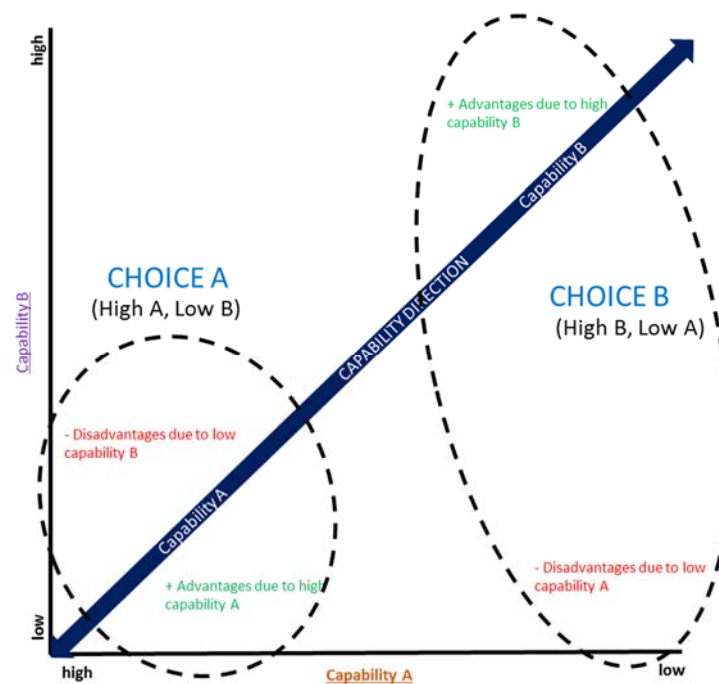


Figure 5: Schematic visualisation of a trade-off between capability A and capability B (choice A = left, choice B = right)

IMPLICATIONS OF NOT PERCEIVING TRADE-OFFS

What are the implications of inadequately perceived trade-off (Figure 6)? When trade-offs are under- or not perceived by the Executive Management, or when they are inconsistently perceived with respect to the other business units, there is a high chance that trade-offs are considered too late or erroneously. As a consequence, one of the two capabilities can be realised, due to the fact that they are conflicting. At that stage, investments in resources are already made, which turn out to be redundant. To solve these unforeseen problems, these investments have to be undone, which is intensive and expensive (Nicholas *et al.*, 2008). Delays in the embedding process can be caused, as well as higher costs and an increased chance for errors. Consequently, objectives that are set appear to be unfeasible.

Trade-offs are inevitable and therefore need to be considered (Steenhuisen, 2009). Notice that capabilities in a trade-off are conflicting, so only one capability can be chosen. Investing in the resources of both capabilities would not make sense when the trade-off is perceived. Therefore, it is important to perceive the trade-offs beforehand so that they can be considered timely. In this way there are no investments made in resources for capabilities that turn out to be redundant or unfeasible in a later stage.

Referring the metaphor at the beginning of this thesis, it can be questioned 'what happens when the capability of steering and the capability of accelerating are conflicting with each other, and both of them are utilised?'. It can be reasoned that, when this trade-off is not perceived or considered, and both capabilities of accelerating and steering are developed, this might lead to a crash. Hence, trade-offs between conflicting capabilities need to be perceived and considered before beginning to embed BDA.

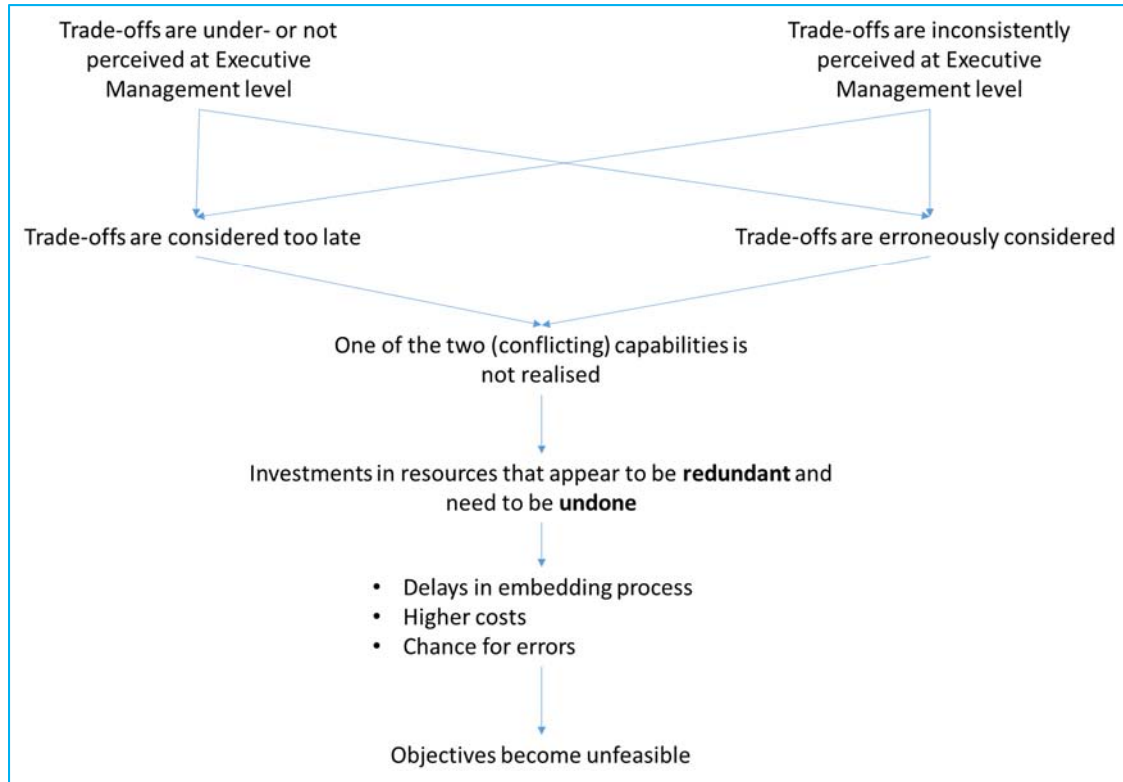


Figure 6: The implications of inadequately perceived trade-off

1.2.2. PROBLEM STATEMENT

The problem statement of this master's thesis is:

According to literature from the Resource Based View, in order to embed BDA in business operations, a firm develop capabilities, which can be created by acquiring and managing BDA resources. However, interrelations between those capabilities are ignored. Whereas complementing or neutral interrelations do not necessarily cause problems, conflicting interrelations force firms to make trade-offs between capabilities. When these trade-offs are not perceived by the involved business units in the organisation, problems can emerge in later stages of the project. Solving these late problems is expensive and intensive. Besides, the trade-off still needs to be considered. As a consequence, objectives become unfeasible. This results in the fact that BDA is not embedded in firms and BDA projects do not fulfil their potential.

As mentioned in section 1.2.1, according to current literature firms should define capabilities in order to embed BDA in their business operations. However, literature that uses the Resource Based View assumes that capabilities can always be combined and thus never conflicting. The Resource Based View-literature does not facilitate to perceive these trade-offs when defining capabilities for embedding BDA. Lacking to perceive these trade-offs has implications leading to unforeseen problems and unfeasible objective. To summarise the research problem of this master's thesis, it is schematically displayed with a conceptual model in Figure 7.

1.2.3. KNOWLEDGE GAP

According to current literature using the Resource Based View, firms can embed BDA in their business operations by taking into account the following aspects (see top of Figure 7).

- A clear **objective** needs to be determined so that it is clear what needs to be achieved.
- A series of BDA **resources** needs to be established and acquired.
- It needs to be defined what **capabilities** the firm should develop.

However, based on scientific assertions in other domains that BDA (as discussed in section 1.2.1), this thesis claims¹ that current literature does not take into account the following aspects, which can cause unsuccessful embedding of BDA (see bottom of Figure 7).

- Current literature using the Resource Based View is solely from a **single-actor perspective**.
- In current literature considering the Resource Based View, it is implicitly ignored that **capabilities cannot always be combined**. Thus, it is unknown what interrelations between capabilities there can be in a firm's BDA embedment strategy.
- In current literature considering the Resource Based View, **trade-offs** between conflicting capabilities **are not perceived**. These can lead to unforeseen problems in later stages of the embedment process.

The above enumeration demonstrates a clear knowledge gap, which is marked in black in Figure 7. Three aspects are not taken into account in current literature, which can lead to unsuccessful BDA embedment. The Resource Based View-related literature on embedding BDA does not discuss the existence of conflicting interrelations between capabilities. Leonard-Barton and Pettit et al. discuss what these conflicting interrelations entail for other domains (product development and supply chain management) but not for the domain of BDA. Besides that, it assumes that capabilities can be defined from a single-actor perspective.

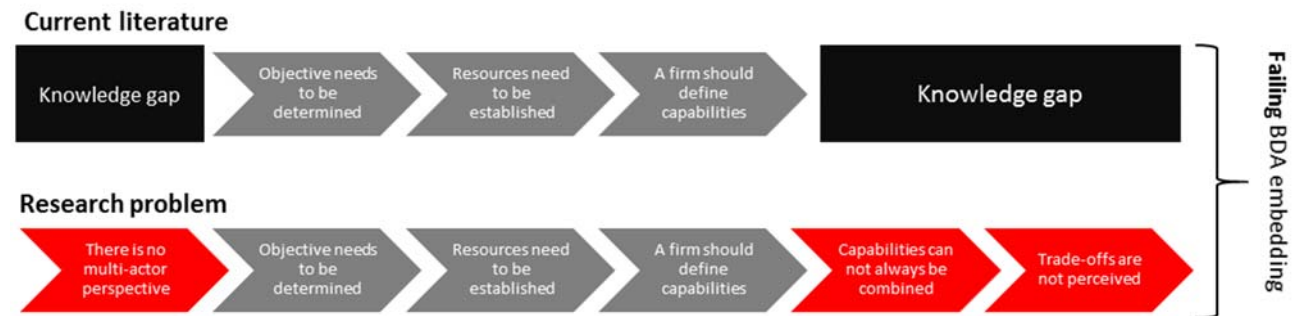


Figure 7: Schematic visualisation of the problem definition and the knowledge gap

1.3. RESEARCH OBJECTIVE

In last section it is discussed that there are three aspects that are not discussed in current literature, which can cause failing BDA embedment. Based on this problem definition and knowledge gap, the research objective is established. The research objective tells what is investigated in this thesis.

1.3.1. OBJECTIVE STATEMENT

The objective statement of this master's thesis is:

It is investigated how firms can perceive trade-offs between conflicting capabilities so that they can consider them in an early stage. In this way, it can be avoided that (related) unforeseen problems emerge in later stages the process of embedding BDA. This is done by assessing which capabilities have a conflicting interrelation

¹ This is investigated in this research, which is discussed later in this thesis (chapters 0, 0 and 0).

between each other. Business units from across the organisation are involved to set a clear and common objective. This research contributes to the Resource Based View in the field of embedding BDA.

The objective of this master's thesis is to investigate how inadequately perceived trade-offs can be avoided. Notice that these steps will be extensively discussed in the rest of the chapters. Reasoned from the research problem (section 1.2), perceiving trade-offs is necessary so that they can be timely considered. In this way, unforeseen problems in later stages due to the unfeasibility of one (of the two) capability are prevented. Then, there is no need for intensive and expensive solutions for solving these late problems. This is schematically displayed with a conceptual model in Figure 8.

1.3.2. CONTRIBUTION AND DELIVERABLES

SCIENTIFIC CONTRIBUTION

In last section discussed three aspects that are missing in current literature, which can cause unsuccessful BDA embedment. Therefore, the scientific contribution of this thesis addresses these three aspects.

Adding multi-actor perspective: business units involvement.

A contribution to the Resource Based View on the involving of a multi-actor perspective. Currently, the Resource Based View assumes that capabilities are defined from a single perspective. In this thesis, Mintzberg's Organisational Model is used to extend the Resource Based View in order to create a multi-actor perspective on both the capabilities and the trade-offs.

Adding multi-capability perspective: interrelations between capabilities.

A contribution to the Resource Based View on the existence of interrelations between capabilities. Currently, the Resource Based View assumes that capabilities can always be combined. However, main assertion of this thesis is that capabilities can also be conflicting. This means that one capability hampers the functionality of another capability. This principle can be applied to the embedding of BDA but also in other domains. For example, it can be used when defining capabilities for supply chain or product development.

Adding the multi trade-off perspective: perceiving trade-offs.

A contribution to the Resource Based View on the perceiving of trade-offs. Currently, the Resource Based View does not take into account, that trade-offs have to be perceived before starting the process. When trade-offs are perceived, they can be considered timely. In this way, it can be avoided that in a later stage unforeseen problems can emerge due to the fact that one of the two conflicting capabilities cannot be realised.

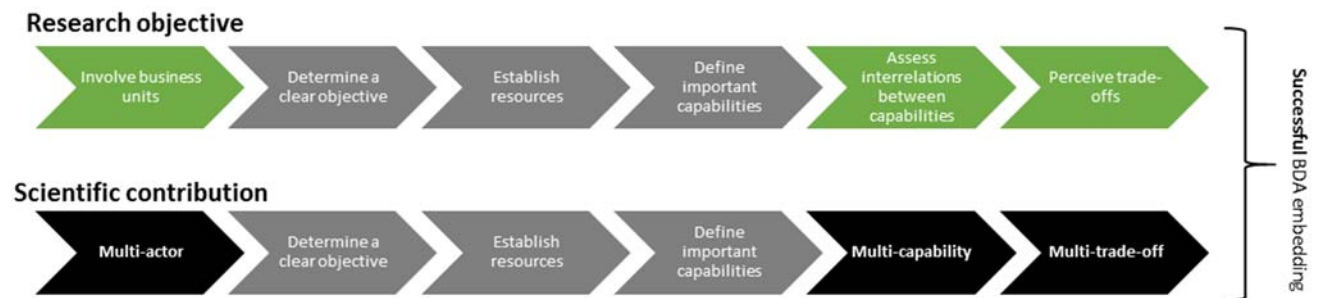


Figure 8: Schematic visualisation of the research objective and the scientific contribution

PRACTICAL DELIVERABLES

In this thesis also empirical research is conducted whereby three practical deliverables are achieved. These deliverables can be used by firms to embed BDA in their business operations.

A list of six important aspects to take into account when embedding BDA.

Six important aspects of embedding BDA are investigated based on exploratory and evaluation interviews supplemented by desk study. These found six aspects (**business units, objective, resources, capabilities, interrelations** and **trade-offs**) are incorporated in the framework design.

An actionable framework design that facilitates Executive Managers of firms to perceive trade-offs when embedding BDA in business operations.

As this master's thesis is a Design Science study, a framework is designed to fill the knowledge gap. This design is based on the findings of the research which are used as requirements (Johannesson et al., 2014). This designed framework facilitates Executive Managers in overcoming the emergence of unforeseen problems due to unperceived trade-offs. The framework supplements the Resource Based View (O, R, C) by adding the **multi-actor**, **multi-capability** and **multi-trade-off** perspective (B, I, T). For that reason, it is named BORCIT.

An overview of perceived trade-offs for an employment agency and a dairy producer.

The BORCIT framework is applied to two case studies, whose findings are discussed and evaluated afterwards. This is the start of a large-scale study in the perception on trade-offs for different industries. By applying the designed framework to more case studies, a clearer view can be achieved in how to improve this perception.

1.4. RESEARCH QUESTIONS

The problem statement, knowledge gap, research objective and expected deliverable together form a 'research space' where this master's thesis is focused on. Whereas the sub research questions divide this space into smaller parts, these are eventually synthesised whereby the main research question is answered.

1.4.2. MAIN RESEARCH QUESTION

The main research question of this thesis is stated below and is briefly discussed.

How can firms perceive trade-offs between capabilities to successfully embed Big Data Analytics into their business operations?

In literature it is discussed extensively that BDA projects do not fulfil their potential because firms are unable to embed BDA in their business operations. As in literature three aspects are not discussed (see section 1.2), there is a knowledge gap encountered in current literature. Interrelations between capabilities are not considered when embedding BDA in business operations. A trade-off needs to be made when capabilities have a conflicting interrelation with each other by weighing up the advantages against the disadvantages. Besides, capabilities are defined without involving actors from other related business units within firms. When these trade-offs are ignored, they can cause problems in later project stages whereby objectives will appear to be unfeasible.

1.4.3. SUB RESEARCH QUESTIONS

The main research question is divided into a series of sub questions. These are briefly explained for the sake of clarification.

0. *Why do Big Data Analytics projects do not fulfil their potential?*

This is the starting point of this master's thesis, therefore, the sub-question is numbered 'zero'. The reason why BDA projects do not fulfil their potential is because firms are unable to embed BDA in their business operations. Six aspects are discussed in section 1.2. that can cause unsuccessful BDA embedment. The theoretical background of these six aspects of embedding BDA is discussed in more detail.

1. *How to define capabilities that are important for embedding Big Data Analytics? What business-unit perspectives of the organisation are important?*

The majority of articles that are reviewed, use the Resource Based View to define capabilities in order to embed BDA. These capabilities (e.g. ability to understand data insights or the ability to secure data) tell where a firm needs to be capable of by managing the BDA resources (e.g. tools, skills, software, data warehouse etc.). However, the question emerges whether the entire organisation has the same objective of BDA where these capabilities are needed for. Therefore, Mintzberg's Organisational Model is used for determining what business units need to be involved when embedding BDA. This question will be mainly answered by literature review.

2. *What capabilities are important for a firm to possess?*

In literature, numerous specific capabilities are encountered that contribute to the embedment of BDA in business operations. However, it is aimed to define a short list of generic capabilities that can be applied to every BDA project regardless of the context or objective. This is done through literature review and empirical research.

3. *What trade-offs between capabilities are important to perceive?*

As is asserted in the research problem definition of section 1.2, in current literature interrelations between capabilities of BDA embedment are not discussed. When two capabilities have an conflicting interrelation, this will lead to a trade-off whereby the most desired option is chosen. This is dependent on the context and objective of a case. Through empirical research, trade-offs are detected between the capabilities defined in last sub-question.

4. *How does a framework look like that facilitates firms to perceive trade-offs?*

As this thesis is design-oriented, the findings of the literature review and empirical research are used as requirements for a framework design. A framework is designed that facilitates firms to perceive the trade-offs between capabilities (from last sub-question) that are important to consider for embedding BDA in their business operations. In this way an attempt is done to fill the 'knowledge gap' as introduced in section 1.2.

5. *How are trade-offs perceived for the case studies by applying the designed BORCIT framework?*

In previous sub-questions literature review and empirical research is conducted where the findings are used as requirements of a framework design that aims to successfully embed BDA in business operations by perceiving and considering trade-offs between conflicting capabilities. The so-called BORCIT framework is demonstrated and evaluated by applying it to two case studies: an employment agency and a dairy producer.

1.5. SCOPE

The research problem, objective and research questions tell where this thesis is aimed on. However, the scope sets out boundaries to demarcate the 'research space', which exactifies the scientific and societal focus of this thesis.

Firstly, in this thesis there is spoken about 'embedding BDA in business operations'. Here, it is important to notice that not the entire process of embedding is within scope, which is displayed in Figure 9. Hence, also the BORCIT framework that is designed only addresses the first step (green) of embedding BDA. Within scope it stated as follows:

A framework that facilitates the Executive Management to perceive trade-offs between conflicting interrelated capabilities when defining capabilities for embedding BDA in order to achieve an objective.

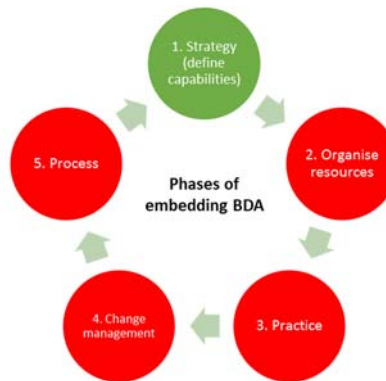


Figure 9: Not the entire process cycle (red) of embedding BDA is within scope; only the strategy part (green)

Secondly, trade-offs between interrelating capabilities can occur on all levels of an organisation when defining objective for BDA embedment. However, this thesis focuses on the capabilities regarding the three business units: the BDA Expert Team ('technical staff'), the organisational management ('middle line') and the executive board ('Executive Management') from Mintzberg's Organisational Model, as displayed in Figure 10 (Mintzberg, 1979). According to Porter these organisational areas are separate business units whereby capabilities and objective can

differ per unit (1989). Trade-offs that might occur in other levels of the Organisational Model are not taken into account for the sake of simplicity.

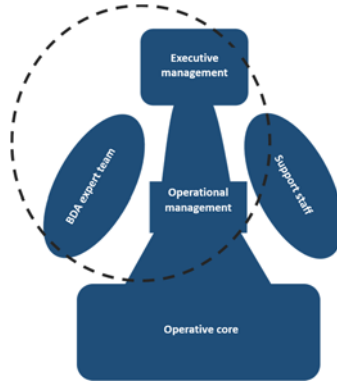


Figure 10: Mintzberg's Organisational Model in the context of BDA embedment: the circle demarcates the organisational areas where trade-offs between conflicting capabilities can take place

Thirdly, this thesis aims on designing an actionable framework that facilitates the perceiving and considering of trade-offs. The framework is designed based on the findings from exploratory interviews. Thereafter, the framework is applied to two case studies and evaluated afterwards. However, it should be noticed that this research is exploratory and aims on demonstrating a (new) phenomenon: *the trade-offs between conflicting capabilities for embedding BDA*. Hence, this research is not focused on establishing a complete list of these trade-offs. For that, more case studies should be conducted with firms with distinct size, characteristics and in different industries.

Fourthly, this thesis uses the Resource Based View for establishing capabilities that are important for embedding BDA. Based on these capabilities the trade-offs are perceived. However, there are multiple theories that tell something about the success of BDA in firms. These are shortly introduced in Appendix IIA, though the Resource Based View is taken as theoretical lens.

Fifthly and lastly, there is a difference between 'analysis' and 'synthesis'. Whereas 'analysis' aims on understanding a concept and apply it in the domain of the research, 'synthesis' aims on creating a new concept in the domain of the research (DifferenceBetween, 2016). Different aspects are discussed that define success of embedding BDA as summarised in section 2.7 and demonstrated in Table 2. However, important to notice is that not all these aspects are aimed to be empirically validated. The first four are analysed in the context of BDA and provide findings that are used for synthesis of the last two aspects. Therefore, the contribution of this thesis aims on these two latter aspects: 1. demonstrating that capabilities can have conflicting interrelations and 2. demonstrating that trade-offs need to be considered between conflicting interrelated capabilities. The overview of Table 2 shows that the emphasis is put on the demonstration of a (new) phenomenon: *the trade-offs between conflicting capabilities for embedding BDA*.

Aspect of embedding BDA in business operations	Scope				Type	Deliverable
	Literature review	Exploratory interviews	Evaluation interviews	"New" contribution to science		
Business units to involve	✓	✓	✓	✓	Synthesis	Adding the multi-actor perspective . Demonstration of 3 business units to involve
Objectives of embedding BDA	✓	✓	✗	✗	Analysis	Validation of 4 types of objectives
Resources for embedding BDA	✓	✓	✗	✗	Analysis	Validation of 3 types of resources
Capabilities for embedding BDA	✓	✓	✗	✗	Analysis	Validation of 10 generic capabilities
Interrelations between capabilities	✓	✓	✗	✓	Synthesis	Adding the multi-capability perspective . Demonstration of 8

						conflicting interrelated capabilities
Trade-offs between conflicting interrelated capabilities	✓	✗	✓	✓	Synthesis	Adding the multi-trade-off perspective . Demonstration of 8 trade-offs between conflicting capabilities

Table 2: Overview of the scope regarding the aspects researched

1.6. RELEVANCE OF THIS THESIS

As is mentioned before, this master's thesis is design-oriented and therefore uses the Design Science book of Johanneson and Perjons (2014) as a guideline. The relevance of this thesis can be explained from the Design Science perspective.

1.6.2. DESIGN SCIENCE

Design Science is a scientific study of systematic designing originally introduced by R. Buckminster Fuller (Papanek et al., 1972). It is comprised of three cycles as can be seen in Figure 11: the Relevance Cycle, the Rigor Cycle and the Design Cycle. The Relevance Cycle concerns the empirical side of the research domain where a research is done on a specific problem. The findings of this research are henceforth used as requirements in the Design Cycle in order to design an artefact that aims to solve the problem. The Rigor Cycle concerns the academic side of the research domain where theories and methods are developed. In a Design Science study, theoretical concepts from the 'knowledge base' are used as a lens to apply it in the 'environment' to shape a empirical research. These deliverables are therefore two-sided: the findings to validate a specific problem and an artefact that is designed to overcome this problem. The two-sided findings of this thesis are explained in the two next sections.

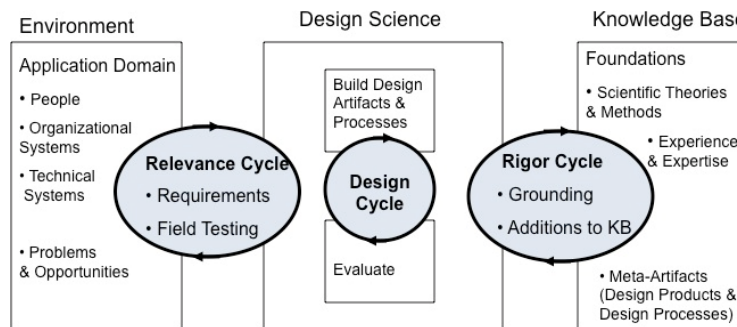


Figure 11: General Design Science visualisation (Hevner, 2007)

1.6.3. PRACTICAL RELEVANCE

Gaining more understanding in why BDA embedment projects fail is essential in the expected relevance of this thesis. As mentioned in the introduction, more than 91% of Fortune 1000 companies have invested in BDA projects. However, between 55 and 70% of these projects did not achieve the expected objectives due to complexities (Clavier et al., 2012; Hannula et al., 2003; Kiron et al., 2014; Olszak, 2016). Perceiving and considering trade-offs in later stages of an embedment project is much more expensive than in the initial stage (Nicholas et al., 2008).

This implies that there is much to gain by studying cases and by learning from best-practices. For KPMG, where this thesis is written in combination with a graduation internship, it is beneficial to know more about why BDA embedment seems so difficult for firms. Their supposition already aligns with literature, which states that BDA embedment is more than solely technology. Their interest is in optimising their service to their clients concerning BDA. Therefore, KPMG provided material for case studies and facilitated interviews with subject matter experts and (former) clients.

Table 2 presents an overview of the deliverables that are contributed. Empirically, the following themes are relevant:

- Important **resources** and **capabilities** for embedding BDA.
- **Business units** that need to be involved when defining an **objective** or embedding BDA.

- **Trade-offs** between conflicting **interrelated** capabilities that must be considered when embedding BDA.
- Application and evaluation of the Resource Based View in embedding BDA.
- The designed BORCIT framework that supports firms in defining strategy to embed BDA.

1.6.4. SCIENTIFIC RELEVANCE

The magnitude of the amount of BDA projects that do not fulfil their potential because of BDA is not embedded in business operations implies that there is much to learn by studying cases and proposing new theories. Although in literature multiple theories are proposed with different manners for managing complex socio-technical projects, in the context of embedding BDA the Resource Based View seems to be most prominent. The Resource Based View has become a popular tool for defining strategies (in general) since 1991. However, it does not take into account that capabilities have interrelations with each other which can in principle be complementing, neutral and conflicting. This results in a 'knowledge gap', as described in section 1.2.3, which states that when these trade-offs are not perceived or considered, they can cause problems in late project stages.

In practice, however, these trade-offs are encountered on a large scale. Not only for BDA embedment, but also for objective defining in general for socio-technical systems. Therefore, the framework proposed in this thesis, extends the Resource Based View so that trade-offs between conflicting interrelated capabilities can be perceived and considered with respect to the objective. This theory-extension contributes to the science, as from now, future research could be done based on this new insight.

Hence, academically, the relevant contributions to the Resource Based View are:

- Adding the **multi-actor perspective**.
 - Demonstration of three **business units** that need to be involved in the process of embedding.
- Adding the **multi-capability perspective**.
 - Demonstration of the existence of the phenomenon of **interrelations** between capabilities that can be complementing, neutral or conflicting.
- Adding the **multi-trade-off perspective**.
 - Demonstration of the existence of the phenomenon of **trade-offs** between capabilities.

1.7. OUTLINE OF THIS THESIS

The outline of the master's thesis can be visualised in summarised form to clarify the flow of the project, as displayed in Figure 12. As can be seen in Figure 12, the Design Science cycle is used from Johannesson and Perjons (2014) which is introduced in section 1.6. The process flow can be elaborated into a more detailed outline of the master's thesis project, as presented in Appendix IA Table 34. Here, the Design Science phases are mapped with the chapters, sub-questions, deliverables, research objective and method and data collection method.

The first phase focuses on introducing the problem and defining the research objective by addressing the 'knowledge gap' based on literature. The second phase focuses on explicating the problem by reviewing literature, which is subsequently used for setting up a research approach. The phase focuses on discussing the findings from the research conducted. Subsequently, these findings are translated to requirements for the framework design. The fourth phase focuses on designing a framework that overcomes the 'knowledge gap' and thereby addresses the problem definition and research objective. The fifth phase focuses on demonstrating the framework design that is designed based on the requirements which are subsequently derived from the research findings. The framework is demonstrated and tested whether it overcomes the 'knowledge gap' and thereby addresses the problem definition and research objective. The sixth phase focuses on evaluating the framework design on its performance on the case studies where it is applied to. The framework is evaluated whether it overcomes the 'knowledge gap' and thereby addresses the problem definition and research objective. Besides, the research questions are synthesised whereby the final conclusion is composed.

1.7.2. READERS TIP: REOCCURRENCE OF BORCIT ASPECTS

This thesis discusses **six aspects** (Business units, Objective, Resources, Capabilities, Interrelations, Trade-offs) that are important for embedding BDA are reoccurring in every chapter. This is done to enhance readability of this thesis report. As is mentioned in various times throughout this thesis, the aspects aim towards the successful embedding of BDA in firms whereby they address the knowledge gap. In section 2.7, they are summarised and supplemented with a short example.



Figure 12: Process flow of this master's thesis based mapped with the Design Science phases

II. Problem explication

2. THEORETICAL BACKGROUND

This is the second chapter of this thesis, which is located in the second phase of the Design Science cycle as can be seen in Figure 13. The second Design Science phase focuses on explicating the problem by reviewing literature, which is subsequently used for setting up a research approach.

In this chapter, subjects are discussed including:

- The emergency and complexity of embedding BDA
- Resources and capabilities for embedding BDA
- Business units to involve for embedding BDA
- Objective definition of embedding BDA
- Interrelations between capabilities
- Trade-offs between conflicting interrelated capabilities
- **Sub-conclusion of sub research question 1**



Figure 13: Second chapter of this thesis in the second Design Science phase.

2.1. THE EMERGENCY AND COMPLEXITY OF EMBEDDING BIG DATA ANALYTICS

2.1.1. WHAT IS BIG DATA ANALYTICS?

Big Data Analytics is a grouping term for Big Data and Data Analytics, which is commonly used in academic literature. According to Davenport and Harris (2007), it can be defined as “the extensive use of data, statistical and quantitative analysis, exploratory and predictive models, and fact-based management to drive decisions and actions”. The goal of BDA is threefold, as is depicted in Figure 14. Insights are created from large amounts of data through analytics. These insights, subsequently, are transformed into value (LaValle *et al.*, 2011). To acquire value, however, action is needed driven by those insights. These three steps are concisely discussed in this section.



Figure 14: Data into insights into through Big Data Analytics and insights into value through action (LaValle *et al.*, 2011)

FROM DATA TO INSIGHTS

Due to digitalisation over the last decades, the amount of data that is captured from transactions has exploded in the last few years. 40 zettabytes (43.000.000.000.000 gigabytes) of data will be created by 2020, which is 300 times more than in 2005. On itself, the data does not tell much about a situation. The power of BDA, however, lies in the translation of large amounts of data into insights. These insights give key information about key aspects. The usefulness of data is determined by “the four V’s of Big Data” described by IBM (2014):

- *Volume* describes the scale of data.
- *Velocity* describes the analysis of streaming data.
- *Variety* describes the different forms of data coming from various sources.
- *Veracity* describes the uncertainty of data.

With the increasing of data *Volume* with high *Variety*, *Veracity* and an enormous *Velocity*, data as a resource has become easily available for business means opening up opportunities for creating value (Buhl *et al.*, 2013; Chen *et al.*, 2012; Kwon *et al.*, 2014). However, in order to create value, insights need to be extracted from the enormous amounts of data. An insight contains ‘timely and sharp’ information that relates to certain business operations (LaValle *et al.*, 2011). It is not beneficial anymore to understand what has happened and why it happened. Organisations need to know what is happening now, but also what will be happen in the future. Interpretations of new signals from the global economy can be made to know where competitive advantage can be achieved. In order to achieve this, however, insights-driven actions are needed.

FROM INSIGHTS TO VALUE

For creating value from insights, action is required from the business side of a firm. When firms possess the right insights, it allows them to detect opportunities for creating value and enhancing the competitive advantage. A survey among 3000 business executives conducted in collaboration with MIT and IBM, asserts that BDA-transformed firms substantially outperform their industry competitors (2011). Insights penetrate change and create new ways of working, communicating and collaborating (Loebbecke *et al.*, 2015). They trump the tendency to use intuition in decision-making and thereby guide the firm towards success (LaValle *et al.*, 2011). Examples of benefits of BDA-driven action in firms are explained below.

BENEFITS OF BDA

There is a wide variety of benefits that can be achieved by conducting BDA in firms. Whereas a supply-chain officer uses data distinctly than a marketer, insights can be used to create value depending on the firm and context. Several generic examples of benefits can be outlined ([DataScienceSeries, 2016](#)):

- Learn to know the customers in the market
- Create new products or services
- Detect opportunities
- Monitor performance
- Detect risks
- Create new revenue streams
- Customise service towards client-demand
- Optimise processes (reduce costs and effort)
- Support business operations

COMPLEXITIES OF BDA

The negative side of BDA in firms is that its implementation is complex. According to Braganza et al. BDA reaches its full potential when it is performed on a frequent basis ([2017](#)). However, these complexities prevent firms from successfully frequently realising this ([Braganza et al., 2017](#)). Main reasons of this are ([LaValle et al., 2011](#)):

- Lack of understanding of how to use BDA
- Lack of engagement of insights
- Lack of skills internally in the line of business
- Inability to get data
- Culture of sharing information
- Lack of executive buy-in
- No trust in the data
- Perceived costs outweigh the benefits

2.1.2. WHAT IS EMBEDDING OF BIG DATA ANALYTICS?

As is discussed in section 1.2, BDA projects fail to achieve their potential due to organisational, human and technological complexities. A common explanation found in literature for this, is that firms are unable to embed BDA in their business operations ([Olszak, 2016](#)). Before going more into depth on this, the question emerges on what embedding of BDA is. In the context of this thesis, it is defined as follows:

*Embedding BDA in business operations means that BDA **resources** are frequently utilised by different **business units** from the organisation to support their tasks and improve decisions. The organisation is **capable** of performing all necessary activities regarding BDA and there is a common understanding of what **objectives** are to be achieved by BDA. The effects of capabilities on the organisation are well considered which means that the **interrelations** that they have on each other are assessed. Conflicting interrelated capabilities, which means that one is hampering another and vice versa, are **traded off** whereby it is prevented that problems emerge in late stages in the project of embedding BDA.*

As can be seen in the description above, there are six aspects represented in bold. These aspects form the frame where this thesis is structured to. Eventually, each aspect represents one phase of the (BORCIT) framework that is designed throughout this thesis (see chapter 6). Therefore, these aspects of BDA embedment are reoccurring in every chapter and every phase of the Design Science roadmap, as can be seen in Figure 12 of section 1.7. In this chapter, literature relating to each aspect is discussed.

The six aspects that are researched in this thesis, as overviewed in Table 3. Notice that the sequence of the sections is not ascending, however, this choice is made to enhance readability of the chapter.

Aspect	Section	Section title
Business units to involve	2.3	Where Big Data Analytics is embedded in organisations
Objectives to achieve	2.4	Strategy definition cycles within organisations
Resources for embedding BDA	2.2	Resource Based View as a tool for defining Big Data Analytics strategy
Capabilities of embedding BDA	2.2	Resource Based View as a tool for defining Big Data Analytics strategy
Interrelations between capabilities	2.5	Conflicts in and Between Strategies
Trade-offs between conflicting capabilities	2.6	Trade-offs in strategy defining

Table 3: Aspects of embedding BDA in business operations and in which section they are discussed of this chapter

ASPECT 1 AND 2: RESOURCES AND CAPABILITIES FOR EMBEDDING BIG DATA ANALYTICS

Although resources and capabilities are often confused and are difficult to distinguished, their main difference can be explained by the way they are described (especially in this thesis). Resources are objects and therefore defined in **passive form**: skills, data governance, analyses, models, data warehouse, knowledge, analytical tools etc., which can be used to perform BDA activities. Capabilities are abilities to do something and therefore defined in **active form**: the ability of a firm (or business unit) to perform actions that use BDA resources in order to achieve an objective.

The definition of resources in the context of this thesis is:

A source of supply, support, or aid, especially one that can be readily drawn upon when needed (Dictionary.com, 2016a).

The definition of capabilities in the context of this thesis is:

The quality of being capable or the ability to undergo or be affected by a treatment or action (Dictionary.com, 2016a).

The relation between resources and capabilities can be explained as follows. First of all, a firm needs an objective, for example: assess the outliers of the internal orders. A firm possesses resources such as data, computer, data interpretation skills, data analyst and a strategic plan (for assessing outliers). Together they form the capability: the ability to analyse data and derive conclusions from it. In this way the firm is able to achieve the objective of assessing outliers. The 'complex' relation between resources and capabilities is further elaborated in section 2.2.4.

2.2. RESOURCE BASED VIEW AS A TOOL FOR DEFINING BIG DATA ANALYTICS STRATEGY

2.2.1. THE RESOURCE BASED VIEW IN GENERAL

Lieberman and Montgomery explain the objective of the Resource Based View in one sentence: "The richer a firm's resources are, the more the firm is able to adopt new resources in an agile manner" (1998). This implies that when a firm has good control over its resources, it provides opportunities to achieve benefits. However, this also implies when a firms do not have adequate control over its resources, barriers are encountered leading to strategic disadvantage.

The Resource Based View was originally initiated by Barney as a tool to acquire a holistic view of a firm's resources in order to explain a firm's success (1991). Barney claimed that a firm's competitive advantage can be explained by the adequacy of how a firm manages its resources whereby capabilities are created. These capabilities emerge through a combination of the dealing with and possessing of physical, human and organisational resources, see Figure 15. Main benefit is that, in complex socio-technical systems, problems can be observed holistically whereby their roots can be identified and intervened on when necessary.

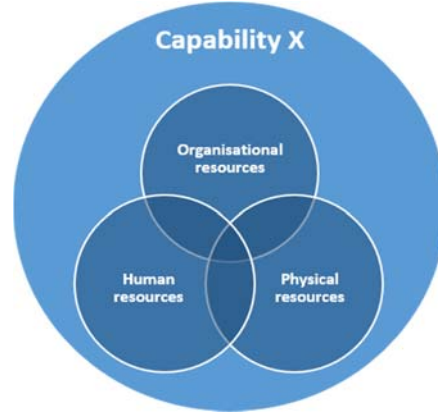


Figure 15: Visual interpretation of the relation between a capability and organisational, human and physical resources of the Resource Based View

Wernerfelt's VRIO criteria are often utilised as an extension to the Resource Based View claiming that, in order to achieve competitive advantage, adequate resource management is not sufficient (1984). Instead, capabilities only provide strategic advantage when resources comply with one or more of the VRIO criteria: 1. They need to be valuable, 2. Be rare, 3. Be inimitable and 4. Have organisational support. When all four criteria are achieved, optimal and prolonged organisational advantage is acquired. However, these criteria should not be considered only once, but iteratively, to maintain this advantage.

2.2.2. THE RESOURCE BASED VIEW IN CONTEXT OF BIG DATA ANALYTICS

In academic literature, many authors use the Resource Based View in the context of Big Data Analytics, as is presented in Table 5. Whereas they agree that there is little known about BDA capabilities, the perspective of research differs and, therefore, is concisely discussed in this section.

Gupta and George empirically validated the existence of a BDA capability by conducting research with survey data from 108 executive technology leaders (2016). They claim, however, that this capability is not acquired by solely managing BDA related resources. More important is the combining of a set of resources, which is unique for each firm, where resources need to be aligned with capabilities and strategy. Table 4 presents an overview of the three types of resources of the Resource Based View in the context of BDA. A distinction is made between first and second order resources that together embody third order resource: the BDA capability. Through this capability, both operational and market performance is achieved.

Resource	Context	2 nd order resources	1 st order resources
Physical	"What we have"	Tangible	Techniques, data, tools, dashboards, infrastructure, capacity, information technologies, basic resources
Human	"What we can"	Human	Insights, training and learning, knowledge, skills, experience, expertise, openness, motivation, organisational learning, technical skills
Organisational	"What we do well"	Intangible	Strategy, policy, organisational structure, cultural, social system, compliance, values, data driven, management skills

Table 4: Overview of the resources according to the Resource Based View (Barney, 1991; Gupta et al., 2016; Johnson et al., 2008)

Olszak et al. also uses the Resource Based View to 'throw new light on the organisation' (2016). They claim that success of a firm's strategy is decided by the configuration of its resources. The concept of the Resource Based View is used to define a capability in the context of Business Intelligence as 'the IT-enabled analytical capability for improving decision making, firm's performance, and adoption to changeable environment' (Watson et al., 2007). These capabilities enable firms to change business models through detecting and adapting to disruptive events. The biggest barrier of lacking implementation of BDA in firms is in many cases the absence of a 'well defined' business

problem, whereas biggest benefit is achieved by successful management resources the quality of data, technologies, skills, sponsorship, alignment between business and BI, and BI usage (Davenport *et al.*, 2007).

Davenport and Harris emphasise that capabilities are created through capabilities and henceforth need to be pursued (2007). They allow firms to react much faster and adapt to the rapidly changing environment. Traditional capabilities need to be supplemented with big data technologies and skills to achieve capabilities.

La Valle *et al.* mention that analytics capabilities must be 'closely linked to business strategy, easy for end-users to understand and embedded into organizational processes so that action can be taken at the right time' (2011). By creating agenda and setting a goal for the extend of possession of analytics capabilities, three levels are distinguished. Firms, should develop their capabilities in order to acquire a more mature analytics capability. Besides, analytical capabilities are created through the development of basic capabilities, whereby they do not serve as a replacement.

Kwon *et al.* use the Resource Based View to assess the capabilities that are important for BDA implementation within a firm (2014). Research is done by a survey to assess how these BDA capabilities differ per industry whereby a wide target group was taken. A series of BDA capabilities is found and claimed to be essential for firm's success, whereby organisational capabilities are emphasised. Hence, this leads to the implication that capabilities need to be developed and aligned with technical resources instead of solely focusing on the technical resources.

Tan *et al.* lecture about business analytics capabilities which they perceive from the Resource Based View (2016). They describe this capability as 'the ability to compete in analytics through organising, standardising, and manipulating data' which is important to possess in today's rapidly changing business environment. To establish competitive advantage, they claim that firms should bundle their resources to create technology-enabled capabilities rooted in core business operations. However, also it is claimed that analytics capabilities on their selves are not sufficient to create value; basic capabilities should be possessed which are regarded as preconditions for successful implementation. Eventually they propose a framework based on a series of reviewed frameworks.

Akter *et al.* use the Resource Based View in order to emphasise the importance of organisational capabilities from the socio-materialism perspective, which need to be constitutively entangled and mutually supportive to achieve optimal firm performance (2016). Alignment of these capabilities is necessary to be distinctive.

Dutta *et al.* claim that in order to achieve successful implementation of a BDA project, several capabilities need to be possessed regarding data-drivenness (2015). Underpinned by empirical research they conclude that BDA capabilities are created through a clear understanding of the business problem, a detailed and well planned project roadmap, a cross functional project team, adoption of innovative visualisation techniques, patronage and active involvement of the Executive Management, and a culture of data driven decision making.

Kowalczyk *et al.* mention that analytics capabilities need to be associated with business intelligence and analytics (2014). They include techniques such as accessing, analysing, analytical processing, and producing interactive dashboards and reports. However, purely focusing on technologic analytics capabilities is sufficient as organisational information processing mechanisms should also be taken into consideration.

Isik *et al.* claim based on a large scale survey that failure of business intelligence project can be explained by the lack of understanding of business intelligence and the possessing of capabilities (2011). However, by studying the relationship between capabilities and business intelligence, majority of the most success-depending capabilities were not directly related to business intelligence. Therefore, they conclude that capabilities can be situated all over the organisation and need to be aligned for the sake of interaction within the firm. In addition to this non-business intelligence capabilities, the key to become an information-based organisation is the development of more advanced business intelligence capabilities.

Chen *et al.* validate the 8 of the 13 types of business intelligence capabilities, proposed by Sallam *et al.* in a Gartner report, that a firm should possess in order to let 'Big Data have Big Impact' (2012; 2011). Without these capabilities, big data is not engaged in business operations and its potential is not achieved. They come up with an overview of the literature on recent developments concerning BDA capabilities and their tools and applications.

Shanks et al. mention that there are many case studies emphasising that capabilities need to be developed in order to achieve successful BDA implementation, however, underpinning theoretical frameworks on this subject are either missing or lacking in strategy defining (2010). In the context of business analytics, relevant capabilities enhance the data-drivenness of decision-making in organisations, and therefore, are important to develop whereby competitive advantage is acquired.

Cosic et al. use the Resource Based View to establish a capability model whereby they claim that business analytics capabilities are created over time when an organisation matures (2012). They argue for more research on business analytics capabilities as the link between IT assets and organisational resources has been empirically approved several times. Business capabilities create business value over time and enhance the strategic advantage of a firm whereby they should include them in their strategy.

Term/name used	Author	Definition of a BDA capability
Business analytics capability	(Tan et al., 2016)	The ability to compete in analytics through organising, standardising, and manipulating data.
Analytical capability	(Olszak, 2016)	The IT-enabled analytical capability for improving decision making, firm's performance, and adaption to changeable environment.
BDA capability	(Davenport et al., 2013)	This capability set obviously makes it possible to escalate much more frequently to adapt to changing conditions in the market.
BDA capability	(Aker et al., 2016)	A distinctive competence of the high-performance business process to support business needs.
Analytics capability	(LaValle et al., 2011)	Engaging analytics-driven insights to trigger new actions across the organization.
BDA capability	(Kwon et al., 2014)	Big Data Analytics is an innovative IT capability and strategic resource that can render competitive advantages to an adopting firm.
BDA capability	(Gupta et al., 2016)	BDA capabilities lead to superior firm performance, which are created by management of first and second order resources e.g. integrating internal and external data.
Analytics capability	(Kowalczyk et al., 2014)	Basic techniques for accessing, analysing, analytical processing, and producing interactive dashboards and reports.
Data drivenness capability	(Dutta et al., 2015)	Firm's characteristics who make the implementation of a Big Data Analytics project successful.
Business intelligence capability	(Isik et al., 2011)	BI capabilities are critical functionalities that help an organisation define the success of BI applications.
Business intelligence and analytics capability	(Chen et al., 2012)	Through cherishing basic capabilities, advanced business intelligence capabilities are acquired, which subsequently ensure successful business intelligence and analytics.
Business analytics capability	(Shanks et al., 2010)	In the context of business analytics, relevant capabilities include business analytics skills and management, competency, practices and routines for using business analytics in decision-making, and the existence of fact-based or evidence-based culture in management.
Business analytics capability	(Cosic et al., 2012)	Capabilities that lead to business value caused by the direct link between IT assets and organisational resources.

Table 5: Summarising overview of the interpretation of capabilities that play role in the success of BDA embedment

2.2.3. DEVELOPING BIG DATA ANALYTICS CAPABILITIES

This section is dedicated to discussing the manners for developing capabilities that are important for BDA. Although there are many roadmaps and frameworks available, this section provides an overview of the main trends, which are also displayed in Table 6.

Tan et al. review a series of framework on the implementation of BDA in firms where they recognised three-stage pattern that seems to be important in every framework (2016). They state that preconditions should be met which serve as attributes to achieve the desired consequences through business analytical capabilities. Eventually, these capabilities create value that contributes to the competitive advantage of the firm.

La Valle et al. discuss three levels of analytics capabilities where a firm can aim on: 1. Aspirational, 2. Experienced and 3. Transformed (2011). Whereas aspirational capabilities exhibit the usage of BDA to justify actions, the

experienced capabilities entail analytics to guide actions and transformed capabilities comprise analytics to prescribe actions. They claim that existing capabilities that are necessary to keep an organisation running do not need to be replaced by BDA capabilities, though need to be supported by them. Based on case studies, they claim that capabilities even grow with adoption of analytics capabilities. Firms need analytics capabilities in order to grow their core capabilities that create their initial added-value. La Valle claims that capabilities need to be embedded in all function-levels across a firm, where analytics are used on all levels and insights are accessible and engaged in every operation. However, this entails that there should be a central BDA unit, where advanced standardised methods are created by research and development. Furthermore, it is claimed that firms should have an updated information agenda where they pursue their strategy by defining clear goals and continuously developing the necessary capabilities.

Davenport and Dyché distinguish five stages in the development of analytical capabilities: 1. Analytically impaired, 2. Localised analytics, 3. Analytical aspiration, 4. Analytical companies and 5. Analytical competitors (2013). These form the fundament for BDA Maturity Models where the development status is measured of the usage of BDA in firm's operations. By Olszak et al. the term maturity is explained as 'the state of being complete, perfect or ready' underpinned by a summary of 13 BI Maturity Models (2016). When a higher maturity level is aimed to be achieved, BDA capabilities need to be developed.

Shanks et al. extend the theoretical framework of the Resource Based View whereby operating strategy, autonomy and BDA maturity are mapped (2010). In these seven steps, they define a matrix whereby operating model strategies are mapped with the extend of business process integration and business process standardisation. Aligned with this strategy, this framework explains how resources contribute to a superior firm performance.

Seddon et al. composed a model that is consistent with the Resource Based View and, dynamic capabilities and combine it with the literature of BDA and business intelligence (2016). Their proposed business analytics success model comprises two parts: the process model and the variance model. Subsequently, nine phases were examined of which five were empirically underpinned. The following steps seem to be important in success of analytics projects: 1. Data Quality, 2. Enterprise wide integrated BI platform, 3. Leadership, 4. Well-chosen agents, and 5. Analytic leadership.

Cosic et al. claim that there is a gap regarding to the realisation of BDA capability development (2012). For that reason they propose the business analytics capability Maturity Model that aims on closing this gap, taking 16 capabilities and allocating a class type to them including governance, culture, technology and people. Eventually they define for each capability a five-level roadmap towards optimised utilisation of business analytics in organisations. It starts with level 0. Non-existent, 1. Initial, poorly developed capabilities, 2. Intermediate, capabilities are well developed, though leaving much room for improvement, 3. Advanced, very well developed capabilities but still little room for improvement and 4. Optimised, whereby capabilities are all fully mature and improvements are difficult to envision. Hence, when for the governance, culture, technology and people maturity – each having four specific capabilities – are highly developed, the overall business analytics capability leads to optimal and sustainable competitive advantage.

Bose et al. assert that a successful business intelligence infrastructure must be able to transform disparate data and systems into an efficient information process (2009). Data must be analysed with a forward-looking view and, eventually, the key information must be delivered to executive decision-makers. In order to achieve a successful strategy, the IT infrastructure must be aligned with business needs. Resources must support the achieving of objectives and goals which can be realised in three main phases of their proposed infrastructural capability framework. Firstly, capabilities for data integration should be developed by enhancing infrastructure. Secondly, capabilities for advanced analytics should be developed by acquiring expertise and skills. Thirdly, intelligence should be delivered to the right decision-makers at the right time through for example dashboards or reports.

Kiron and Shockley admit that achieving a momentum of strategic competitive advantage is hard work (2014; 2011). They discuss three types of firms concerning the usage of BDA in their operations: analytical challenged, analytical partitioned and analytical innovators. Although they claim that the competitive advantage is stalling as more and more firms adopt BDA in their organisation, still improvements can be made on the area of BDA related capabilities.

Through empirical research they claim that the three most important analytics capabilities are culture, data management and skills, which should be developed in order to compete on analytics. They propose five key questions that management executives should ask themselves in order to keep themselves ahead of the competition, which lead to seven concluding statements evaluated against the three analytics capability levels: 1. Treat data as a core asset, 2. Analytics need top level support, 3. Investments: the precursor to analytics success, 4. Use analytics to guide strategy, 5. Analytics changes business conduct, 6. Advanced users report better financial performance and 7. Be open to new ideas.

As showed by literature wide variety of authors using the Resource Based View agree upon the fact that firms should develop capabilities in order to successfully adopt BDA into their business operations. Regardless, as capabilities can be divided in different categories, BDA embedment strategies can comprise a set of capabilities (Cosic *et al.*, 2012; Davenport *et al.*, 2013). Therefore, a strategy should take these capabilities into consideration.

Cosic *et al.* assert that BDA related capabilities can be divided up in levels including governance, culture, technology and people (2012). Within each category four capabilities are defined which eventually contribute to the overall BDA capability. Davenport and Dyché propose a level division that looks similar to Cosic's levels, which is called the 'Big Data Stack' (2013). Here, layers such as storage, platform, data, application code and functional services, business view and presentation and consumption are classified. Between these layers, data is exchanged and, henceforth, capabilities are necessary on every level having impact on different actors.

Capability development framework	Author	Stages
Developing business analytics capabilities	(Tan <i>et al.</i> , 2016)	1. Attributes: preconditions for business analytics capabilities, 2. Consequences: business analytics capabilities, 3. Value: creating competitive advantage.
Five stages in development of analytical capabilities	(Davenport <i>et al.</i> , 2013)	1. Analytically impaired, 2. Localised analytics, 3. Analytical aspiration, 4. Analytical companies and 5. Analytical competitors
PADIE framework: three levels of analytics capabilities	(LaValle <i>et al.</i> , 2011)	1. Aspirational, 2. Experienced and 3. Transformed
Extended theoretical framework for business analytics capabilities	(Shanks <i>et al.</i> , 2010)	1. Business analytics resources (technology), 2. Business analytics capabilities, 3. Value creating actions, 4. Firm performance, 5. Autonomy, 6. Operating model strategy, and 7. Maturity level.
BASM: business analytics success model	(Seddon <i>et al.</i> , 2016)	Assuming that preconditions are met of 1. Enabling of technology and 2. Analytical people, they provide five steps: 1. Data Quality, 2. Enterprise wide integrated BI platform, 3. Leadership, 4. Well-chosen agents, and 5. Analytic leadership.
Three level business analytic Maturity Model	(Cosic <i>et al.</i> , 2012)	Analytics capabilities are created through 1. Governance, 2. Culture, 3. Technology, 4. People whereby there are 5 levels: 0. Non-existent, 1. Initial, 2. Intermediate, 3. Advanced, 4. Optimised.
Intelligence framework using advanced analytics	(Bose, 2009)	Three stages are highlighted: 1. Data integration, 2. Processing capability, and 3. Business intelligence delivery.
Framework towards competing on analytics	(Kiron <i>et al.</i> , 2011)	Three stages are highlighted: 1. Data-oriented culture, 2. Information management practice, and 3. Analytics expertise

Table 6: Summarising overview of the frameworks towards development capabilities that are important for BDA

2.2.4. THE RELATION BETWEEN RESOURCES AND CAPABILITIES

It can be questioned what 'happens' between the resources and capabilities. According to Barney *et al.* (1991) and Wernerfelt *et al.* (1984) capabilities are created when resources are managed adequately. However, there is ambiguity on what is meant with 'adequate management'. There is a 'gap' between resources and capabilities, which can be interpreted in various ways (see Figure 16). This is aimed to clarify in this section.

When referring to the metaphor as mentioned at the beginning of this thesis, the resources are the bike, eyes, hands, arms and legs. As is displayed in Figure 16, capabilities are the ability to brake, to accelerate, to steer and to anticipate. A combination of the resources and a combination of the capabilities ensures that the person can ride

his or her bike, can steer and can anticipate to obstacles. Without resources a capabilities are worth nothing (e.g. without a bike, accelerating is not possible), and without capabilities the resources cannot be used (e.g. without the ability to accelerate, it is not possible to ride the bike).

In the context of BDA, capabilities are necessary to embed the resources in an organisation so that the business operations can be supported. Figure 16 demonstrates an example of embedding BDA whereby the objective is using BDA insights to minimise the inventory of a supermarket. Here, the resources are analytics tools, data warehouse, BDA skills, dashboard and transaction data. The capabilities are the ability to understand data, create insights, derive conclusions and involve complete data in the analyses. This blend of resources and capabilities contribute to the objective.

It can be criticised, however, that the Resource Based View does not discusses this into sufficient detail. Neither the authors that use the Resource Based View to define capabilities in order to use BDA resources to achieve an objective discuss this in detail. Therefore, it should be noticed that the Resource Based View has its limitations regarding the practical application. It can be reasoned that there are 'transaction costs' caused by the 'organisational capacity' that are necessary to create these capabilities (Foss *et al.*, 2005). These, however, are not visible in by using the Resource Based View. It can be questioned, what 'organisational capacity' is required and what 'transaction costs' are caused by this. This is

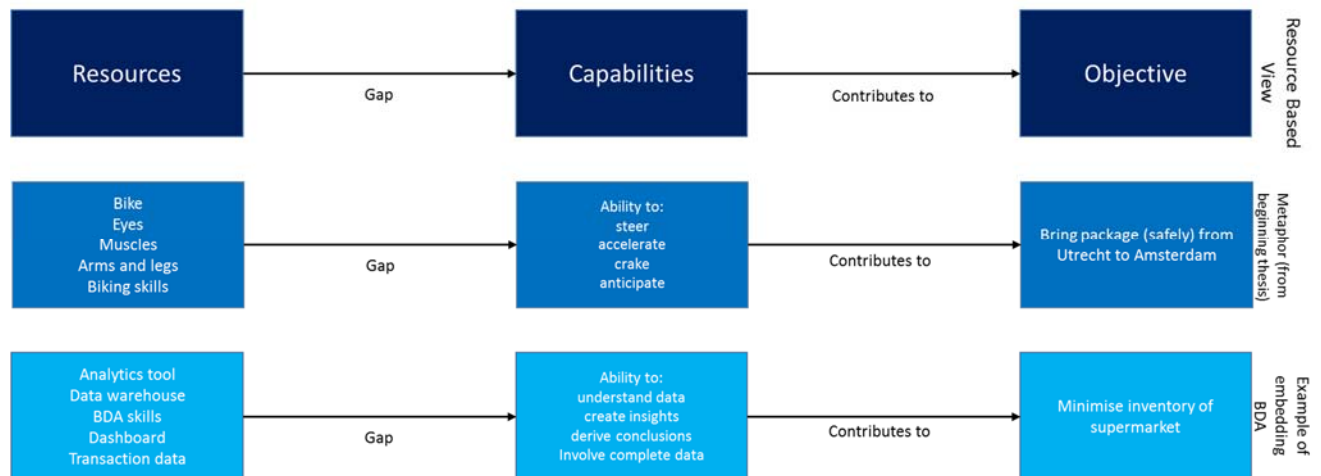


Figure 16: The relation between resources and capabilities with respect to realising an objective

2.2.5. CRITICISM: DOWNSIDE OF CAPABILITIES

Literature shows that capabilities do not solely entail benefits but also have a dysfunctional downside, which is asserted by Leonard-Barton (1992). Whereas firm's capabilities tell where a firm is capable of, they can hamper other parts of a project, especially in development projects. For this reason, firms should take into account these rigidities for other parts.

Another argument is made in the supply chain industry, where Pettit *et al.* claim that capabilities tend to entail vulnerabilities, whereby both sides need to be taken into consideration (2008). Whereas capabilities bring opportunities for eroding profits, vulnerabilities expose firms to risks.

In the Resource Based View, the implicit assumption is made that a firm is perceived as a single entity or unit whereby it has one compliant corporate strategy. In practice, however, Porter claims that firms have a two-level strategy comprising a corporate strategy and business level strategies (1989). Between those strategies, conflicts in goals may be encountered, which can be explained by the intrinsic values and interests of different units (Thomas, 1992). Remarkable is, that nothing in the field of BDA embedment is mentioned about the down side of capabilities.

Based on these assertions it can be reasoned that capabilities can have interrelations between each other, which can in principle be completing, neutral or conflicting. Whereas complementing or neutral interrelated capabilities

would not necessarily cause problems, conflicting interrelations can hamper the objective. This is elaborated in section 2.5.

Besides that, another school of criticism on the Resource Based View assert that it is too static with respect to the dynamic and complex environment. When a firm wants to survive here, it needs to be able to adapt to the changes which can be either imposed externally or created internally. Teece et al., therefore, claim that the capabilities from the Resource Based View need to be complemented with dynamic capabilities (1997). The Dynamic Capability Framework is furthermore discussed in Appendix IIA.

ASPECT 3: BUSINESS UNITS TO INVOLVE WHEN EMBEDDING BIG DATA ANALYTICS (MULTI-ACTOR PERSPECTIVE)

The definition of business units in the context of this thesis is:

A organisational area, taken from the Organisational Model that, that has its own goal and is responsible for its performance (Mintzberg, 1979). In technological projects, such as embedding BDA, three of these business units are affected: the technical staff, strategic board and the middle-line management (Steenhuisen, 2009).

2.3. WHERE BIG DATA ANALYTICS IS EMBEDDED IN ORGANISATIONS

2.3.1. MINTZBERG ORGANISATIONAL MODEL

Mintzberg created the Organisational Model which has become a popular tool to create an overview of a firm when defining strategy (1979). Mintzberg suggests that that organisations can be differentiated along three basic dimensions (Lunenburg, 2012). Firstly, there is the key part of the organisation that determines the success or failure of a firm. Secondly, the prime coordinating mechanism which comprises the supervision, standardisation and adjustment on different levels. Thirdly, the type of decentralisation used, which can be configured differently according to a firm's organisational strategy and sub-coordinates the operative core.

The first dimension, the key part of the organisation, five different organisational areas can be derived, which can be seen as business units each having their own goals and strategy. This is visualised in Figure 17. The Executive Management leads the company and creates a mission, vision and strategy (Johnson et al., 2008). The operative core, is the part of a firm that executes the core operations in order to create the core value. Furthermore, there is the technical staff and the support staff, that provide support to the organisation with secondary tasks to keep the firm running including technology deployment, research and development, accounting and control, legal counsel, canteen service, public relations etc. (Lunenburg, 2012). Eventually, the middle-line management, that is, the part of the firm where managers are 'owner' of a specific process who need to their own targets and, therefore, have their own strategy. This does not necessarily have to be in line with the corporate strategy as maintained by the executive board. As can be reasoned, this is also the reason why conflicts between interests can occur.

The second dimension, the prime coordinating mechanism of the firm comprises activities as supervision of operations, standardisation of work processes in order to improve performance, standardisation of skills in order to improve the competences of employees, standardisation of output to achieve a performance with constant quality, and finally, mutual adjustment, where internal organisational communication is aimed to enhance (Lunenburg, 2012).

The third dimension, concerns the type of decentralisation it assumes. Here, vertical decentralisation is possible, whereby there is a clear hierarchical chain of command. Horizontal decentralisation, to what extent executives are positioned across the firm and, hence, are able to make decisions on their own. Selective decentralisation, whereby certain departments or business units have decision-making power on their specific area (Lunenburg, 2012).

In next section, Mintzberg's Organisational Model is placed in the context of BDA embedment in business operations of a firm, whereby the different organisational areas or business units are highlighted.

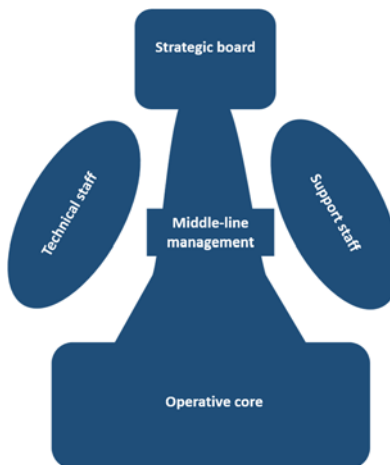


Figure 17: Mintzberg's Organisational Model that provides an overview of an organisation

2.3.2. MINTZBERG'S ORGANISATIONAL MODEL IN THE CONTEXT OF BIG DATA ANALYTICS

In the context of BDA embedment in business operations, the Organisational Model of Mintzberg can be used to highlight business units or organisational areas which are involved prominently. Notice that this is an important part of the scope, as it is not excluded that there is no involvement of other areas than the those demarcated, as is presented in Figure 18.

This organisational view provides insights in where conflicts can occur between strategies of business units, which will be elaborated more in section 2.5. There are three main business units identified, based on Mintzberg's Organisational Model and Porter's assertion on corporate strategies (1979; 1989). These are: 1. Executive Management, 2. The BDA Expert Team and 3. The Operational Management. These are also displayed in Figure 18 and are briefly discussed next.

The strategic board, in the context of BDA renamed to 'Executive Management' of a firm defines the mission, vision, goals and objectives on a firm which it includes in its strategy. In this strategy, capabilities are defined, which its firm needs to possess in order to pursue its strategy. In the context of BDA embedment in core operations, the role of the Executive Management is not active, yet their interest is important (Davenport *et al.*, 2013).

The technical staff, can be renamed to BDA Expert Team, as its purpose is to implement a BDA project, which is not a core operation of a firm. Dutta *et al.* named the business unit that executes a BDA project as 'BDA Expert Team' (2015). Their goal is to successfully implement a BDA project, whereby several steps are to be taken. Dutta *et al.* emphasised that it is important that project teams are formed (2015).

The middle-line management, in the context of this thesis renamed to 'Operational Management', has the responsibility to reach its objectives and goals, which the Executive Management has allocated. In the context of BDA embedment in core operations, it defines its own strategy as the application of BDA can be different for each type of process.

These three business units, as demarcated in Figure 18, have interactions with each other when they aim on implement a BDA project. Together they form a project team which together need to define a strategy (Davenport *et al.*, 2013; Dutta *et al.*, 2015; Gupta *et al.*, 2016). In this strategy, the interests of all business units need to be aligned and conflicts between interests need to be coped with (Steenhuisen, 2009).

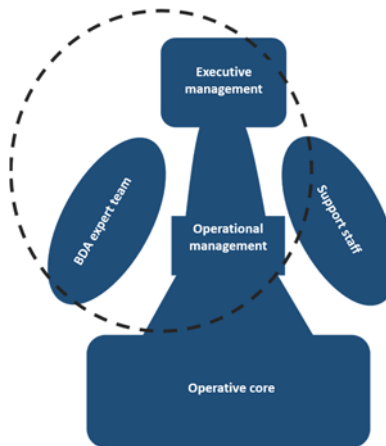


Figure 18: Mintzberg's Organisational Model in the context of BDA embedment: the circle demarcates the involved areas

ASPECT 4: OBJECTIVE DEFINITION OF EMBEDDING BIG DATA ANALYTICS

The definition of objectives in the context of this thesis is:

A specific result that a person or system aims to achieve within a time frame and with available resources (Dictionary, 2016). It is the goal that has to be achieved by embedding BDA in business operations.

2.4. STRATEGY DEFINITION CYCLES WITHIN ORGANISATIONS

As discussed in section 2.3.2, three organisational areas or business units of Mintzberg's Organisational Model have a prominent role when embedding a technology such as BDA in business operations, see Figure 18 (Steenhuisen, 2009). According to Lunenburg et al., the link between strategy and organisational structure is still in its infancy stage (2012). Chandler et al. extended Mintzberg's work by investigating how strategy can be aligned with organisational structure (1990). Putting the capabilities of the Resource Based View in perspective of Mintzberg's Organisational Model, it can be reasoned that capabilities theoretically need to complement each other. This, however, can be criticised as business units within the organisation have their own interests and goals as is asserted by Leonard-Barton and Porter et al. (1992; 1989). This is further elaborated in section 2.5.

In order to clarify where and why conflicts can occur between strategies of business units, the strategy definition cycles are briefly introduced and depicted. Firstly, the Executive Management who creates the corporate level strategy that comprises more than solely BDA embedment on its strategic agenda. Secondly, the Operational Management that has its own business unit-level strategy concerning the execution of a series of processes. And thirdly, the BDA Expert Team that has its own strategy concerning technological projects, which in this case is BDA embedment. The process cycles of these three business units, as displayed in Figure 18, are concisely introduced below in order to clarify in what areas conflicts can emerge.

In the context of BDA embedment, it needs to be noticed that strategies defined by business units comprise more than only BDA embedment and entail more than only strategic capabilities. However, they tell what an organisational area or business unit is expected to be capable of. This, subsequently, forms a basis for a firm how to utilise its resources.

2.4.1. ALIGNMENT OF STRATEGY CYCLES

Until now, the question on why these strategy definition cycles are relevant (as discussed in Appendix IIB IIC and IID) remains unanswered. According to Jellema et al. (2010), it is important when managing complex information-related projects, to align the organisational cycles to prevent problems and conflicts. They emphasise that objectives of such projects need to be commonly defined beforehand. When this is not done, it could be the case that for example the cycle of the Executive Management is already in the second phase, whereas the cycles of the other business units have not started yet. Jellema et al. assert that in that case problems occur due to the difference in expectations of the involved business units.

This is in line with the fact that one of the three types of resources is: 'organisational resources'. This resource is necessary for aligning the human and technical resources of Table 4. For example, the organisational resource such as 'strategy and planning' ensure that the right human resources human skills 'expertise and knowledge' and the physical resources 'techniques, models, tools' are deployed on the right place and the right time.

Therefore, it should be ensured that each business unit, that is affected by embedding BDA, is involved in an early stage. In this way, a common objective can be defined through negotiations and all parties have a 'buy-in' in the project. Eventually, this also increases the chance that a BDA solution is actually engaged in tasks and decisions.

2.4.2. TYPES OF OBJECTIVES OF BIG DATA ANALYTICS

Roughly said, there are four types of objectives that can be achieved with BDA: descriptive, diagnostic, predictive and prescriptive BDA (Ciandt, 2014). This does not imply, however, that there are only four objectives where BDA can contribute to. But depending of the objective, it can be derived what type of BDA is needed for achieving that, as can be seen in Figure 19.

Descriptive BDA is the least complex type, but also create the least value. Objectives regarding descriptive BDA aim on determining what is 'happening' whereby data from the organisation is used. For example, when there is a trend, descriptive BDA would aim on defining what this trend is.

Diagnostic BDA is the second type, and aims on explaining what is 'happening' based on the data from the organisation. Objectives regarding diagnostic BDA search for explanations behind events. For example, when a trend is detected, there is looked for reasons why this has happened.

Predictive BDA is the third type, which aims on looking in the future to be able to tell what is going to 'happen'. Here, historical data of trends are used together with the explanations why these trends exist in order to predict what new trends would be. For example, each year trends are detected on a specific subject, but now the firm wants to know what the next trend will be in order to prepare itself for this trend.

Prescriptive BDA is the most complex but also the most value creating type of objective. It goes further than the three other types that are discussed as it used predictions on future trends in order to prevent them from 'happening'. For example, when a trend is reoccurring but every time it changes slightly. When predictions can be made on what the next trend will be, also the underlying reasons of this future trends are understood completely. This allows a firm to anticipate to this trend by making changes in the related variables.

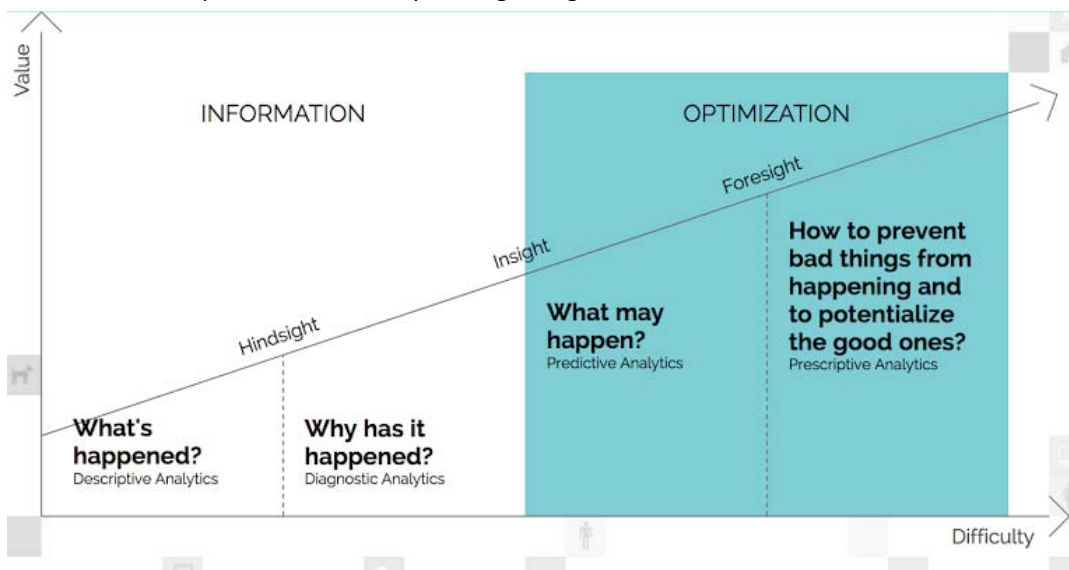


Figure 19: Four types of objectives that can be achieved with BDA

ASPECT 5: INTERRELATIONS BETWEEN CAPABILITIES (MULTI-CAPABILITY PERSPECTIVE)

The definition of interrelations in the context of this thesis is:

The impact or consequence that a capability has on another capability whereby, in principle, there are three options. Neutral interrelations meaning that there is no influence from one capability on another capability. Complementing interrelations meaning that one capability has a positive influence on another capability. And conflicting interrelations meaning that one capability has a negative influence on another capability.

2.5. CONFLICTS IN AND BETWEEN STRATEGIES

As mentioned in section 2.4, organisational areas or business units on Mintzberg's Organisational Model have different values and interests whereby they also have their own strategy definition cycle in order to achieve their goals. Amongst these strategies, it is inevitable that conflicts occur where decisions lead to favourable outcomes for one and unfavourable outcomes for another (Steenhuisen, 2009). These conflicts lead to inevitable and implicit trade-offs.

For this reason, this section is dedicated to reason in what ways these strategies can conflict with each other. As showed by literature, roughly three types of conflicts can be distinguished: 1. Conflicts inside a strategy (see Appendix IIE), 2. Conflicts between strategies of distinct business unit (see Appendix IIF) and 3. Conflicts between corporate level and business unit strategy (see Appendix IIG). Each of the conflicts is visualised with a mapping on Mintzberg's Organisational Model and supplemented with an example. Conflicts between capabilities

Reasoned from the fact that there can be conflicting interrelating capabilities in strategies, it is implied that there are also neutral and complementing interrelations between capabilities. Figure 20 presents a visualisation of these three types of capabilities in a strategy represented as gears (capabilities) rotating within an engine (strategy).

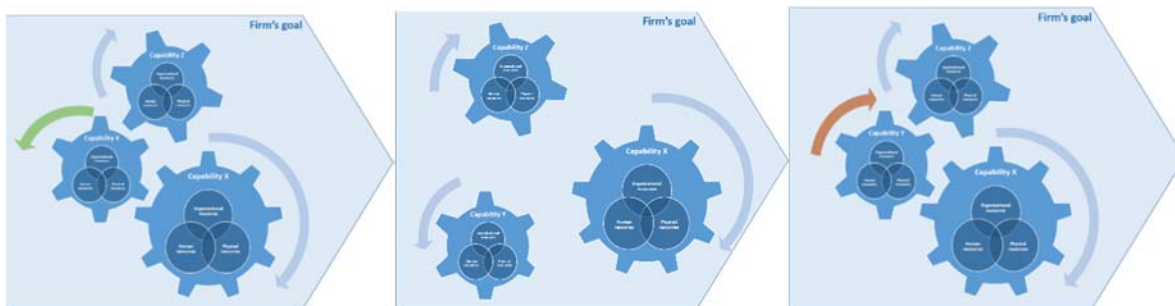


Figure 20 : **Complementing** (left), **neutral** (centre) and **conflicting** (right) interrelations between capabilities plotted in a visual interpretation of the Resource Based View

Section 2.5 discussed how conflicts between strategic capabilities can emerge and where they take place on Mintzberg's Organisational Model. Conflicts are reasoned to be both unavoidable and impossible according to Steenhuisen et al. due to intrinsic competing interests and values between groups (2009). Even though the organisation is one entity, the larger it becomes, the heavier its business units. These business units have their own personnel with their own interests and define their own strategy (Porter, 1989). Interests and values can be translated into goals and strategy. Subsequently, strategy can be translated into capabilities, according to the Resource Based View, that business units should exhibit in order to pursue their strategy and achieve their goals (Barney, 1991; Johnson et al., 2008). Therefore, paradoxically, trade-offs between values seem to be inevitable (Steenhuisen, 2009).

By making a trade-off between two conflicting capabilities, implicitly, a direction is taken towards achieving a specific goal. However, this also implies that one capability acquired and another is neglected or prioritised less high. It can be reasoned that, depending on a firm's goal and characteristics, capabilities can differ. For instance, a set of capabilities for a transport firm is likely to be different for a banking firm which can be explained by their deferring goal, resources and characteristics.

Therefore, the hypothesis is that capabilities included in strategies can conflict with each other, whereby decision-makers are forced to make trade-offs. It can also be placed in context of defining strategic capabilities for embedding BDA in business operations to achieve a certain goal. In that case, the Executive Management would not per se have an active role regarding the consideration of trade-offs. Since the process of embedding BDA in operations takes place on an operational level, the BDA Expert Team and Operational Management are likely to encounter trade-offs. However, important is to notice that eventually the business unit strategies need to be in frame with the corporate strategy despite of the occurrence of potential conflicts between their enclosed capabilities, as is mentioned in Appendix IIE, IIF and IIG.

As is already mentioned in section 2.8, the Resource Based View can be criticised due to that interrelations are not factored in when defining strategic capabilities, which implies that conflicts are ignored. Figure 20 depicts that capabilities can be seen as gears rotating within an engine, whereby they altogether contribute to a collective goal: movement of a vehicle. However, in case that gears are not aligned or even rotating in conflicting directions, friction will be caused and movement (the goal) is hampered. Regardless of the fact that all of these gears are beneficial, they obstruct each other.

	C1	C2	C3
C1		+	-
C2			0
C3			

Table 7: Schematic example of capabilities that have complementing (green), neutral (light-green) and conflicting (red) interrelations

ASPECT 6: TRADE-OFFS BETWEEN CONFLICTING INTERRELATED CAPABILITIES (MULTI-TRADE-OFF PERSPECTIVE)

The definition of trade-offs in the context of this thesis is:

The exchange of one thing for another of more or less equal value, especially to effect a compromise (Dictionary.com, 2016b). A trade-off between conflicting interrelated capabilities implies that a choice must be made between two outputs both entailing advantages and disadvantages.

2.6. TRADE-OFFS IN STRATEGY DEFINING

Until this point it has been explained that a firm comprises a two-level strategy whereby the first level is the corporate strategy and the second level comprises the strategies of the business units in the organisation (Porter, 1989). Due to differing interests and values, different groups in the organisation have different goals where they aim their strategy on (Lunenburg, 2012). For this reason, however, these strategies can also be conflicting on certain aspects (O'Brien, 2015). In a situation where organisational groups are required to collaborate, this inevitably lead to trade-offs (Steenhuisen, 2009).

Trade-offs are complex decisions that have two or more outcomes, which can either be desirable or undesirable. Compromises are aimed to achieve as there are no fully satisfying alternatives. By Dictionary.com a trade-off is defined as: 'the exchange of one thing for another or less value, especially to effect a compromise' (2016b). As strategies are series of decisions taking a specific course, numerous trade-offs are comprised. Consequences of clusters of decisions are weighted against consequences of other clusters whereby eventually the most favourable outcome is chosen.

However, trade-offs can also occur without the decision-maker knowing it (Steenhuisen, 2009). In this case, trade-offs can be taken erroneously, unknowingly or too late. Erroneous decisions are generally the result of trade-offs where information was incomplete or imperfect (Holmström et al., 1983). Hence, to prevent undesired outcomes, trade-offs should be considered carefully by walking through every scenario.

Late trade-offs detection is also undesired as they lead to late decisions, due to path dependence which restricts future decisions because of former taken decisions. If a trade-off is taken unknowingly in an early stage and in a later stage this decision seems to be incorrect, adjustments have to be made in the strategy or plan. According to Nicholas

and Steyn, however, these late decisions increase the costs of projects tremendously (2008). Namely, late adjustments can cause that preceding decisions need to be undone, whereas the costs spent cannot be retrieved. For that reason, it is favourable that trade-offs are encountered in an early stage, so that they are not taken unknowingly. However, this argument does not imply that decisions need to be taken in an early stage. Dym et al. assert that decisions should not be taken before they need to be taken (1994). The knowing about the existence of trade-offs can help to maintain this rule, as erroneous decisions resulted from unknown trade-offs are prevented.

2.6.1. TRADE-OFFS BETWEEN CAPABILITIES

As is asserted in last section, there can be conflicts between capabilities whereby developing one capability hampers another capability. In that case, trade-offs need to be made, which are complex dilemmas whereby both outputs both entail to advantages and disadvantages. This implies when one capability is developed, this is at the expense of the other (conflicting) capability. Therefore, it is important that this trade-off is considered before making it. When trade-offs are not identified before starting BDA embedment, it can be the case that there is invested (e.g. time and money) in both capabilities before discovering that developing both is not possible. To enhance understanding of this complex phenomenon, Figure 21 illustrates an example of a trade-off between two capabilities:

The first capability is “the ability to derive conclusions and interpret data insights”, named in the figure as ‘**understandability**’.

The second capability is “the ability to involve complete data in analyses and create detailed insights” named in the figure as ‘**completeness**’.

When it is assumed that there is a conflicting interrelation between these capabilities as follows: when a firm wants to be able “to involve complete data in analyses and create detailed insights”, it becomes more complex to be able “to derive conclusions and interpret data insights”. Hence, the following trade-off has to be made between ‘**understandability**’ and ‘**completeness**’.

Figure 21 displays the same trade-off visualisation as discussed in section 1.2, but now applied in the context to provide an example. As can be seen, when a high “ability to involve complete data in analyses and create detailed insights” is chosen, this automatically results in a low “ability to derive conclusions and interpret data insights”. Thus, the following outputs are possible as overviewed in Table 8:

- When the capability of ‘**completeness**’ is high, the capability of ‘**understandability**’ is low.
- When the capability of ‘**understandability**’ is high, the capability of ‘**completeness**’ is low.

	Output choice A (high understandability, low completeness)	Output choice B (high completeness, low understandability)
Advantages	• Understandable insights • Agile conclusion derivation • Easy visualise able information	• Detailed insights • Complete overview • In-depth information
Disadvantages	• Basic insights • Incomplete overview • Missing information	• Difficult to visualise • Complex insights • Poor understanding • Slow conclusion derivation

Table 8: Consequences of the outputs of the two choices from the example trade-off

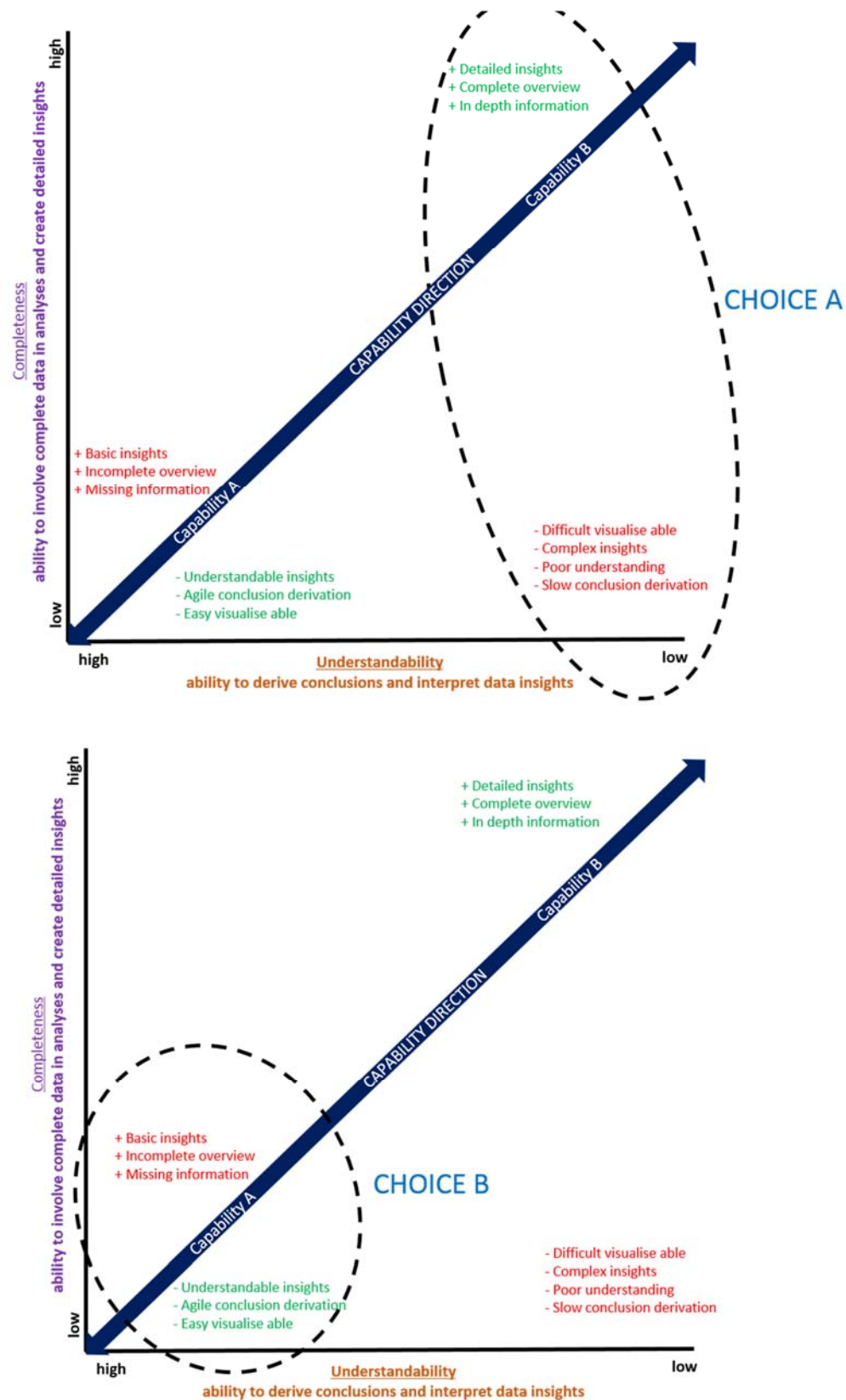


Figure 21: Schematic visualisation of a trade-off between two capabilities: understandability vs. completeness

2.6.2. WHAT ARE IMPLICATIONS OF INADEQUATELY PERCEIVING TRADE-OFFS?

Until now, it is discussed what the potential outputs are from both sides of the example of a trade-off between two conflicting interrelated capabilities, as discussed in section 2.6.1. Yet, it is not discussed what the consequences are of trade-offs when they are not perceived and henceforth are not considered.

Steenhuisen et al. (2009) assert that trade-offs are inevitable and therefore need to be considered. Especially in an early stage it is desired to consider trade-offs. On the other side, Dym et al. (1994) claim that decisions should not be made before it is necessary. However, this does not imply that trade-offs should not be perceived beforehand.

When a firm does not perceive a conflicting interrelation between capabilities, it cannot consider the advantages and disadvantages that they entail. Referring the metaphor at the beginning of this thesis, it can be questioned 'what happens when the capability of steering and the capability of accelerating are conflicting with each other, and both of them are utilised?'. It can be reasoned that, when this trade-off is not considered, and both capabilities of accelerating and steering are developed, this might lead to a crash. Hence, trade-offs between conflicting capabilities need to be perceived and considered before beginning to embed BDA. When these consequences are not considered they can lead to unexpected negativities leading to the emergence of problem.

Ignored trade-offs lead to problems, the impact of these problems depend on the project stage. Especially in late project stages, problems are very expensive due to investments already done and path dependency (Nicholas et al., 2008). In Figure 22 it can be seen that when changes are made in late project phases, impact that they have on the effort and costs increases steeply. This is because of path dependency: the earlier investments made are hard or impossible to undo. Therefore, it is from high importance that trade-offs are perceived and considered in an early stage to prevent the need for late and high impact changes.

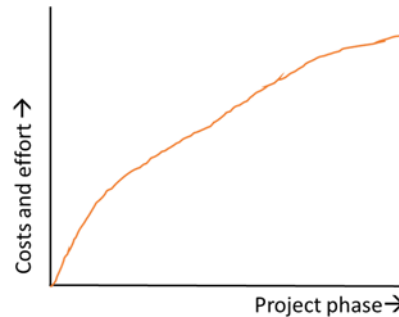


Figure 22: Cost and effort impact of a change in later project phases

In current literature on BDA, nothing is mentioned about the trade-offs between conflicting interrelated capabilities. It is assumed that capabilities cannot conflict with each other, hence, the existence of trade-offs is implicitly ignored. Therefore, the questions remain unanswered regarding how to perceive trade-offs when defining strategic capabilities for BDA embedment in order to achieve a certain goal. Thereby all literature implicitly assume that all capabilities can always collaborate with each other. This thesis asserts that this is not the case. Therefore, next sections aim on investigating what capabilities are important for embedding BDA in business operations and how these trade-offs can be perceived. When trade-offs are not considered before starting BDA embedment, it can be the case that there is invested (e.g. time and money) in both capabilities before discovering that developing both is not possible.



Figure 23: The ability to involve complete data in analyses and create detailed insights vs. The ability to interpret and visualise data and derive conclusions from insights

2.7. WHY BIG DATA ANALYTICS PROJECTS DO NOT FULFIL THEIR POTENTIAL?

N.B. notice that the question in the title is similar to sub-research question 0. This sub-question is introduced to clarify what the starting position is of this research. It helps to structure the theoretical background and give an early overview of what is within the scope.

A prominent explanation found in academic literature for the failure of fulfilling potential of BDA is, is that firms are unable to embed BDA in their business operations (Olszak, 2016). A firm is challenged by many organisational, human and technological complexities when aiming to embed BDA in its business operations. There are six aspects of failing to embed BDA in business operations. On the other side, when these phases are walked through adequately, they can transform in success. These phases are incorporated in the (BORCIT) framework that is designed throughout this thesis (see chapter 6). Figure 24 displays a causal model of these six aspects that explain failure of embedding BDA (section 2.1.2). These six aspects are briefly discussed below.

SIX ASPECTS FAILING PERCEPTION OF TRADE-OFFS FOR EMBEDDING BDA

First aspect of failing BDA embedment is that the 'BDA solution' is not engaged on a frequent basis in decision-making or supporting the tasks of **business units** in the firm (Braganza et al., 2017). When a BDA Expert Team is hired by the Executive Management of a firm to develop a BDA solution without involving the end-users from various business units in the firm, problems can occur due to misalignment of expectations and interests (Ross et al., 2006; Steenhuisen, 2009). When the BDA solution is not in line with the interests of the end-user business units, there is a high change that they are not going to use it for various reasons (LaValle et al., 2011). For example, it might be that the business units do not understand the BDA solution, or that they do not trust the insights that are presented to them because they do not recognise it (Schick et al., 2011). Besides, every business unit has a different interest and strategy which do not necessarily have to be complementing with each other (Porter, 1989).

- For example, when a purchase manager of supermarket AP wants to use actual BDA insights to anticipate on sales trends of products. A BDA Expert Team develops a BDA solution for the purchase department. However, eventually the BDA solution is not used in the purchase operations. Thus, BDA is not embedded in these operations.
- Therefore, literature regarding the involvement of business units is discussed in section 2.3.

Second aspect of failing BDA embedment is that the **objective** is not clear that needs to be achieved by embedding BDA. As can be reasoned, when many data sources are involved from several systems of the organisation, the BDA solution can become very complex (Gupta et al., 2016). Development costs and required time tend to be high for a BDA solution. When the objectives are not clear that need to be achieved, the project is doomed to fail (Nicholas et al., 2008). Important to emphasise is that the objective of BDA embedment should not be 'embedding BDA', which is still often the case (Davenport et al., 2013). Eventually, actors from different business units from the organisation need to use the BDA solution, therefore, the objectives should be common and clear.

- For example, the purchase manager of supermarket AP wants to 'remove all inventory by using BDA insights whereby the predicted sales are corresponding with the delivered products'. However, it can be questioned whether this objective is feasible.

- Therefore, literature regarding the definition of objectives that are achieved by embedding BDA is discussed in section 2.4.

Third aspect of failing BDA embedment is that the **resources** of BDA are not known, planned or managed adequately. Many firms are unable to deploy the expensive BDA resources, because of their complexity. It should be noticed that resources of BDA are not merely technological resources (e.g. databases, BDA tools, servers and analytics), but there are also organisational and human resources needed (Isik *et al.*, 2011). In order to deploy technological resources, it need to be combined with human resources (e.g. skills, knowledge, expertise). When the right people are not the right place, it is difficult to adequately utilise the technological resources. In addition to that, it needs to be in line with organisational resources (e.g. policy, governance, culture, rules, standards) to create consistency in the firm. When these are missing or lacking, the firm's processes and people are not adequately organised whereby performance lacks (Barney, 1991; A. S. Bharadwaj, 2000).

- For example, the purchase manager of supermarket AP purchases a real-time BDA dashboard which is developed by a BDA Expert Team. However, as the dashboard is complex, nobody in the supermarket has the skills or knowledge to use it. Therefore, it is not used in the business operations.
- Therefore, literature regarding the management and planning of BDA resources is discussed in section 2.2.

Fourth aspect of failing BDA embedment is that the firm does not know where it should be capable of in order to achieve a specified objective. These so called **capabilities** tell where a firm is capable of by managing and deploying its resources (Barney, 1991). However, when these are not clearly defined, it is unclear how a firm should deploy its resources for achieving the objective. There is a gap between the resources independent of their nature (technological, human or organisational) and the capabilities of a firm. Resources are 'useless' when they are not utilised by a firm 'to be able to perform actions'. Hence, capabilities have to contribute directly to the achieving of the objective (Watson *et al.*, 2007). Referring to the metaphor at the beginning of this thesis, it can be questioned 'where do you need to be capable of in order to use you bike to go from Utrecht to Amsterdam?'.

- For example, the purchase manager of a supermarket purchases a real-time BDA dashboard which is developed by a BDA Expert Team. However, as there is no data made available or no access is granted, the dashboard cannot be updated whereby its insights are not accurate enough.
- Therefore, literature regarding the development of capabilities important for BDA embedment is discussed in section 2.2.

Fifth aspect of failing of BDA embedment is that a firm does not know what **interrelations** capabilities have on each other. When this is unknown, it is unclear whether capabilities solely bring benefits or also entail difficulties with respect to a specified objective. Capabilities do not merely produce beneficial outcomes but also entail undesired side-effects (Leonard-Barton, 1992). This means that capabilities have also vulnerabilities that hamper other capabilities with respect to a specified objective (Pettit, 2008). Hence, in order to choose capabilities adequately, their interrelations should be considered with regard to advantages and disadvantages.

- For example, the executive manager of supermarket AP wants to have insights for every employee in the firm. Therefore, the BDA Expert Team develops an enhanced dashboard with detailed insights. However, now it has become very complex whereby none of the employees knows how to use it. Here, a conflicting interrelation is encountered between the following two capabilities:
 - The ability to include detailed and enhanced insights in dashboard.
 - The ability to understand data insights and derive conclusions from them.
- Therefore, literature regarding the interrelations between capabilities of BDA embedment is discussed in section 2.5.

Sixth and last aspect of failing BDA embedment is that a firm does not consider conflicting interrelations whereby **trade-offs** are implicitly ignored. When a firm does not perceive a conflicting interrelation between capabilities, it cannot consider the advantages and disadvantages that they entail. Referring the metaphor at the beginning of this thesis, it can be questioned 'what happens when the capability of steering and the capability of accelerating are conflicting with each other, and both of them are utilised?'. It can be reasoned that, when this trade-off is not considered, and both capabilities of accelerating and steering are developed, this might lead to a crash. Hence, trade-

offs between conflicting capabilities need to be perceived and considered before beginning to embed BDA. When these consequences are not considered, they can lead to unexpected negativities leading to the emergence of problem. Especially in late project stages, problems are very expensive due to the investments that are already made and path dependency (Nicholas *et al.*, 2008).

- For example, the executive manager of supermarket AP has to consider the trade-off between the two conflicting interrelated capabilities mentioned in last paragraph. Including both capabilities would result in an unfeasible objective (both detailed and easy-understandable is not possible). One has to be chosen by weighing up the advantages and disadvantages. Questions should be answered such as:
 - What capability is relatively more important to achieve the objective?
 - Do the advantages outweigh the disadvantages?
- Therefore, literature regarding trade-offs between capabilities is discussed in section 2.6.

The flipside of these six aspects of failing BDA embedment is that they can also be seen as six aspects of success. Figure 24 displays a causal model of these aspects that are discussed and demonstrates the causal relations between each aspect. This model is used as the starting position of the rest of this thesis, and thereby answers sub research question 0 (see section 1.4.3).

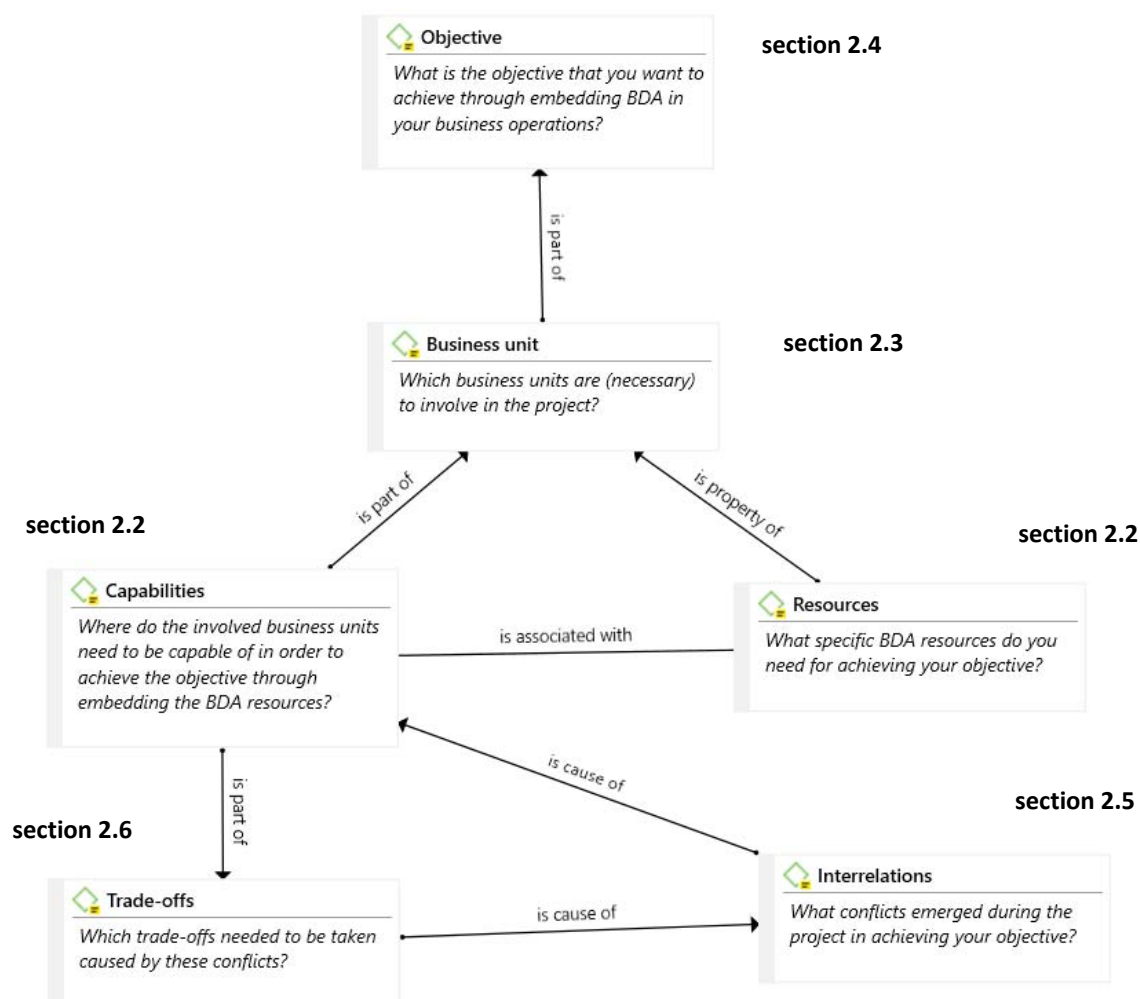


Figure 24: Relational model of the aspects of failing/successful embedding of BDA in business operations

2.8. SUB-CONCLUSION OF SUB RESEARCH QUESTION 0 AND 1

At this point, sub-questions 0 and 1 can be answered.

0. *Why do Big Data Analytics projects do not fulfil their potential?*

In literature it is prominently discussed that many BDA projects do not achieve their objectives. A common explanation for this is that firms are unable to embed BDA in their business operations. Instead, BDA activities are not performed on a frequent basis nor created insights are engaged to support business decisions or processes. To achieve embedded BDA, literature discusses that capabilities need to be created by acquiring and using the right BDA resources. However, it is not discussed that capabilities can have a negative impact on each other, hampering the course to achieve the objective. This implies that trade-offs between those conflicting interrelations need to be considered. When trade-offs are not perceived, the chance increases that unforeseen problems emerge in later stages of the process of embedding BDA. These late problems are intensive and expensive to solve whereby objective become unfeasible.

In this thesis it is asserted that failing BDA embedding projects can be explained by six aspects. First aspect is that the developed 'BDA solution' is not engaged in decision-making or supporting the tasks of **business units** in the firm. When they are not involved in the development of the solution, this can cause the misalignment of expectations and interests. Second aspect is that it is not clear what **objective** is to be achieved. As can be reasoned, when many data sources are involved from several systems of the organisation, the BDA solution can become very complex and difficult to engage in decisions. Third aspect is that the **resources** of BDA are not known, planned or managed adequately. Many firms are unable to deploy the expensive BDA resources, because of their complexity. Fourth aspect of failing BDA embedment is that the firm does not know where it should be capable of in order to achieve a specified objective. These so-called **capabilities** tell where a firm is capable of by managing and deploying its resources. Fifth aspect is that a firm does not know what **interrelations** capabilities have on each other. When this is unknown, it is unclear whether capabilities solely bring benefits or also entail difficulties with respect to a specified objective. Sixth and last aspect is that a firm does not perceive these conflicting interrelations whereby **trade-offs** are implicitly ignored. When these consequences of trade-offs are not perceived, they can lead to unexpected negativities leading to the emergence of problems. Especially in late process stages, problems are very expensive due to the investments that are already made.

With these six aspects, this study adds three perspectives to current literature in order to bridge the knowledge gap:

1. Multi-capability perspective implicating that capabilities cannot always be combined and can have interrelations with other capabilities, 2. Multi-trade-off perspective implicating that trade-offs need to be perceived before initialising the embedding process, and 3. Multi-actor perspective implicating that the different business units across the organisation need to be involved in the embedding process.

1. *How to define capabilities that are important for embedding Big Data Analytics? What business-unit perspectives of the organisation are important?*

Regarding embedment of BDA, the Resource Based View is a common-used theoretical lens that defines where a firm should be capable of in order to improve performance of their business operations (e.g. 'the ability to capture, store and access relevant transaction data in systems'). These, so called, capabilities are created when the expensive BDA resources (e.g. technology, tools, knowledge, expertise and governance) are adequately managed and deployed.

In a situation where BDA is embedded in business operations, an objective needs to be defined which must be achieved by embedding BDA. It should be clear what capabilities the organisation possesses that describe where its different business units have to be capable of in order to achieve the objective. These defined capabilities also give understanding in how resources can be deployed.

Besides that embedding BDA in business operations is a technological complex process is, it is also a challenge of the organisation. A technological artefact needs to be implemented in an organisational context, whereby resources from across the organisation are required. Therefore, the different business units of the organisation need to be

aware of what capabilities they should possess. Furthermore, actors from these business units need to participate actively. Three principal business units are distinguished:

1. Executive Management, is the highest in hierarchy, that makes strategic decisions, imposes policies and regulations. It aims to pursue the firm's strategy (e.g. performance, competitive advantage) by adopting innovative technologies, which in this case is BDA.
2. Operational Management, represents the middle-line management, that is responsible for business processes and that use BDA insights to improve their performance.
3. BDA Expert Team, is part of the technical staff, that collects and stages data, performs analyses, creates insights and provides them to business units that need them.

However, criticism on literature - that uses the Resource Based View on embedding BDA - states that interrelations between BDA capabilities are not taken into account whereby the existence of negative effects of capabilities is implicitly ignored. When interrelations between capabilities are conflicting, trade-offs need to be taken. When these trade-offs are not perceived and considered, they can lead to unforeseen problems and conflicts in later process stages (e.g. changes to requirements, struggles with laws and regulations, wrongly managed expectations, etc.). Solving these problems can result in late project changes, which are expensive and time intensive (e.g. due to former investments done). As a consequence, objectives may not be achieved. Therefore, this thesis aimed on identifying these interrelations between capabilities to perceive these trade-offs and design a framework.

This is explained with an example from the metaphor (of the beginning of this thesis). When investments are made in a new bike (resource) and in training the ability to anticipate and use a GPS system (capabilities). Suddenly, it seems that these capabilities are conflicting, as anticipating and using a GPS system cannot simultaneously performed. As a consequence, the biker is did not see an obstacle whereby he crashes. Afterwards, he decides to leave out the capability of using a GPS system. However, the costs are already made, which now seem to be unnecessary.

3. RESEARCH APPROACH

This is the third chapter of this thesis, which is located in the second phase of the Design Science cycle as can be seen in Figure 25. The second Design Science phase focuses on explicating the problem by reviewing literature, which is subsequently used for setting up a research approach.

In this chapter, subjects are discussed including:

- Introduction
- Research strategy
- Data collection
- Data analysis
- Reflection on research and data issues

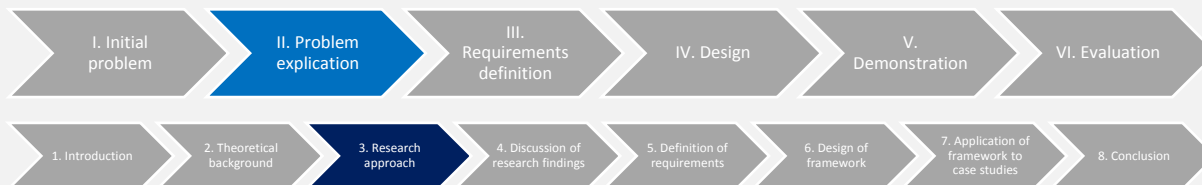


Figure 25: Third chapter of this thesis in the second Design Science phase.

3.1. INTRODUCTION

At the moment of writing this thesis, there is much known about technology adoption whereby the Resource Based View is a prominent theory. In the context of embedding BDA in business operations to achieve specific goals, much has been discussed in literature about the fact that many BDA projects do not achieve their full potential. However, little is known about linking the capabilities from the Resource Based View to the reasons why BDA embedment projects fail. Different articles have asserted that capabilities have both advantages and disadvantages. Besides, it is acknowledged by many that strategies can conflict within an organisation. However, no literature has been published on potential problems that are created by conflicts between capabilities throughout the organisation. Hence, the existence of trade-offs between capabilities is not asserted yet in the context of BDA embedment in business operations. For this reason, the nature of this research pertains to be exploratory in order to detect these trade-offs. These are, subsequently, used to design a framework for institutionalising these trade-offs.

In order to shape the research of this master's thesis, Design Science of Johannesson et al. is maintained as a roadmap (2014). This section reports how methodology is used to establish the research approach. First, the selection of the research strategy and case study for this thesis is commented. Second, it is discussed how representative and relevant data is collected through desk study and interviews. Third, it is explained how the retrieved data is processed and used for analysis, and how this analysis is performed. Fourth and last, research and data issues encountered during the research are reflected.

3.2. RESEARCH STRATEGY: CASE STUDY

The research strategy serves as a roadmap for conducting the research study (Johannesson et al., 2014). It supports the planning, executing, and monitoring of the study. While the research strategy provides information on a high level, the research methods embody the study on a detailed level. Common research strategies in Design Science are: experiments, surveys, case study, ethnography, grounded theory, action research and phenomenology (2014). However, for a research strategy it is important that it is feasible from a practical perspective. Access is required to data sources such as documents and people related to the subject. Furthermore, it is important that all information acquired needs to stay confidential and cannot be used for other purposes than this master's thesis.

Therefore, the research method of this master's thesis is chosen to be a qualitative case study approach, which focuses on one instance of the phenomenon at matter. It is directed to investigate the case thoroughly in order to acquire rich and in-depth insights on the aspects as displayed by Table 9.

Aspect	Corresponding with sub research question	Data collection method	Contribution
Business units to involve	1	Exploratory interviews	Multi-actor perspective
Objective of embedding BDA	2	Exploratory interviews	n.a.
Resources for embedding BDA	2	Exploratory interviews	n.a.
Capabilities of embedding BDA	2	Literature review and exploratory interviews	n.a.
Interrelations between capabilities	3	Exploratory interviews	Multi-capability perspective
Trade-offs between conflicting interrelated capabilities	3	Evaluation interviews	Multi-trade-off-perspective

Table 9: Overview of the investigated aspects in the case study

After trading off depth and validity in order to stay within time constraints, the choice has been made to perform two case studies. Per case study the focus is on one project instance, which is analysed in depth. Relationships and processes are analysed by studying the project instance in an holistic way. According to Johannesson et al., exploratory case study is particularly valuable when there is not much known about the phenomenon (2014).

Criticism on case studies is mainly that results encountered only apply to one instance of study. This implies that these results cannot be generalised without demarcating under what conditions they apply. The fact that two case studies are chosen to investigate, addresses this argument, as this improves validity regarding generalisability.

Nevertheless, there are many industries where many firms with different characteristics operate under different conditions. Hence, this exploratory study serves as a beginning of future studies to be performed.

3.2.2. CASE STUDY CRITERIA AND SELECTION

Before selecting the case studies, criteria need to be established. These criteria ensure that the case study is feasible for demonstration of the designed framework (Johannesson *et al.*, 2014). Based on the literature review of chapter 2, a series of case study criteria is derived. However, it is also taken into account that these criteria cannot be too strict, as a limited amount of case studies is available. The case studies that are selected are overviewed in Table 10.

- The firm needs to be a professional firm, implying that the firm needs to have multiple perspectives (Executive Management, Operational Management and BDA Expert Team).
- The case objective needs to be BDA-oriented: the firm wants to achieve something with BDA.
- The firm has BDA resources available for deployment.
- There must be a clear aim on what is to be achieved with BDA.
- At least three interviewees should be conducted with people involved in the case study.

Criteria	Case study 1: an employment agency	Case study 2: a dairy producer
Professional firm	Yes	Yes
Different business units involved	4 actors in 3 business units	4 actors in 3 business units
Case objective is BDA oriented	Yes (auditing)	Yes (process mining)
BDA resources available	Yes	Yes
Aim	To choose the best timesheet process	To enhance the underperforming production lines
Amount of interviewees per case	3	3

Table 10: Case study selection based on the criteria

3.2.3. CASE STUDY 1: AN EMPLOYMENT AGENCY

The employment agency is situated in the Netherlands and operates in countries all over the world. Its aim is to start using BDA to optimise processes. Hereby, costs need to be reduced, quality of information processes has to be kept high and it has to be made more time-efficient. A small part of the strategy concerning BDA is used in this case study to derive the objective for one country and one process; completing timesheets in Australia. The objective is: *“To optimise average lead times of the different types of timesheets used in the Australian part of the firm”*.

Currently, there are four types of completing timesheets that are used in the Australian part of the firm. After employees hired by the employment agency have finished their (periodical), they have to complete their timesheet to get paid. This is one of the main administrative processes of the employment agency. However, it can become complex due to the irregularities of the employees. For example, they have different wages, locations, types of job, expertise, function roles and working times. Based on the timesheets the client firms are billed, which forms the main revenue of the employment agency. In order to ensure correct billing, it is important to make this activity as efficient as possible. It has to be performed correctly, in time, and it should not take too much effort.

3.2.4. CASE STUDY 2: A DAIRY PRODUCER

The dairy producer is situated in the Netherlands and operates in several countries in Europe. There are many production lines from farmers to the factory in the Netherlands. However, Its aim is to start using BDA to detect which production lines are beneficial and which ones are not. Also an explanation is searched by examining the root causes. Therefore, the objective of embedding BDA *“to determine which supply chains are underperforming and why”*.

Currently, there are various combinations how a production line can look like. As farmers have different locations, the distance and temperature play important roles. Most important is that the dairy products stay in good state hence that the quality is high. Besides that, the production times and costs need to be optimised. However, due to the large amount of different production-line combinations data becomes complex. It is difficult to monitor what lines are performing positively and negatively. Therefore, the dairy producer wants to use BDA to achieve insights

that can be monitored and controlled when necessary. These insights need to lead to actions, as the firm wants to optimise its commercial position.

3.3. DATA COLLECTION: DESK STUDY AND INTERVIEWS

The data collection exists of two main parts: desk study and interviews. Firstly, as the nature of this research is exploratory and the subject at matter is, at this moment, relatively undiscussed in literature, data is collected through open-ended semi structured interviews and desk study with documents. According to Johannesson, in principle, any data collection method can be used to follow a specific research strategy (2014). However, it can be helpful to use more than one method to validate the findings, which is called a 'mixed methods approach'.

This 'mixed methods approach' is maintained as first desk study with documents such as academic publications, organisational records and management letters. Academic publications, on capabilities important for embedding BDA in business operations, are plenty available. Through study of academic publications, a long-list of capabilities is established whose purpose is to support the matching and identification of capabilities with interviewees responses. However, documents do not tell anything about what trade-offs could be encountered when embedding BDA into business operations. Therefore, organisational records and management letters are studied to acquire insights on what potential trade-offs could have occurred during the BDA embedment project. This is further explained in section 3.3.2.

Secondly, during the semi-structured interviews a list of open questions is maintained that structure the interaction between interviewer and respondents. Whereas in a fully structured interview respondents can only choose from a specific list when answering, in a semi-structured interview the respondents are free to provide answers. The latter suits best in the case as the projects of the different case studies probably differ, and henceforth, ensure that no information is missed. Besides, questions are repeated in different ways to increase the understanding of the answers provided. All interviews are recorded with audio, transcribed and sent back to the respondent for validation. Interviews of this research are structured in two rounds, as is presented in Table 9. Round 1 are the exploratory interviews which are dedicated to the identification of capabilities, that are important for BDA embedding in business operations, interrelations between capabilities and what trade-offs need to be taken when capabilities conflict with each other. Round 2 are the evaluation interviews, wherein the trade-off model is evaluated through ex-ante validation. Here, the trade-off model design is conceptual and not yet employed but feedback is requested to enhance the design. This is further explained in section 3.3.3.

3.3.2. DESK STUDY

The first part of the data collection for this research is performed through desk study. The desk study comprises two main parts: the general and the case-specific part. In the general part, literature survey of related articles with regard to BDA embedment is performed. Here, it is aimed to acquire a list of capabilities wherefrom its importance is emphasised by literature. In the case-specific part, organisational records and management letters are studied related to the case studies performed. The aim is here to grasp the case's problem definition in order to provide a solution in the demonstrate artefact part of this thesis. However, first, the documents criteria are drafted to which documents of the desk study must comply.

LITERATURE SURVEY

The research method of this scientific article is a systematic literature review through the lens of the Resource Based View to encounter capabilities that are important for BDA embedment. An extensive search for these capabilities is executed, by using related articles.

In order to enhance the reliability and representativeness of literature, a series of most appreciated scientific databases by the TU Delft Library is used including Scopus, Web of Science, IEEE Xplore Digital Library, JSTOR, Google Scholar and NARCIS. In these databases the following key-terms are used:

Big Data Analytics, Innovation Adoption, Process Optimisation, Business Intelligence, Capabilities, Vulnerabilities, Decision-making, Resources.

As the amount of articles found in each database was too large when "OR" was put between the key-terms and too small when "AND" was put between the key-terms, a few criteria were established. Articles on the first several pages

of the search engines were checked whereby based on their abstract and title of these articles, it was decided whether the article was related or not. Besides, articles that go into depth on solely the BDA technology were not included as the main focus of this paper is to get an impression on the state-of-art of the adoption of BDA. Eventually, an amount of 54 useful scientific articles was found, as displayed in Table 11.

Scientific Database	Amount of articles found	Amount of useful articles
Science Direct	166	12
Scopus	26	3
IEEE Xplore Digital Library	17	5
JSTOR	170	4
Google Scholar	1000+	30
NARCIS	0	0

Table 11: Overview of related articles found

CASE STUDY DOCUMENTS

For confidentiality reasons, KPMG provided several management letters and presentation books of the two case studies. However, these documents are already concise and only provide information on executive level. Details and data could not be used for the case studies. However, for the purpose of this research, management letters and presentation books are sufficient. In the evaluation interviews also more information was asked on the case. Eventually, sufficient information was available. Notice that for this reason no criteria for document search was necessary.

3.3.3. INTERVIEWS

The second and largest part of the data collection is acquired through interviews, which are briefly discussed in this section before defining the interviewees criteria. The interviews are structured in two rounds whereby the strategy and method of interviewing differs per round. An overview of the organisation of the interviews is presented in Table 12, which demonstrates what the strategy, method, objectives, inputs and outputs are. In this way, it becomes clear what criteria are needed for achieving successful interviews where all necessary data is collected.

In order to allow Qualitative Data Analysis, all interviews are recorded for which verbal consent was sought and given. Also verbal agreement was made that recordings and transcriptions of interviews are sent back to the interviewee for validation.

	Round 1	Round 2
Interview strategy	Exploratory	Evaluation (ex-ante validation)
Interview method	Semi-structured questions and open answers	Analytic Hierarchy Process-structure Additional ad-hoc questions
Amount of interviews	6	6
Objective	Review capabilities and identify trade-offs	Assess trade-offs for a specific case study
Input	- List of capabilities from literature - Semi-structured questions	- Trade-offs encountered in exploratory interviews - Case briefing from desk study
Output	- List of important capabilities - Important trade-offs encountered	- List of perceived trade-offs - Evaluation of framework design

Table 12: Overview of the organisation of the interviews

ROUND 1: EXPLORATORY INTERVIEWS

The first interview round is of exploratory origin, as the goal is to acquire more understanding of BDA projects and ask interviewees about important capabilities and resources. In addition, the interviewee is asked about conflicts

that he or she has encountered during projects and how these translated into trade-offs. The desired output of this interview round a list of capabilities and trade-offs which are found impactful by the interviewees.

SEMI-STRUCTURED QUESTIONS

Interviews can be organised in different manners whereby a choice needs to be made of what is aimed to achieve. Based on the Design Science book of Johannesson et al., the interview questions are determined (2014). In this first round, main objective is to review the capabilities list from literature. Therefore, the interview is comprised of semi-structured questions. However, the answers are open as the interviewees are free to argument why they include or exclude a capability.

As can be noticed, it is impossible that all capabilities and trade-offs can be detected with these interviews. However, by applying the exploratory approach, a naturally selection is made by the interviewee him or herself, which emphasises the importance of these capabilities and trade-offs. The most important capabilities and trade-off are aimed for, and ad-hoc questions are asked to get more into depth.

The exploratory interview questions are structured in six parts, see appendix IIIA for the interview protocol. They are derived from the different aspects which are discussed in the chapter 2.

- The aspect 'business unit' uses Mintzberg's Organisational Model.
- The aspect 'objective' uses Porters theory on competitive advantage and literature on what can be achieved with BDA.
- The aspect 'resources' uses the Resource Based View.
- The aspect 'capabilities' uses the Resource Based View.
- The aspect 'interrelations' examines the existence of conflicts between capabilities.
- The aspect 'trade-offs' questions are asked how these trade-offs of conflicting interrelations are made.

ROUND 2: EVALUATION INTERVIEWS

The second round of interviews aims to achieve two objectives: 1. Applying the framework in on a specific case and 2. Evaluating the final design of the framework which is composed throughout the thesis. Therefore, these interviews are to evaluate (ex-ante) the design in order to make judgements about its functionality. However, first the framework needs to be applied to the case study, so that the framework is 'used' by a interviewee. The first four steps of the framework are already executed in the prior rounds due to time limits. Therefore, only the last step of the framework is performed. This is done by Analytical Hierarchy Process, which forms main part of the last step, further explained in next paragraph.

This is an essential round, as the evaluation of the design is determined after applying it into context of the case study. In case that aspects of the design are lacking, these can be incorporated in the design before actually proposing the final framework in the conclusions. The output of this interviewing round is used in the Demonstration and Evaluation phase of the Design Science cycle, where limitations and conclusions are derived from.

ANALYTIC HIERARCHY PROCESS

Analytical Hierarchy Process is used as a method for the interviews of round 2. It is a general theory of measurement, which can be used to derive ratio scale from both discrete and continuous paired comparisons (Saaty, 1987). These comparisons can be either based on personal perceptions and feelings or actual measurements, whereby two options are evaluated. This evaluation is two-sided and can be expressed in a numerical scale. In order to use Analytical Hierarchy Process to model a problem, a hierarchic or network structure is required to establish the relations between compared options. Eventually, these comparisons lead to a dominant matrix as comparisons are reciprocal (Saaty, 1987).

Saaty et al. mention that Analytical Hierarchy Process can be used to solve an unstructured large-scale socio-technical decision problem (1987). The order of priority is determined, which is why pairwise comparisons are essential to be executed in order to encounter trade-offs. Here, the Likert scale is used that expresses the relative importance of one capability with another capability with the numbers 1, 3, 5, 7 and 9 (Saaty, 1987).

Although, in principle, trade-offs are always present when there is a conflicting interrelation between two capabilities, their relative difference in importance determines the prominence of a trade-off. For instance, conflicting interrelations where both capabilities have a high importance, are more prominent trade-offs than where one of the two conflicting capabilities has a low importance.

	A	B	C	D
A		1/7	7	1
B	7		1/5	1/9
C	3	1/7		9
D	1	9	1/9	

Table 13: Example of an Analytical Hierarchy Process matrix

Through determining the relative importance between two conflicting capabilities, the priority of a trade-off is established. Namely, two capabilities that are appreciated on the same level of importance in a specific case, the trade-off becomes more difficult to make. However, when one capability is appreciated to have a higher importance than another, the trade-off is easier to make.

The interview protocol of the evaluation interviews is included in Appendix IIIB, which is divided in two parts. The first part is uses Analytic Hierarchy Process to determine what trade-off are most difficult to overcome. And in the second part, the interviewees are asked to sort the trade-offs on difficulty. Without knowing, they evaluated themselves as both questions lead to similar output. However, the first is used as main finding and the latter is used as reflection of the case studies.

INTERVIEWEE'S CRITERIA

In last section, the organisation of the interviews is discussed whereby a clearer view is acquired on the criteria for the interviewees. This is of high importance since interviews are a 'scarce asset' and therefore needs to be used efficiently. Besides, interviewees need to be in line with the problem statement of this thesis and the theoretical background in order to potentially provide answers to the research questions.

Most important argument of formulating interviewee's criteria is that the multi-actor perspective is taken into consideration. In the theory section of this thesis, Mintzberg's Organisational Model is used for defining three different actor groups. Notice, however, that these groups need to be 'translated' into real function roles in order to conduct interviews. For instance, the firms at matter defined a different name than 'operational managers', but 'managers' or 'senior managers'. Regardless, these criteria help to organise the interviews so that the desired information is acquired within the limited amount of time. They are concisely enumerated below per interviewee type in the upcoming sections. Table 37 presents an overview of the required interviewees per round and how actual function roles match with the organisational areas of Mintzberg's Organisational Model.

I. Executive Management

As mentioned in the theory section, the Executive Management are in line with the upper management of Mintzberg's Organisational Model. These are the highest hierarchical function roles of the firm. Within KPMG, this means that partners, senior managers and managers are interviewed. For the case studies, the function role terminology differs per firm. However, they need to comply with several criteria, including:

- The firm of the interviewee needs to be a professional firm, implying that the firm needs to have multiple perspectives (which can be mapped with Mintzberg's Organisational Model).
- The interviewee must have participated in BDA projects as an executive manager.
- The interviewee must be a decision-maker on both decisions of relating to BDA and not relating to BDA.
- The interviewee needs to make decisions on multiple projects at the same time.
- The interviewee needs to have experience in project-portfolio management where business units across the firm needed to collaborate.

II. Operational Management

On the middle management level, the Operational Management is situated, which occupies itself intensively with a few projects. Operational managers are more engaged than executive managers in a specific BDA project. Within KPMG, this means that managers, senior-consultants and consultants are interviewed. They have decision-making power on a limited level, but need to report their decisions at the Executive Management. For the case studies, this function role terminology differs per firm. However, important is, that they comply with the following criteria.

- The firm of the interviewee needs to be a professional firm, implying that the firm needs to have multiple perspectives (which can be mapped with Mintzberg's Organisational Model).
- The interviewee must have participated in BDA projects as a manager or a senior operator.
- The interviewee must be an executive in projects concerning BDA and not concerning BDA.
- The interviewee needs to make decisions on project level, but has limited decision-power whereas reporting to executive manager is required periodically.
- The interviewee needs to have experience in technology adoption projects whereby collaboration with other business units was necessary.

III. BDA Expert Team

As technical support to the operative core and Operational Management with regard to BDA projects, the BDA Expert Team is engaged. Within KPMG this is not one BDA team, but is divided in two separated teams on Big Data and Data and Analytics technologies. Even though these teams collaborate a lot with each other and their projects overlap, the skills, expertise and knowledge is possessed within each team. Different than Executive Management and Operational Management, is that client firms normally do not have a BDA Expert Team. That is the reason why they hire KPMG and engage experts and consultants on realisation of a specific operational goal or strategy. The interviewees need to comply with the following criteria.

- The firm of the interviewee needs to be a professional firm, implying that the firm needs to have multiple perspectives (which can be mapped with Mintzberg's Organisational Model).
- The interviewee must have participated in BDA projects as a Big Data (senior) consultant or a Data and Analytics (senior) consultant.
- The interviewee must be a technical executive in projects concerning BDA and not concerning BDA and, henceforth, must take the technical perspective on a project.
- The interviewee has limited decision-making power regarding the project, but can make decisions on technical areas.
- The interviewee needs to have experience in technology adoption projects whereby collaboration with other business units was necessary.

INTERVIEWEE SELECTION

After consideration of the interviewee criteria and the available employees at KPMG and the client firms from the case studies, a selection of interviewees is made. **Table 37 in Appendix IIIC** presents of the selected interviewees and interview data. As can be seen in the table, first, three mock interviews were organised in order to refine and revise the interview protocol. Several changes were made to the interview questions and strategy aiming to optimise the findings in the given amount of interviewing time.

3.4. DATA ANALYSIS: QUALITATIVE APPROACH

A large amount of data is acquired during desk study and interviews. In order to analyse this data, it needs to be structured and coded. Various Qualitative Data Analysis tools are available for this process. For this thesis, Atlas.ti was chosen to be used as Qualitative Data Analysis tool that helps researchers to uncover and systematically analyse complex phenomena hidden in unstructured data (Lewins *et al.*, 2007). This software application allows researchers to locate, code and annotate findings for weighing their importance and visualising complex hidden relations. Although many features are offered by Atlas.ti, only the coding of text is used, in which objectives, capabilities and resources are marked. With regard to the interviews, before being able to code the text, the audio recordings of the

interviews need to be transcribed. No automatization tool is used for this, as the amount of interviews is limited and the price of transcription software out of budget. The three activities that form part of the Qualitative Data Analysis are discussed in next sections.

3.4.2. TRANSCRIBING

The first activity of the Qualitative Data Analysis is transcription of audio recordings from the interviews. As all documents of the desk study are already in written form, transcription is not required there. All interviews, as overviewed in Table 37, are written down as precise as possible. However, fillers and stop words are filtered out. Also grammar, language and spelling errors in the sentences are repaired. The reason for this, is that coding is difficult with texts that include these fillers or errors, which can lead to misinterpretation of arguments.

The transcriptions are structured according to the questions asked during the interviews, followed by the answers of the respondent. Eventually, the transcriptions are sent back to the interviewee for validation. Employee names and company names mentioned in the interviews are filtered out due to confidentiality.

3.4.3. CODING

The second activity encloses the coding of the both the desk study documents and the transcribed interviews. The aim of this is to detect and retrieve several aspects in order to answer parts of the research questions as presented by Table 14. Firstly, the business unit is discussed which tells something about the perspective of the employee with regard to Mintzberg's Organisational Model. Secondly, the objective of the project provides insights about what was wanted to achieve with the BDA project. Thirdly, the resources that were enablers of the project, are discussed. Fourthly, the capabilities that the organisation needed to have. Fifthly, the interrelations between those capabilities, which provides understanding on what pairs of capabilities need to be taken into account. And finally, the trade-offs that were encountered in the transcriptions.

Coding enables the mapping of desk study with interview information and vice versa, so that in the next step of Qualitative Data Analysis insights can be derived. Even though these codes seek for specific terms, an argumentation is always pursued to achieve. This is in line with the explorative research strategy in which the phenomenon is aimed to be detected to open a new field of research. Therefore, argumentation is considered as essential in making deriving conclusions from the research. An complete overview of the is found in Appendix IV.

Aspect	Code group	Retrieved aspects in relation to research question	Research sub-question
Business units to involve	Business unit	From which business unit perspective in Mintzberg were the arguments made?	1
Objective of embedding BDA	Objective	What were main objectives of the BDA projects discussed?	2
Resources for embedding BDA	Resource	What resources were important during the projects?	2
Capabilities of embedding BDA	Capability	Where must the organisation be capable of after having embedded BDA?	2
Interrelations between capabilities	Interrelation (complementing/ conflicting)	How do capabilities have interrelations with each other?	3
Trade-offs between conflicting interrelated capabilities	Trade-off	What trade-offs were encountered during the BDA projects?	3

Table 14: Codes used and retrieved aspects with their relation to the research questions

3.4.4. IDENTIFYING AND ANALYSING THEMATIC NETWORKS

The third and last activity of the Quantitative Data Analysis concerns the analysis of the coded information for which Applied Thematic Networks are used. Applied Thematic Networks includes a series of guidelines to identify and analyse themes from textual data (Attride-Stirling, 2001). It is a transparent process which makes the method of extracting findings from data objective. A similar method which is also considered to be used is Grounded Theory, however, as this concerns the seeking for specific complex phenomena from text, certain flexibility is required. This is also underpinned by Guest et al., who consider that Applied Thematic Networks are most suitable for deriving

complex underlying meanings from text (2011). Besides, Johannesson et al. mention that establishing requirements for designs, Grounded Theory is less suitable as it is more aimed at social science studies (2014). Hence, after considering both methods, Applied Thematic Networks was chosen to be used.

After all relevant information is retrieved and coded, this data needs to be transformed into clear findings. As in the Design Definition, requirements need to be established, the research findings need to be unambiguous. The variety of codes is reduced by merging terms and mapping empirical findings with literature in order to establish thematic networks of concepts. Function roles of interviewees are mapped with business units from Mintzberg's Organisational Model. Objectives are classified and generalised, and resources, capabilities, their interrelations and trade-offs are enumerated. All the derivations that are made, are backed up with original argumentation from the primary sources. The importance of the codes are determined by the counting of the times an aspect is mentioned and by the reasoning behind the argumentation of each aspect. In this way, requirements are established and prioritised.

3.5. REFLECTION ON RESEARCH AND DATA COLLECTION

The research is an exploratory study supplemented with two case studies. Based on the exploratory study, which is conducted by literature research and exploratory interviews, a framework is designed. This framework is then subsequently applied to two case studies, which are performed by conducting evaluation interviews.

Both expected and unexpected issues (see Appendix IIID) came up during the execution of the research in the data collection as in the data analysis. Mainly because the interviewees found the discussion topic difficult to grasp and too abstract. Besides that, the interviews were difficult to structure, as they provided many arguments that are not necessary for this research. A gap is encountered between practice and literature. In literature other terminology are used for general phenomena, in practice these are more specific. Interviewees think in solutions and not in problems, whereby it is difficult to determine the root causes of the problem.

III. Requirements definition

4. DISCUSSION OF RESEARCH FINDINGS

This is the fourth chapter of this thesis, which is located in the third phase of the Design Science cycle as can be seen in Figure 26. The third Design Science phase focuses on discussing the findings from the research conducted. Subsequently, these findings are translated to requirements for the framework design.

In this chapter, subjects are discussed including:

- Introduction
- Business units to involve when embedding BDA
- Objective to achieve by embedding BDA
- Resources for embedding BDA
- Capabilities for BDA embedment
- Interrelations between capabilities
- Trade-offs between conflicting capabilities
- Reflection on results
- **Sub-conclusion of sub research question 2 and 3**

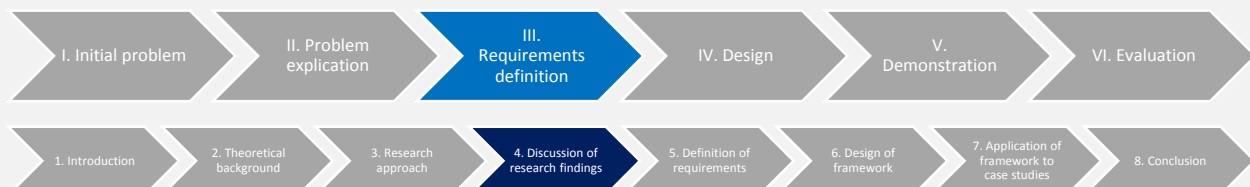


Figure 26: Fourth chapter of this thesis in the third Design Science phase.

4.1. INTRODUCTION

This section discusses the results of the research conducted with the literature review and exploratory interviews. The goal of this thesis is to identify and outline an artefact that can address the problem, which is explicated in previous section (Johannesson *et al.*, 2014). Hence, these research findings serve as requirements of the framework design phase according to the Design Science roadmap, which are formulated in chapter 5.

The research findings are structured in six different groups corresponding with the aspects of the questions asked in the exploratory interviews (see chapter 3). These exploratory interviews are preceded by literature review in order to prepare and compose the interview. The findings discussed in this section are thus a composition of literature review and case study. The different aspects have a causal relation with each other, as is displayed in Figure 27. Based on the research questions, also the research findings are structured as follows:

1. **Business units** that need to be involved (section 4.2).
2. **Objective** to achieve by embedding BDA (section 4.3).
3. **Resources** that need to be managed (section 4.6).
4. **Capabilities** required for BDA embedment (section 4.7).
5. **Interrelations** between capabilities (section 4.8).
6. **Trade-offs** between conflicting capabilities (section 4.9).

First, the findings regarding the business units that are or need to be involved in the project of BDA embedment. These business units can have a different perspective and therefore their interests should be taken into account when defining a BDA embedding strategy. Second, it is discussed why it is important that a clear objective is determined. During the exploratory interviews it was emphasised that embedding BDA is not the goal, though it is the mean whereby a specific objective is aimed to be achieved. Third, the resources necessary to possess for embedding BDA are discussed wherefore capabilities are needed. Fourth, capabilities are defined that are necessary for embedding BDA, which acquired by adequate management of the BDA resources. Fifth, the interrelations that can be complementing, neutral and conflicting are discussed. And finally, the trade-offs that need to be taken are introduced.

Notice that, the priority of these trade-offs are case-specific whereby their outcome cannot be generalised. However, they are included in the framework design (in chapter 6) and are applied on two cases afterwards (in chapter 7).

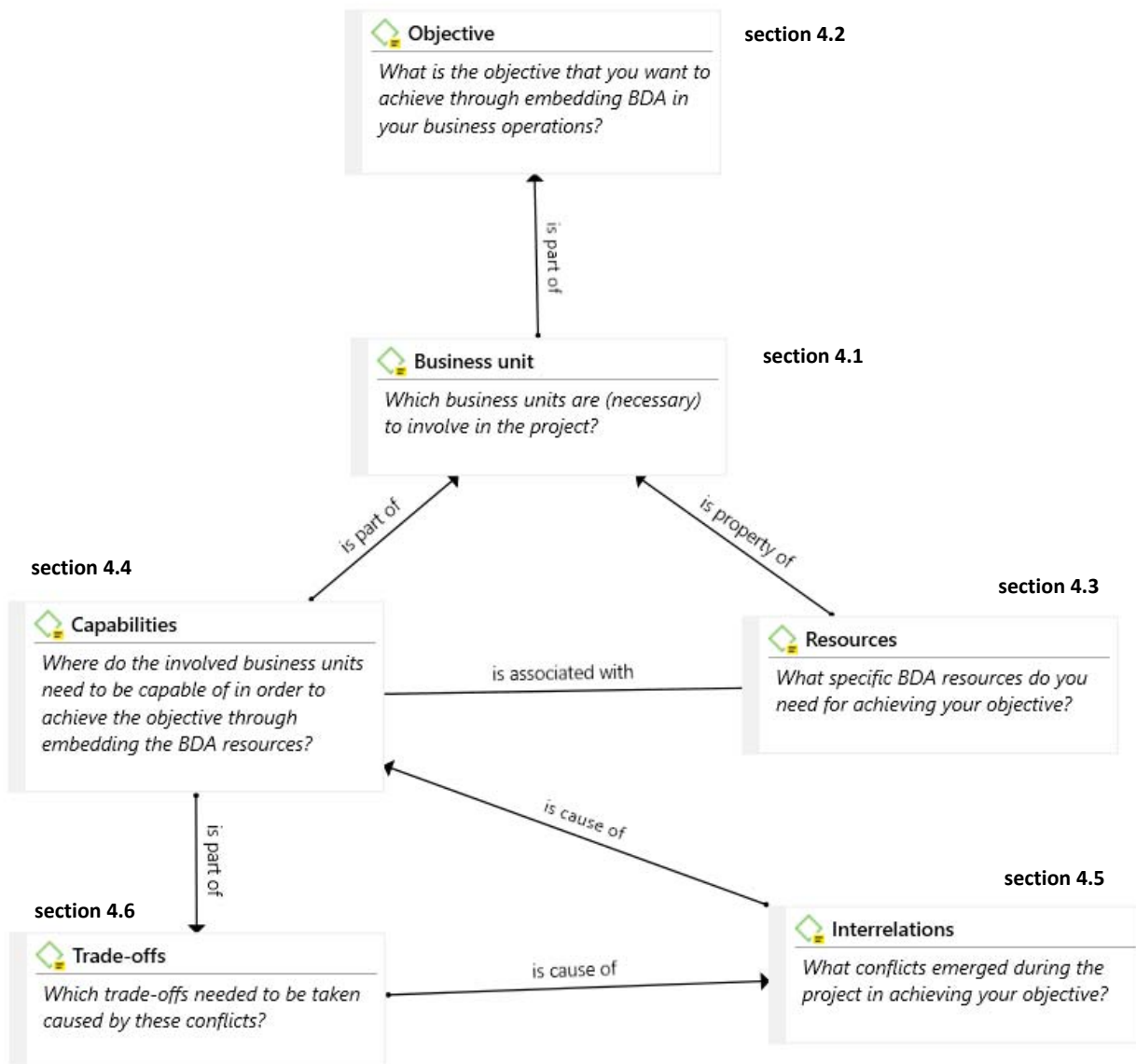


Figure 27: Six aspects of embedding BDA that are used in section 2.7 which is used to structure the research findings that are discussed in next sections

4.2. BUSINESS UNITS TO INVOLVE WHEN EMBEDDING BIG DATA ANALYTICS

The interviewees were asked what actors need to be involved from the different business units in the organisation. First, a short literature recap on this aspect is presented and then the findings are discussed. Finally, several key finding statements are stated.

4.2.2. LITERATURE RECAP

In literature, already, many authors speak about the importance of involving people from both the technical side and the operational side of the firm (Steenhuisen, 2009). Mintzberg's Organisational Model can be used as an overview to demarcate the organisational business units involved (1979). Three business units are identified that add the **multi-actor perspective** on the embedding of BDA:

1. Executive Management
2. Operational Management
3. BDA Expert Team

4.2.3. EXPLORATORY INTERVIEW FINDINGS

During the exploratory interviews the cross-organisational perspectives on a BDA embedment project were discussed. This section discusses a couple of remarkable quotations that both provide understanding and confirm claims from literature relating to Mintzberg's Organisational Model (as discussed in section 2.3).

"Support should be created among the different stakeholders to come up with a solution that is adopted by all the involved parts of the organisation" – Partner KPMG, Data and Analytics

From the exploratory interviews, almost all interviewees stated that involvement of both the business part and technical part of the firm is required in order to come up with a successful solution. An important reason for this is that a solution is in many cases a result of negotiations from the different stakeholders.

"When defining the project plan it is important to involve the client so that a clear scope can be defined" – Manager at KPMG, Data and Analytics

Before defining the project scope, the client should also provide input on the agenda. In this way, the client has more understanding of where the project is about. The goal is then composed through communication, which ensures supportiveness of the client. This enhances the collaboration in later stages where the project becomes more technological complex and the project team is challenged by emerging issues.

"A buy-in of the IT department is a 'must' before starting the process, as when you perform data analysis you are very dependent on the IT. Besides that is where the data is captured and accessed." – Senior manager at KPMG, Data and Analytics

As BDA projects require access to systems to retrieve data and in many cases analyses are ran in the client's application environment, it is a IT-dependent process. For this reason, it is important that the IT department has a buy-in in the process. Intensive cooperation between the project team and IT should be aimed to be achieved.

"Business must be involved during the entire process, although one should be careful that they do not dictate the project agenda. Otherwise business will not accept the proposed solution due to the lack of understanding and perception of relevance" – Senior manager at KPMG, Data and Analytics

The majority of the interviewees emphasised that participation of the business is needed throughout the project. Eventually, the business department will use the proposed BDA solution, therefore, they must also express their interest in the project to come up with a composed solution. If this is not done, the business people will never accept or use the solution.

"Business and IT people have different characters, which do not match well, therefore, you will need a project manager that speaks both languages and has decision-making power" – Senior consultant at KPMG, Data and Analytics

Several interviewees mentioned that there is a continuous friction between business and the IT. Conflicts tend to emerge when the project becomes complex. In general, the IT department does not understand the business' interests and vice versa. A project manager, with decision-making power and knowledge of both sides that is able to bridge the gap needs to be involved.

In Figure 48, many arguments are found that can be mapped with the three business units of Mintzberg's Organisational Model. However, the 'client' is not directly locatable on that model. This can be explained by the fact that from the context of KPMG IT Advisory, clients are also organisations whereby involvement is preferred from all three business units. This creates a multi-dimensional model whereby each business unit needs to be involved from both KPMG and the client organisation.

4.2.4. KEY FINDING STATEMENTS

- Involvement of people from different business units is essential in the definition of success. In this way a project team is constituted that ensures that interests can be expressed and included in the project objective.
- Although these can be mapped with the business units of Mintzberg's Organisational Model, they can be defined more specific (e.g. sales, marketing and inventory control are all part of the Operational Management unit of Mintzberg).

4.3. OBJECTIVE TO ACHIEVE BY EMBEDDING BIG DATA ANALYTICS

The interviewees were asked how an objective should be established, which can be achieved by embedding BDA. First, a short literature recap on this aspect is presented and then the findings are discussed. Finally, several key finding statements are stated.

4.5.1. LITERATURE RECAP

Sharp definition of the objective is essential when defining strategy on what the firms must achieve (Porter, 1989). Nicholas and Steyn emphasise the importance of defining a scope (2008). This is an important demarcation of the project's outcome whereby already the first trade-offs need to be made. These are high level trade-offs between time, costs and quality. Notice, that these are not the trade-offs where this research is about.

Objectives can be different for each BDA project. For instance, a supermarket inventory manager most probably has a different goal of what to achieve with BDA than a stock trader of a bank. This was also recognised in the exploratory interviews as numerous specific examples were found, which can create infinite list of possible applications of BDA. However, four generic types of objectives of BDA can be described (Ciandt, 2014):

- Descriptive: 'what has happened?'
- Diagnostic: 'why some things happened?'
- Predictive: 'what may happen?'
- Prescriptive: 'how to prevent bad things from happen and realise the good ones?'

4.5.2. EXPLORATORY INTERVIEW FINDINGS

Based on the exploratory interviews it can be said that an objective of a project should be a negotiated composition of interests of the stakeholders. This stakeholders' support ensures that a project's solution is accepted by all parties. This sections discusses a couple of interesting quotations that both provide understanding of the 'competitive advantage' is created by embedding BDA (as discussed in section 2.4).

"When defining the project plan, it is important to involve the client so that a clear scope can be defined" – Manager at KPMG, Data and Analytics

One of the most important parts of defining a project objective is the definition of a scope, that demarcates the solution space. When deliverables are defined collectively, stakeholders of different units of the organisation know what they can expect as an outcome. This is mentioned as one of the most important factors of 'perceived success'. Based on the this quotation, research done providing percentages of 'unsuccessful' projects can be argued. When deliverables are not sufficiently defined nor agreed upon, there is a misalignment of perceived expectations that can lead unsatisfied stakeholders. When there is alignment of expectations, this issue can be prevented.

"When defining a management proposal, it is essential that good contracts are set up to clarify scope and demarcate scope" – Senior consultant at KPMG, Data and Analytics

To prevent ambiguity on the final product a clear objective should be defined. Although this is not a necessity for BDA but for any type of project, it should be demarcated with a scope. All of this, should be included in an

engagement contract, where acceptance criteria are enumerated. However, when project team is constituted with internal employees, this contract is less official than when an external party is engaged.

"It should be prevented that Data Analytics is seen as a goal. On the contrary, it is the mean for achieving a goal"
– Partner at KPMG, Data and Analytics

It was mentioned, in the exploratory interviews, that many firms frame BDA as one of their annual goals. However, this should be not the case, as objectives would then be undefined. Therefore, the underlying goals should be sought for so that the strategic plan can focus on achieving these.

"First of all, it is important that a business case is set up, whereby already a trade-off can be detected between quality, time and costs" – Senior manager at KPMG, Data and Analytics

It was mentioned that, in the objective definition, already a trade-off emerges. For instance, when high quality and low costs are aimed to be achieved, this would lead to a late completion date. Otherwise, when high quality and quick completion date is desired, the costs will increase. Although this is a high-level trade-off, a consideration should be made by choosing two and deprioritising one

4.5.3. KEY FINDING STATEMENTS

- 'Embedding BDA in business operations' is not the objective that should be pursued, though it is a mean for realising a specific objective.
- This objective should be clearly defined where support of stakeholders is required by incorporating their interests. This ensures that the final project deliverable will be accepted by all business units.
- Objectives for BDA can be related to four generic types: descriptive, diagnostic, predictive and prescriptive.

4.6. RESOURCES FOR EMBEDDING BIG DATA ANALYTICS

The interviewees were asked what resources are important for embedding BDA in business operations. First, a short literature recap on this aspect is presented and then the findings are discussed. Finally, several key finding statements are stated.

4.6.1. LITERATURE RECAP

In the literature articles, several resources were enumerated that are most of the times based on the Resource Based View. According to the Resource Based View, once a clear objective is negotiated, the resources need to be defined. They form the basis for embedding BDA and can be divided in three groups:

- **Physical:** techniques, data, tools, dashboards, infrastructure, capacity, information technologies, basic resources
- **Human:** insights, training and learning, knowledge, skills, experience, expertise, openness, motivation, organisational learning, technical skills
- **Organisational:** strategy, policy, organisational structure, cultural, social system, compliance, values, data driven, management skills

4.6.2. EXPLORATORY INTERVIEW FINDINGS

As can be seen in the thematic network depicted by Figure 50, many resources (displayed in white) were mentioned during the exploratory interviews. Based on the Resource Based View, they can be divided in three groups: organisational, human and physical resources. With the qualitative analysing Atlas.ti, a mapping was made between the resource-types and resources found exploratory interviews based on the arguments provided by the interviewees. Only the resources that were grounded more than four times in the exploratory interviews are showed in Table 38. The full overview can be found in Appendix IVC.

Starting with the physical resources, regard all the technological elements, that form the fundament for performing BDA. An IT infrastructure is important for interaction between different applications and controlling the information flows between them. This can, for instance, be achieved by purchasing ERP systems from vendors that use common standards. These ERP systems capture all the transaction data whereby, in principle, structured data is acquired. The advantage of structured data is that standardised analyses can be executed and little time is required for interfacing

and staging. Most ERP vendors also offer their BDA add-on solutions, but also other analytics tools can be used. In some cases, however, data is not acquired from ERP systems but from other data sources such as documents, folders, multimedia etc. Then, information retrieval takes an significant amount of time and acquiring a structured system should be seriously considered.

The human resources concerns everything where human skills, experience, expertise and knowledge comes into play. Analytic skills are necessary for developing analyses and testing results. Business process knowledge should be taken into account when developing these analyses. Main reason for this is that the business processes need to be optimised in order to increase competitive advantage, whereby data insights can be used. As the IT architecture forms the basis of a firm's information flows, IT related skills are required for data capturing and extracting. IT architecture can differ per firm and therefore knowledge and skills provide essential support in the process of BDA embedment. On a higher level, strategic management skills are needed for planning and coordinating entire process and making decisions whenever necessary.

Organisational resources form an institutional layer around the human and physical resources. The data insight on themselves do not cause change required for achieving the objective. Therefore, once the data insights are produced, a strategy should be defined on actually engaging them in the business processes. Here, a data governance policy is required, which guides the employees of the firm through the required processes of engaging BDA insights. In the exploratory interviews it was emphasised several times that trust in data and insight is a necessity for success. When business people do not trust the insights they will not engage them in their decisions. Therefore, the insights need to be recognisable. Before starting a project, an engagement letter should be established where agreement is made on all the objectives and deliverables by the different stakeholders. When an external party is hired for performing the BDA tasks, this should be done with engagement contracts. Nevertheless, also a security policy should be maintained for fencing off security or privacy breaches. Finally, documentation is important as it can concern highly complex systems and analyses where specific knowledge is required for. This knowledge is possessed by employees, though it should be prevented that this knowledge is gone in case employees leave.

In Table 15 the resources are displayed that are mapped with the business units where they are mentioned by. As can be seen several resources were only mentioned by only one or two business units. This means that when defining a strategic plan for embedding BDA in business operations, it is important that the different business units are involved. In that way issues are prevented regarding missing or lacking resources.

Resource	Resource description	Executive Management	Operational Management	BDA Expert Team
Analytic skills	"Allocate employees in your team that know what analysis fits with the objective"	✓	✓	✓
Analytical tools	"Nowadays, there are many useful analytical tools that can be directly used from Microsoft, Oracle and SAP"	✓	✗	✓
Business process knowledge	"You need people that know the ins and outs of the business process"	✓	✓	✓
Business use case	"One of the first steps is that you have to get a business case, and ask how is the project paying off?"	✓	✗	✗
Collaboration with universities	"We have several professors and PhD's in our team, which is good to bridge the gap between business and academy"	✓	✗	✓
Compliance policy	"A governance model regarding compliance is important, as there were projects that were halfway but had to shut down as the regulations were not complied with"	✗	✗	✓
Dashboard	"Data insights from analyses must be brought to the people that have to know them, a dashboard is useful for that"	✗	✗	✓

Data governance policy	"To embed data analytics in daily, weekly or monthly processes you will need data governance"	✓	✓	✗
Data mapping interface	"The first step is interface all the data sets"	✗	✓	✓
Data mining techniques	"Data and process mining skills are rare nowadays, however, techniques are broadly available"	✗	✗	✓
Data staging skills	"The right people with skills is difficult to acquire"	✗	✓	✓
Data warehouse	"It is essential to create a data lake, therefore a data warehouse is required"	✗	✗	✓
Documentation of knowledge	"Important is that specific knowledge is documented so that when employees leave the knowledge is not gone"	✗	✗	✗
Documentation policy	"Documentation costs a lot of effort and time, though it is from high importance"	✗	✗	✓
ERP system	"When there is an ERP system, the data is automatically structured, which saves a lot of time"	✓	✗	✓
Good data	"Good data is a pre-condition of starting any data analytics project"	✓	✓	✓
IT architecture	"Good IT systems are the fundament of retrieving structured data"	✓	✓	✓
IT knowledge	"Best is to engage people with knowledge about the IT system landscape"	✓	✓	✓
Knowledge base	"At the moment knowledge is not yet exchanged, which is a waste of time, but that would be our objective"	✓	✗	✗
Project contracts	"When defining a management proposal, it is essential that good contracts are set up to clarify scope and demarcate scope"	✓	✓	✗
Security policy	"Even though there is high security on the ERP system, when security is lacking when a data analyst takes all the data to analyse it"	✓	✗	✓
Standardised analyses	"Structured data allows us to execute a standardised set of analyses, to create initial insights"	✓	✓	✗
Strategic management skills	"Strategic managing skills for guiding the project"	✓	✓	✓
Strategy for engaging insights	"Without telling how to act based on the insights, there is no effective change"	✓	✓	✓
Tailored analyses	"We could not use standardised analyses, hence, we had to tailor them to the specific case"	✓	✓	✓
Time	"Everything that should be done must be trade-off against time"	✓	✓	✓
Trust in data	"It is important that people from the business trust in the data"	✓	✓	✓
Visualisation tools	"Data is difficult to understand when there are not tools for visualising it"	✗	✗	✓

Table 15: Overview of the resources necessary for embedding BDA and by which business unit they were referenced to

4.6.3. KEY FINDING STATEMENTS

- Based on literature review and exploratory interviews a set of resources is defined that is important to possess for embedding BDA in business operations. These BDA resources are the basis for realising the objective.
- Resources can be divided in three main groups: organisational, human and physical resources.
- Different resources are mentioned by the interviewees from the different business units.

4.7. CAPABILITIES ESSENTIAL FOR BIG DATA ANALYTICS EMBEDMENT

This aspect comprises two parts: first, the findings from literature review of literature articles are discussed, second, the findings from the exploratory interviews are presented. The interviewees were asked what capabilities are important for embedding BDA in business operations. First, a short literature recap on this aspect is presented and then the findings are discussed. Finally, several key finding statements are stated.

4.7.1. LITERATURE RECAP

According to Barney and Wernerfelt capabilities define where a firm is capable of (1991; 1984). These capabilities are created when resources are managed adequately. In the context of embedding BDA, a capability is described as

the ability to improve decision making, enhance firm's performance, and adapt to changeable environment through analytics (Olszak, 2016). Although capabilities can be defined very specific as can be seen in Appendix IVD, the most generic capability can be described as the 'embedded Big Data Analytics capability'.

4.7.2. LITERATURE REVIEW FINDINGS

Literature review is performed based on articles to define capabilities that are important to create when embedding BDA in business operations in order to achieve a specific goal. After researching 54 articles, a list of 48 capabilities was produced, as is displayed in Table 39. However, to prevent infinity of the list and reduce overlap of capabilities, related capabilities mentioned by different authors are merged. This resulted in a smaller list of nine, more generic, capabilities.

Figure 51 depicts an overview of the specific capabilities and how they are mapped with more generic terms for capabilities. In this way, nine generic capabilities are encountered that are briefly discussed in this section.

I. Data Availability – the ability to capture, store and access relevant transaction data in systems

Obviously, BDA projects need data available to both their systems and their personal for performing analytics (Chawda et al., 2016; Gupta et al., 2016; Kwon et al., 2014; Wamba et al., 2016). Data at the right time at the right place is a prerequisite for an organisation becoming more data driven (Chen et al., 2012; Clavier et al., 2012; Davenport et al., 2013; Dutta et al., 2015; Ross et al., 2013; Tan et al., 2016). For this reason, organisations need to ensure that systems are configured so that necessary data is captured, through data collection or data entry (Gupta et al., 2016; Isik et al., 2011; Loebbecke et al., 2015).

II. Data Completeness – the ability to involve complete data in analyses and create detailed insights

Following on the availability of data, it also needs to be complete. BDA is about creating insights on what is 'unknown' based on what is 'known' with a high chance of certainty, whereby it is important that essential data fields are complete (Isik et al., 2011; Kwon et al., 2014). When BDA is aimed to be performed to answer specific questions and create detailed insights, specificity of the data is important to cherish (Buhl et al., 2013; Elbashir et al., 2008; Kowalczyk et al., 2014; Zack, 2007). Missing information needs to be either replaced or retrieved when possible in order to achieve a representative data set.

III. Data Understandability – the ability to interpret and visualise data, and derive conclusions from insights

Whereas data need to be specific and complete enough, it need to allow the deriving of conclusions from it (Akter et al., 2016; Clavier et al., 2012; Davenport et al., 2013; Elbashir et al., 2008; Gupta et al., 2016; Olszak, 2016). Decisions require specific data which in many cases are time-dependent. Understandability is dependent of the presentation of the data, wherein visualiseability of insights plays key role in this interpretation (Dutta et al., 2015). Due to the volume and variety of data, a clear defined goal or task that necessitates elements to be derived from the data insights, assist the understandability for decision making.

IV. Data Quality – the ability to create accurate, relevant and correct insights from analyses

Associated with Data Completeness, it also need to be perfect to attain certainty of making conclusions (Isik et al., 2011; Janssen et al., 2012; Kwon et al., 2014; Pospiech et al., 2012; Tan et al., 2016). High quality of data significates correct and actual data, which leads to robust insights. Incorrect data fields needs to be prevented, whereby checks need to be performed that represent a large part of a BDA project (Gupta et al., 2016). For this reason, the data needs to be actualised frequently depending on the situation and goal of a BDA project (Davenport et al., 2013; Gupta et al., 2016; Loebbecke et al., 2015).

V. Manageability – the ability to create, process and manage BDA activities

Coordination of BDA processes, necessitates the monitoring of information flows from data entry to output of insights (Akter et al., 2016; Chen et al., 2012; Davenport et al., 2013; Dutta et al., 2015; Gantz et al., 2011; Loebbecke et al., 2015; McAfee et al., 2012; Olszak, 2016). Also transparency of insights-driven conclusions and decision making need to be cherished in order to be capable of supervising and managing the BDA processes (Buhl et al., 2013; Gupta et al., 2016; Kwon et al., 2014; Pospiech et al., 2012; Watson et al., 2007). As embedment of BDA in business operations is aimed to be achieve, BDA processes should be standardised (Chawda et al., 2016; Janssen et al., 2012;

Tan *et al.*, 2016). Namely, standardised BDA processes are more transparent and supervise able as they are easier to organise.

VI. Autonomy and Flexibility – the ability to autonomously create insights and derive conclusions

Insights produced by BDA, are a result of specific data and goal in the context of a specific process. Therefore, decisions need to be taken autonomously, so that insights are aligned optimally with the information needs (Davenport *et al.*, 2007; LaValle *et al.*, 2011; Olszak, 2016; Tan *et al.*, 2016). In large socio-technological projects, problems can be complex whereby decision-decentralisation is required to make specialised decisions (Koppenjan *et al.*, 2011). An advantage of this, is that learning is encouraged on different parts of the process, as employees are trained in a specific domain and can become process experts that can use their creativity to optimise their process (Dutta *et al.*, 2015; Gupta *et al.*, 2016; Watson *et al.*, 2007). Ad-hoc decisions are made, which increase the anticipate ability and resilience of a process (Gantz *et al.*, 2011; Kim *et al.*, 2012; Pettit, 2008). Furthermore, the agility of deriving conclusions is enhanced as no authorisation is required from higher hierarchical level, which also augments the flexibility (Arnott *et al.*, 2008; A. S. Bharadwaj, 2000; Chen *et al.*, 2012; Işık *et al.*, 2013; Kwon *et al.*, 2014).

VII. Interoperability – the ability to integrate and interface data sources for creating insights

Access to data and insights need to be granted to the right individuals in order to enable them to engage BDA in their decisions (Gupta *et al.*, 2016; Isik *et al.*, 2011; Kowalczyk *et al.*, 2014; Olszak, 2016; Pospiech *et al.*, 2012). To achieve BDA engagement on a frequent basis, however, an interoperable system landscape is required, where systems interact and are compatible with each other (Chawda *et al.*, 2016; Davenport *et al.*, 2013; Janssen *et al.*, 2012; Wamba *et al.*, 2016). One of prominent agenda points towards BDA are, therefore, augmenting IT maturity and replacing legacy systems (Olszak, 2016; Tan *et al.*, 2016; Watson *et al.*, 2007). IT capabilities, created by mature IT systems, are important enablers for frequent BDA engaging.

VIII. Security and Integrity – the ability to secure data sources and processing information with integrity

As it regards to acquiring insights from data, it is a valuable resource that can comprise sensitive information. Security of systems is important to cherish in order to prevent breaches, which can lead to privacy breaches, fraudulent use or misuse of this information (Akter *et al.*, 2016; Janssen *et al.*, 2012; Tan *et al.*, 2016). Data has become an important asset, it should be backed up frequently so that recovery is possible. Through IT audits, security can be ensured, as well as authentications and risk detecting and control measures (Davenport *et al.*, 2013; Elbashir *et al.*, 2008; Gantz *et al.*, 2011; Kim *et al.*, 2012).

IX. Predictability – the ability to predict insights based on standardised and consistent analyses

In addition to the other capabilities, firms need to be able to make predictions based on the data that they possess. Independent of what kind of process BDA is engaged to, performance needs to be ensured. As processes are not stable at all times, predictions should be made for future situations (Akter *et al.*, 2016; Davenport *et al.*, 2013; Dutta *et al.*, 2015; Kwon *et al.*, 2014; LaValle *et al.*, 2011). This, however, can also take place for historical data, in case of imperfect or incomplete data. Through synthesising different data sources predictions can be augmented (Arnott *et al.*, 2008; Chen *et al.*, 2012; Işık *et al.*, 2013; Olszak, 2016; Watson *et al.*, 2007).

4.7.3. EXPLORATORY INTERVIEW FINDINGS

During the exploratory interviews open questions were asked in order to discuss BDA projects in depth whereby practical examples were asked to the respondents. As is mentioned in the chapter 3 of this thesis, capabilities were aimed to be detected in the argumentations of the respondents. These are compared and mapped with the generic capabilities encountered in related literature articles of Table 39.

A cloud of statements is depicted by Figure 53 that maps where a firm should be capable of in order to embed BDA in their business operations. With Atlas.ti these statements are derived from the underlying argumentation. Each capability is briefly underpinned with one quotation to provide context. The full overview of quotations relating to capabilities is included in Appendix IVD.

“Every time I start a project, I have to ask for the data, which is a very slow process as departments are not keen on sharing it before they understand the purpose” – Manager at KPMG, IT Risk Consulting

The Data Availability is an important capability for achieving success with embedding BDA. It takes much time to acquire the desired data, as firms are hesitant on providing their data for Security and Integrity reasons. Especially when embedding BDA in weekly or monthly operations, easy access to data sources should be facilitated. Otherwise the data insights would have a delay whereby in the meantime its value declines.

“After the goal is defined on what to achieve with data analytics, it is very important that the right data is acquired and that it is complete” – Partner at KPMG, Data and Analytics

In order to assess performance of a specific process, different data sources are needed that create insights from different perspectives. Therefore, completeness of the data is an important matter. Especially when insights get more specific, a wide-ranging data set is required. Normally, the amount of data is not necessarily a problem, however, the problem is to get a complete view of the ‘right’ data.

“As firms use ERP systems that capture every single transaction, it is important that the data is understood and not just fire 80 different analyses on it” – Manager at KPMG, Data and Analytics

Understanding of the data is a prerequisite when performing analyses. Nowadays, firms possess enormous quantities of data as they have modern systems capturing every transaction. Then, the challenge is to decide what to do with the data. As is mentioned in the exploratory interviews, there are many predefined analyses that can be executed, though more important is to achieve understanding and create focus.

“It is of high importance that data has good quality, it is one of the four pre-conditions of successful analytics” – Partner at KPMG, Data and Analytics

Quality is perceived as an essential capability for successful data analysis. Different interviewees mentioned that insights based on poor quality data are not accepted by the business. Mainly because they are not recognised by the people that have to engage them in the process. Therefore, trust should be created in BDA by testing and performing quality checks.

“As data analytics projects can be very complex, it should be avoided that they unmanageable. Therefore, we often choose to start acting small and thinking great” – Senior manager at KPMG, Data and Analytics

Especially when firms do not have a clear understanding of BDA, it should be avoided that large projects are initiated that are difficult to manage. As was mentioned by different interviewees, it is best to start with a smaller project whereby fast (but small) success is achieved. Short sprints such as Agile and Scrum can be used whereby development cycles are short and results fast delivered. Directly starting with large projects with high stakes will lead to long development cycles and higher change for delay.

“In many cases unexpected issues come up, then it is good that ad hoc solutions are found instead of waiting for a manager to respond which would result in delays” – Manager at KPMG, IT Risk Consulting

Although management is important when performing BDA, unexpected problems emerge frequently. There are three different ‘lines of defence’ regarding decision making based on processes with BDA. The first line of defence should make ad hoc decisions of moderate issues. However, when the priority level is high, it should be done by the second or even the third line of defence. Afterwards, these issues have documented and briefed to the higher lines of defence. However, intervention from the management is not always necessary nor efficient.

“When a complete data set is aimed to be acquired, data sets have to be interfaced whereby it is desirable that their underlying platforms are interoperable” – Senior consultant at KPMG, Data and Analytics

Firms, normally, have an application landscape with many different systems between which the information flows. However, when BDA needs to be embedded in the business, interfaces should be made to make the different data sources (systems) interoperable. Once this is achieved, data can be extracted frequently and standardised analyses can be performed.

“Security and Integrity are important capabilities which I do not consider in a trade-off, they are more like pre-conditions that cannot be ignored” – Partner at KPMG, Data and Analytics

Depending on a firm and the context where BDA is embedded into, Security and Integrity of data is a capability that firms cannot ignore. Firms that possess high confidential data on classified processes and methodologies (e.g. beer

breweries or pharmaceutical producers) need to be hesitant on making data available. In that case, a highly secured information system is necessary with a strict security policy. On the other side, there should also be a privacy policy to prevent abusing of data. Especially when firms possess data regarding personal sensitive (e.g. hospitals or employment agencies) data need make clear agreements on the purposes of the data analyses.

“The advantage of working with structured data is that you can fire a series of standardised analyses on it, whereby you can ensure the outputs” – Manager at KPMG, Data and Analytics

Predictions allow firms to look into the future and assess whether they will need to make strategic changes or not. Analyses of historical data can make this possible, however, it is a more complex process as many externalities need to be factored in. On the other side, predictability is important in answering the question to what extent the analytics results can be relied upon. Therefore, it is an aspect where firms should be capable of when embedding BDA in their business processes.

“Without a concrete plan for change management, the data insights will not lead to improvement. Hence, action is needed” – Senior consultant at KPMG, Data and Analytics

As can be seen in Figure 53, one capability emerged that was not encountered in literature articles: Insights Engageability. In literature also there is spoken about the ability to engage insights from data analytics in decisions. During literature review this was considered as a specific capability. However, based on the qualitative analysis on the exploratory interviews, seven more specific capabilities were encountered related to the engage ability of data insights in decision-making. Therefore, this capability is added to the list of generic capabilities.

The capability of engaging data insights in decision-making is established as a ‘capability gap’ is encountered. Although it closely related to the manageability of data analytics and the embedment of BDA in decision-making, this gap causes that the ‘circle of generic capabilities’ is not completed. As manageability focuses more on the organisation and the execution of the analyses, to achieve embedded BDA in processes, there must be a capability that defines the ability to actually use the acquired insights to manage towards change.

Table 16 depicts the ten generic capabilities that are encountered in the literature review and exploratory interviews. Also here, it can be seen that several capabilities were not mentioned by all different business units. This emphasises the importance of the input from different business units in strategies.

Capability name	Capability description	Purpose	Executive Management	Operational Management	BDA Expert Team
Data Availability	The ability to capture, store and access relevant transaction data in systems	Access to data sources and readily available insights.	✗	✓	✓
Data Completeness	The ability to involve complete data in analyses and create detailed insights	Acquisition and provision of a complete overview and specific insights.	✗	✓	✓
Data Understandability	The ability to interpret and visualise data, and derive conclusions from insights	Acquisition and provision of understandable and practical insights.	✓	✗	✓
Data Quality	The ability to create accurate, relevant and correct insights from analyses	Acquisition and provision of high quality insights that are correct, relevant and up to date.	✓	✓	✓
Manageability	The ability to create, process and manage BDA activities	Good coordination and planning of BDA related activities.	✓	✗	✓
Autonomy and Flexibility	The ability to autonomously create insights and derive specific conclusions	Agile and autonomous decision-making that increase the flexibility and resilience of BDA related activities.	✓	✓	✗

Interoperability	The ability to integrate and interface data sources for creating insights	Easy to combine data sets in analyses from multiple sources.	✓	✓	✓
Security and Integrity	The ability to secure data sources and processing information with integrity	Compliance with the data protection acts and privacy regulations. Protection of sensitive firm information from being exposed.	✓	✓	✓
Predictability	The ability to predict insights based on standardised and consistent analyses	Acquisition and provision of realistic predictions and insights.	✗	✗	✓
Insights Engageability ²	The ability to engage insights in business decisions and operations	Intervention based on data insights to improve performance and realise objectives.	✓	✗	✓

Table 16: Overview of the ten most important generic capabilities (based on both literature review and exploratory interviews)

4.7.4. KEY FINDING STATEMENTS

- Capabilities are necessary for adequately managing the BDA resources of the firm. They tell where the firm needs to be capable of when aiming to achieve an objective.
- Whereas 'embedded Big Data Analytics capability' can be seen as an upper level capability, numerous specific capabilities were encountered in both literature review and exploratory interviews.
- After filtering and merging the specific capabilities, a list of ten generic capabilities is created that are essential to develop when embedding BDA.
- Some capabilities are not mentioned by interviewees from the different business units.

4.8. INTERRELATIONS BETWEEN CAPABILITIES

The interviewees were asked whether there is a complementing, conflicting or no interrelation (neutral) between capabilities that are important for embedding BDA. The focus is put on conflicting interrelations as these lead to trade-offs. These are discussed in section 4.9. First, a short literature recap on this aspect is presented and then the findings are discussed. Finally, several key finding statements are stated.

4.8.1. LITERATURE RECAP

The negative effects that capabilities can have on each other are discussed in other domains than BDA embedment. These are shortly recapped:

- In technological product development, Leonard-Barton mentioned that capabilities can have a negative downside (1992). Although these capabilities are in essence positive as they describe where a firm is good at or capable of, they also can hamper other parts of the firm.
- In supply chain engineering, Pettit asserted that capabilities can have vulnerabilities that need to be considered in order to reduce the chance for disruptions (2008).

Yet, in literature there is not spoken of interrelations between capabilities in the context of embedding BDA in business operations. This implies that, currently, it is assumed that capabilities always are complementing or independent from each other (and thus do not hamper each other). In order to add the **multi-capability perspective** on the embedding of BDA, the existence of conflicting interrelations between capabilities is researched.

4.8.2. INTERRELATIONS BETWEEN CAPABILITIES

Eight conflicting interrelations between capabilities are encountered during the exploratory interviews. These are displayed in Figure 54 and Table 41. As these capabilities hamper each other, they first need to be traded off before including them in a strategic project plan for embedding BDA.

Eight complementing interrelations between capabilities are identified during the exploratory interviews. These are displayed in Figure 53 and Table 41. These capabilities have a beneficial effect on each other, whereby they can both be included in a strategic project plan for embedding BDA.

Table 17 present the complementing and conflicting interrelations between capabilities. It can be seen that not all interrelations were mentioned by all different business units. For instance this can be seen, only the interrelation

² This capability was not encountered in the literature research but was found during the exploratory interviews.

between 'Data Understandability' and 'Security and Integrity' was only mentioned by the BDA Expert Team and not the other two business units. The conflicts however, are almost all mentioned by the interviewees.

Only the conflicting interrelations between capabilities result in trade-offs, as complementing interrelations do not cause problems. Therefore, these trade-offs are discussed in next section.

Capability 1	Capability 2	Interrelation	Example citation	Executive Management	Operational Management	BDA Expert Team
Data Completeness	Data Understandability	Conflicting	"The more data sources you use, the more complex it gets"	✓	✓	✓
Data Completeness	Data Quality	Conflicting	"You can never achieve 100% correct data when you use a lot of data sources"	✓	✓	✓
Data Understandability	Security and Integrity	Conflicting	"When (personal) data is easy understandable, privacy of individuals becomes in dispute"	✗	✗	✓
Data Completeness	Manageability	Conflicting	"It is difficult to manage data analytics projects and engage insights in governing, when a large series of data sources is used"	✓	✓	✓
Data Completeness	Security and Integrity	Conflicting	"As (personal) data becomes more complete, derivations can be made that can trace back individuals"	✓	✓	✓
Data Availability	Security and Integrity	Conflicting	"When data is easy to access and available for analysis, this is at the expense of the systems security and privacy"	✓	✓	✓
Autonomy and Flexibility	Predictability	Conflicting	"It is difficult to predict the performance/outcome of flexible analyses and autonomous derivation of conclusions"	✓	✓	✓
Predictability	Data Understandability	Conflicting	"When insights are not understood, they are trusted and cannot be used for predictions"	✓	✓	✓
Data Quality	Data Understandability	Complementing	"The quality of data is important in understanding the insights, as incorrect insights are difficult to derive"	✓	✗	✗
Data Understandability	Manageability	Complementing	"Easy understandable insights are better manageable and engage able in decisions"	✓	✓	✓
Interoperability	Data Quality	Complementing	"Interoperable systems allows the interfacing and structuring of data enhancing the quality"	✓	✓	✗
Predictability	Manageability	Complementing	"When outcomes of analyses are predictable they are easier to manage and plan"	✓	✓	✓
Interoperability	Manageability	Complementing	"When the IT systems are interoperable it is much more coordinate able"	✓	✓	✗
Interoperability	Autonomy and Flexibility	Complementing	"Interoperable systems provide opportunities for flexible analyses, staging and deployment"	✗	✗	✗
Autonomy and Flexibility	Manageability	Complementing	"Supervision is easier when analysts can make autonomous decisions and can perform flexible analyses"	✓	✓	✓
Interoperability	Data Understandability	Complementing	"When data is standardised and has interoperable format, it is easier to understand and interpret"	✓	✗	✗

Table 17: Overview of the interrelations and the business units they were referenced to by

4.8.3. KEY FINDING STATEMENTS

- Complementing interrelated capabilities have a positive effect on each other whereas conflicting interrelated capabilities hamper each other.
- Through exploratory interviews a list of eight conflicting interrelations and eight complementing interrelations is established.

- Due to limited interviewing time the most prominent interrelations are discussed. Hence, it not necessarily mean the non-discussed interrelations are neutral, but they were not mentioned during the exploratory interviews.
- Interrelations between capabilities are generic, hence, not case-specific.
- **These conflicting interrelations need to be traded off in order to prevent problems** in later project stages (section 2.6.2 and **Error! Reference source not found.**).

4.9. TRADE-OFFS BETWEEN CONFLICTING CAPABILITIES

The conflicting interrelations between capabilities result in trade-offs. Their consequences are explained briefly in this section. First, a short literature recap on this aspect is presented and then the findings are discussed. Finally, several key finding statements are stated.

4.9.1. LITERATURE RECAP

When two capabilities have a conflicting interrelation with each other, a trade-off needs to be made. Trade-offs are complex dilemmas whereby both outputs both lead to advantages and disadvantages. This implies when one capability is developed, this is at the expense of the other (conflicting) capability. Depending on the context and objective of the case, a trade-off needs to be made. For instance, a hospital is likely to prioritise capabilities as Security and Integrity and understandability more than a car manufacturer, who is likely to prioritise capabilities as Autonomy and Flexibility.

However, it is important that this trade-off is considered before starting to embed BDA in business processes. When trade-offs are not considered before starting BDA embedment, unforeseen problems can emerge in later stages. Then, it can be the case that there is invested (e.g. time and money) in the resources of both capabilities before discovering that developing both is not possible. Hence, in order to add the **multi-trade-off perspective** on the embedding of BDA, two statements are made:

- Trade-offs need to be made between conflicting interrelated capabilities.
- Trade-offs differ on the context or objective of the case.

4.9.2. EXPLORATORY INTERVIEW FINDINGS

The conflicting interrelations between capabilities, as depicted in Figure 54 and Table 41, need to be traded off. Both directions (capabilities) entail advantages and disadvantages (see Table 18). The implications of these trade-offs are shortly discussed below. It should be noticed that these trade-offs do not imply that when a 'direction' is chosen, this does not necessarily have to be 100% direction one or two. Instead, it means that one direction is relatively preferred over another in a specific case.

I. Data Completeness vs. Data Understandability

The ability to involve complete data in analyses and create detailed insights hampers the ability to interpret and visualise data, and derive conclusions from insights and vice versa. When more data is included in order to achieve more complete and detailed insights, the analyses become more complex. This is at the expense of the ability to derive conclusions, make visualisations and create understandable insights. However, on the contrary, when it is aimed to easily derive conclusions, make visualisations and create understandable insights, it is at the expense of the level of detail and completeness of the data insights that are included in the analyses.

II. Data Completeness vs. Data Quality

The ability to involve complete data in analyses and create detailed insights hampers the ability to create accurate, relevant and correct insights from analyses and vice versa. When more data is included in order to achieve more complete and detailed insights, the chance increases that data or insights contain errors (due to level of detail and specificity), irrelevant data is used or incorrect assumptions are made. This is at the expense of the ability to create accurate, relevant and correct insights. However, on the contrary, when it is aimed to create accurate, relevant and correct insights, it is at the expense of creating complete and more detailed data insights.

III. Data Understandability vs. Security and Integrity

The ability to interpret and visualise data, and derive conclusions from insights hampers the ability to secure data sources and process information with integrity and vice versa. When the data is secured strictly, privacy and integrity rules are complied with strictly, this can lead to omitting or anonymising specific data fields so that no information can be related to individuals or specific sensitive entities. However, this is at the expense of the ability to derive conclusions, interpret and understand the data insights due to the omission and anonymization. On the contrary, when it is easy to make interpretations, visualise data and derive conclusions from insights, this is at the expense of privacy and the security of the data because relations to individuals or other specific sensitive entities are made easily, and information behind the data is easily discovered.

IV. Data Completeness vs. Manageability

The ability to involve complete data in analyses and create detailed data insights hampers the ability to create, process and manage BDA activities and vice versa. When more data is included in order to achieve more complete and detailed insights, managing the BDA activities such as staging, analysing and data processing become more complex and intensive. In that case, it is difficult to coordinate the process, and manage the involved resources. On the contrary, when it is aimed to agilely create, process and manage BDA activities, increasing the agility of BDA, concession must be made to reduce the involvement and creation of complete and detailed data and insights.

V. Data Completeness vs. Security and Integrity

The ability to involve complete data in analyses and create detailed insights hampers the ability to secure data sources and manage BDA activities and vice versa. When much and complete data is included in the analyses and detailed insights are created, this is at the expense of privacy and the security of the data because relations to individuals or other specific sensitive entities are made easily, and information behind the data is easily discovered. On the contrary, when the data is secured strictly, privacy and integrity rules are complied with strictly, this can lead to omitting or anonymising specific data fields so that no information can be related to individuals or specific sensitive entities. However, this is at the expense of including large and complete amounts of data and acquiring detailed data insights.

VI. Data Availability vs. Security and Integrity

The ability to capture, store and access relevant transaction data in systems hampers the ability to secure data sources and processing information with integrity and vice versa. When it is aimed to capture and store all (e.g. transaction) data, and these data sources are made easily accessible, this is beneficial for the accuracy of analyses (due to combination of data sources). Also it enhances access to the created insights for employees throughout the organisation so that these can be used when necessary to support their operations. However, it is at the expense of privacy and security of the data because relations to individuals or other specific sensitive entities are made easily, and information behind the data is easily discovered.

VII. Autonomy and Flexibility vs. Predictability

The ability to autonomously create insights and derive specific conclusions hampers the ability to predict insights based on standardised and consistent analyses and vice versa. When analyses are standardised (e.g. by creating standard series of analyses) in order to create a constant and consistent output, this allows the making of predictions and prescriptions (e.g. on performance) decisions can be based upon. However, this is at the expense of the Autonomy and Flexibility of BDA as the space for making decisions is small. This can lead to the consequence that outputs, even though they are standardised and consistent, are not optimal or most accurate. A reason for this is that depending on the context of the situation, analyses and outputs need to be more specific.

VIII. Predictability vs. Data Understandability

The ability to predict insights bases on standardised and consistent analyses hampers the ability to interpret and visualise data, and derive conclusions from insights and vice versa. Predictions (e.g. on performance), it supports a firm in looking forward and making decisions for the future. In this way it can anticipate to the environment. However, this is at the expense of making interpretations, visualisation or conclusions from the data. The reason for this is that, predictions can become complex whereby derivations are difficult to make. This can lead to the

consequence that employees cannot recognise the predictions as it is not in line with their experience or 'gut feeling' whereby they do not trust the insights.

It is important to notice that trade-offs depend on the context and objective of a situation. For instance, whereas a hospital that wants to use BDA insights for optimising diagnosis would make trade-offs different than a car manufacturer that wants to use BDA insights for optimising their supply chain. The hospital would probably prioritise security and privacy over availability as it would concern sensitive patient data. And the car manufacturer would prioritise predictability over Autonomy and Flexibility as throughput of produced cars need to be constant.

	Output choice A	Output choice B
I. Data Completeness vs. Data Understandability	High Data Understandability, low Data Completeness	High Data Completeness, low Data Understandability
Advantages	• Understandable insights • Agile conclusion derivation • Easy visualise able information	• Detailed insights • Complete overview • In-depth information
Disadvantages	• Basic insights • Incomplete overview • Missing information	• Difficult to visualise • Complex insights • Poor understanding • Slow conclusion derivation
II. Data Completeness vs. Data Quality	High Data Completeness, low Data Quality	High Data Quality, low Data Completeness
Advantages	• Detailed insights • Complete overview • In-depth information	• Ensuring accuracy and correctness • Solely including relevant insights
Disadvantages	• Making wrong assumptions (due to wide scope) • Increasing chance for containing errors on detailed level • Enclosing irrelevant data	• Basic insights • Incomplete overview • Missing information
III. Data Understandability vs. Security and Integrity	High Data Understandability, low Security and Integrity	High Security and Integrity, low Data Understandability
Advantages	• Understandable insights • Agile conclusion derivation • Easy visualise able information	• Protected data (by anonymization) • Restricted access to sources • Compliance with regulations
Disadvantages	• Derivations can be made to personal entities • Personal sensitive information visible • Change of breaking regulations	• Difficult to visualise • Complex insights • Poor understanding • Slow conclusion derivation
IV. Data Completeness vs. Manageability	High Data Completeness, low manageability	High manageability, low Data Completeness
Advantages	• Detailed insights • Complete overview • In-depth information	• Adequate management of BDA activities • Agilely data staging and analysing • High control on outputs
Disadvantages	• Difficult to process and manage BDA activities • Data staging and analysing become more complex and intensive • Low control on outputs	• Basic insights • Incomplete overview • Missing information
V. Data Completeness vs. Security and Integrity	High Data Completeness, low Security and Integrity	High Security and Integrity, low Data Completeness
Advantages	• Detailed insights	• Protected data (by anonymization)

	• Complete overview • In-depth information	• Restricted access to sources • Compliance with regulations
Disadvantages	• Derivations can be made to personal entities • Personal sensitive information visible	• Basic insights • Incomplete overview • Missing information
VI. Data Availability vs. Security and Integrity	High Data Availability, low Security and Integrity	High Security and Integrity, low Data Availability
Advantages	• Easy access to data insights • Insights available on places where needed to support operations • Increasing accuracy (due to multiple data sources)	• Protected data (by anonymization) • Restricted access to sources • Compliance with regulations
Disadvantages	• Derivations can be made to personal entities • Personal sensitive information visible • Chance for data leakages	• Difficult to access data insights • Insights not available on places where needed, thus not supporting all operations • Missing data sources (due to restrictions) causing lower accuracy
VII. Autonomy and Flexibility vs. Predictability	High Autonomy and Flexibility, low predictability	High predictability, low Autonomy and Flexibility
Advantages	• BDA solutions tailored to problem • Specific analyses • Ad-hoc decision-making and conclusion derivation • High resilience	• Standardised analyses • Consistent data outputs • Corresponding insights • Allowance for predictions and prescriptions
Disadvantages	• Inconsistent data outputs • High variance in insights • Predictions and prescriptions not possible (due to variation)	• Less specific insights • Low variation and flexibility in BDA activities • Low resilience
VII. Predictability vs. Data Understandability	High predictability, low Data Understandability	High Data Understandability, low predictability
Advantages	• Standardised analyses • Consistent data outputs • Corresponding insights • Allowance for predictions and prescriptions	• Understandable insights • Agile conclusion derivation • Easy visualise able information
Disadvantages	• Difficult to visualise • Complex insights • Poor understanding • Slow conclusion derivation	• Inconsistent data outputs • High variance in insights • Predictions and prescriptions not possible (due to variation)

Table 18: The eight most important trade-offs and their consequences that are assessed for each case study

4.9.3. KEY FINDING STATEMENT

- Trade-offs need to be made between two conflicting interrelated capabilities.
- Trade-offs are dilemmas whereby both options lead to favourable and unfavourable outputs.
- The result of trade-offs is dependent on the context and objective of a case.
- Eight trade-offs are detected through exploratory interviews.
- These trade-offs are considered for the two case studies in chapter Application of framework to case studies.

4.10. REFLECTION ON RESULTS

Important is to emphasise that these research findings have their limitations. As can be seen in Table 19, there are many blank spots in the matrix of possible interrelations. Due to limited time, not all interrelations are discussed in

the exploratory interviews. The choice is made to discuss in-depth the conflicting interrelations (which lead to trade-offs) that are perceived as most prominent by the interviewees. Therefore, more interviews should be conducted in order to obtain a more complete overview and fill in the blank spots of the matrix.

	Data Availability	Data Completeness	Data Understandability	Data Quality	Manageability	Autonomy and Flexibility	Interoperability	Security and Integrity	Predictability	Insights Engageability
Data Availability								✗		
Data Completeness			✗	✗	✗			✗		
Data Understandability				✓	✓		✓	✗	✗	
Data Quality							✓			
Manageability						✓	✓		✓	
Autonomy and Flexibility							✓		✗	
Interoperability										
Security and Integrity										
Predictability										
Insights Engageability										

Table 19: Not all interrelations between capabilities are discussed whereby not all trade-offs are determined

As a limited amount of exploratory interviews was conducted, the capabilities that are encountered to play key role in defining success of a BDA embedment project are not generic. It is probable, that in case more exploratory interviews are organised, other capabilities would be detected. Same argument applies for the conflicts encountered between capabilities. The focus of this research was to go more into depth on the conflicts instead of attempting to identify all potential conflicts. Although less capabilities and conflicts are discussed, they are perceived as more important by the respondents. Because, the relevance of capabilities and conflicts is naturally determined by the respondents by the number of times that they are mentioned in the exploratory interviews.

In the analysis of the research results, it was aimed to achieve a completed circle with generic capabilities. As there are nine capabilities encountered based on the literature review with literature articles (section 4.7.2), based on the exploratory interviews analysis it appeared that one capability was missing. This was the capability in between managing of BDA and embedding it: the ability to engage the data insights to manage towards change. This led to an amount of ten generic capabilities, as is discussed in section 4.7.3. Although this circle of capabilities is 'completed' based on the research findings of this section, it can still be possible that specific capabilities cannot be mapped with one of the generic capacities. This point of criticism is taken into consideration when performing the case studies and reflected upon in last chapter (evaluation).

Another point of criticism is, that it can be argued to what extent results encountered in exploratory interviews can be generalised, as they are used as requirements for the framework design. The named capabilities and conflicts are based on specific BDA embedment instances, whereby it should be noticed that these requirements are not exclusive. Since the purpose of a framework is to structure a process in any circumstance, more exploratory interviews are needed in other industries and types of firms to empirically validate the genericity of the framework. In this thesis, the framework is tested by applying it to two case studies.

4.11. SUB-CONCLUSION OF SUB RESEARCH QUESTION 2 AND 3

On this point, sub-questions 2 and 3 can be answered.

2. *What capabilities are important for a firm to possess?*

Ten generic key capabilities were aimed to be defined that are essential for a firm to possess in order to successfully embed BDA in their business operations. This was done through, firstly, conducting literature research wherein 52 specific capabilities were identified that are related to BDA embedment. And secondly, exploratory interviews which were conducted with people with roles in the different business units: Executive Management, Operational Management and BDA Expert Team. The findings of the interviews are mapped with the capabilities, resulting in a list of ten generic capabilities (see Table 16).

In addition, based on the exploratory interviews, it is encountered that actors from the different business units of the organisation differ in perception on what the necessary resources and capabilities for organisations are to embed BDA. This emphasises the importance of involving multiple business units in the process.

3. *What trade-offs between capabilities are important to perceive?*

In order to find the trade-offs, questions about the six aspects are asked during the exploratory interviews. A set of resources as displayed in Table 46 should be defined and acquired that enable BDA execution. The set of ten generic capabilities is used to determine whether the interrelations between each pair of capabilities are complementing, neutral or conflicting. Eight complementing and eight conflicting interrelations are identified. As complementing interrelations are beneficial and not necessarily cause problems, these are left out of scope. For these conflicting interrelations, however, trade-offs need to be perceived to prevent the emergence of late project problems. As the perception of trade-offs is case-specific, this is done for two case studies regarding an employment agency and a dairy producer, which is discussed in the answer of sub research question 5.

In addition, it is found that actors from different business units have a different perception on what interrelations between capabilities there exist when embedding BDA. This emphasises the importance of involving multiple business units in the process. Table 44 presents an overview of the eight trade-offs between conflicting interrelated capabilities, which are encountered in the exploratory interviews.

5. DEFINITION OF REQUIREMENTS

This is the fifth chapter of this thesis, which is located in the third phase of the Design Science cycle as can be seen in Figure 28. The third Design Science phase focuses on discussing the findings from the research conducted. Subsequently, these findings are translated to requirements for the framework design.

In this chapter, subjects are discussed including:

- Introduction
- Business units
- Objective
- Resources
- Capabilities
- Interrelations
- Trade-offs
- Summary

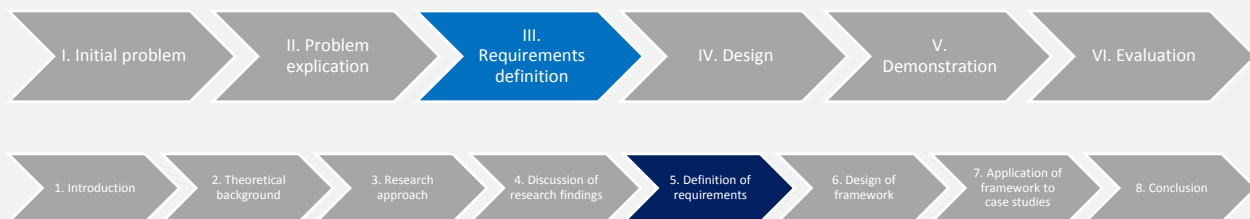


Figure 28: Fifth chapter of this thesis in the third Design Science phase.

5.1. INTRODUCTION

This chapter is dedicated to the definition of requirements based on the research findings and analysis. At this point, the research findings are discussed and analysed. As this thesis is design-oriented following the principles of Design Science, these findings are used for establishing requirements for a framework design (Johannesson *et al.*, 2014). This framework needs to solve the problem as defined in the problem statement, by taking both literature and the research findings into account. This problem statement, as defined in section 1, is recapped in one sentence:

Literature using the Resource Based View on embedding BDA does facilitate to perceive trade-offs between conflicting capabilities whereby unforeseen problems can emerge in later stages.

The presence of this problem statement demonstrates that there is a knowledge gap in this field. This gap is addressed with a framework underpinned by state-of-the-art literature and exploratory research based on case study. This knowledge gap, as defined in section 1, is recapped in one sentence:

In current literature using the Resource Based View on embedding BDA, it is unknown which trade-offs can occur between conflicting capabilities and how they can be perceived.

The action required to bridge the knowledge gap and the provide solution for the problem statement is defined by the research objective. This research objective, as defined in section 1, is recapped in one sentence:

It is investigated how firms can perceive trade-offs between conflicting capabilities so that they can consider them in an early stage.

Several requirements can be derived from the findings that need to be processed in the framework design in order to address the research problem, bridge the knowledge gap and achieve the research objective. Table 20 presents an overview of these requirements. **Each requirement addresses one of the six aspects of embedding BDA** (section 2.7). Firstly, the business unit is important to acquire a multi-actor perspective of the strategy. Secondly, the objective of what is aimed to be achieved by embedding BDA needs to be stated. Thirdly, the BDA resources that are required for achieving this objective need to be enumerated. Fourthly, the capabilities that are acquired by managing of the BDA resources, which the firm should exhibit in order to embed BDA in business operations, need to be clear. Fifthly, the consequences of the capabilities need to be known through identification of the interrelations that capabilities have between each other. And lastly, the trade-offs that can emerge due to the conflicting interrelations between capabilities need to be considered. As explained in the theory section, trade-offs can cause wrong decisions and late project changes leading to elevating costs, lower quality and delayed completion times.

Research problem	Knowledge gap	Research objective
Literature using the Resource Based View on embedding BDA does facilitate to perceive trade-offs between conflicting capabilities whereby unforeseen problems can emerge in later stages.	In current literature using the Resource Based View on embedding BDA, it is unknown which trade-offs can occur between conflicting capabilities and how they can be perceived.	It is investigated how firms can perceive trade-offs between conflicting capabilities so that they can consider them in an early stage.
Finding	Coarse-grained requirement	
There is a difference in perspective on what has to be done to embed BDA in business operations.	The actors of the different business units need to be actively involved in the process.	
It is not clear what the objective is of embedding BDA.	The objective of what is aimed to be achieved with BDA needs to be clearly defined and scoped.	
It is not clear how the BDA resources need to be deployed efficiently.	The deployment of the required resources need to be planned for achieving.	
There are ten important BDA related capabilities that a firm should possess in order to achieve its objective.	The capabilities should define where the firm needs to be capable of by deploying its BDA resources.	
Both complementing as conflicting interrelations between capabilities are encountered.	The consequences of capabilities need to be considered by determining what interrelations there are between capabilities.	
Conflicting interrelations are encountered that eventually will lead to trade-offs.	The trade-offs that emerge based on conflicting interrelations need to be considered.	

Table 20: Design Canvas recapping the research problem, the knowledge gap and the research objective, linked to findings which are translated into requirements for the framework design (Johannesson *et al.*, 2014)

5.5.1. REQUIREMENT 1: BUSINESS UNITS

Interviews are conducted with several members of the different business units of Mintzberg's Organisational Model. From the interviews, it became clear that there is a difference in perspective of the various actors involved in a BDA embedment project, as is discussed in section 4.2. Therefore, it is important that these are taken into account when defining a strategy for embedding BDA in business operations.

Specifically, three business units need to be taken into account, although in larger organisations this division can be too rough and henceforth need to be made even more detailed. In this thesis, the groups of Mintzberg's Organisational Model were directly translated to function roles. The reason for this is that limited interviews were conducted. In case of a large scale application of the framework design, it would be more important to make the business unit division more precise. Nevertheless, independent of the level of detail of the business units, the framework needs to be capable of considering different perspectives of business so that the actor-perspectives are taken into account. They all are important in acquiring success of the BDA embedment project. Table 45 presents the three business units that need to be active in the project of embedding BDA in business operations. Based on the research findings, a functional requirement is established regarding the different actor perspectives.

The framework must take into account the interests and perspectives on trade-offs by the involved different business units.

5.5.2. REQUIREMENT 2: OBJECTIVE

The objective needs to be clear before defining a strategy regarding embedding BDA in business operations. Although for every project the objective can be different, it is essential that the objective of a project is not 'embedding BDA' on itself. Like the one of the interviewees of the Executive Management said: "BDA is not the goal, it is the mean for achieving a goal". Projected into theoretical context, this means that BDA is the resource whereby the objective is aimed to be achieved.

The objective, therefore, should be one of the first steps of the framework. Without knowing the objective, it is impossible to define a substantive strategy. In addition to that, scoping of this objective is important to prevent issues regarding time, quality and costs. Based on the research findings, a functional requirement is established regarding the objective of BDA embedment.

The framework must guide the Executive Manager to define a tangible objective of what is aimed to be achieved by embedding BDA.

5.5.3. REQUIREMENT 3: RESOURCES

Important resources for BDA are discussed in the theory section. However, when a substantive strategy is aimed to be defined, this needs to go more into depth. Resources need to be planned in detail, as resources are enablers for capabilities: through adequate management of resources, capabilities are created. Therefore, the framework design also needs to take this into consideration.

Although these resources can be the same for each BDA project, their utilisation can differ based on the specific objective. Table 46 present an overview of the resources that are encountered in research. Based on the research findings, a functional requirement is established regarding the objective of BDA embedment.

The framework must guide the Executive Manager towards determining of BDA-related resources to create capabilities.

5.5.4. REQUIREMENT 4: CAPABILITIES

Capabilities for embedding BDA in business operations are created through adequate management of BDA-related resources. After definition of the objective from the different perspectives and planning of the required resources, the capabilities need to be defined and considered. Based on literature and case study, a list of capabilities is encountered that are key input for defining strategy for embedding BDA in business operations.

Capabilities, therefore, need to be defined by the framework, after the objective and resource are known. Subsequently, these capabilities need to be considered throughout the organisation whereby substantive planning is required. Table 47 presents an overview of the capabilities together with their frequency of occurrence in the

quantitative analysis. As not all capabilities can be included in the requirements of the framework design, only those with frequency of occurrence in top ten are incorporated. Based on the research findings, a functional requirement is established regarding the objective of BDA embedment.

The framework must guide the Executive Manager in defining capabilities (based on the resources) in order to achieve the objective.

5.5.5. REQUIREMENT 5: INTERRELATIONS

As is mentioned in the knowledge gap, the interrelations between capabilities are currently not taken into account in any of the literature articles studied. Several articles mentioned that capabilities can have negative consequences, which need to be taken into account to prevent vulnerabilities. As these interrelations can be complementing, neutral or conflicting, this can lead to undesired consequences. When conflicting interrelations are taken into account, trade-offs emerge, which need to be considered. The research of this thesis, therefore, aimed to identify these interrelations between capabilities.

Interrelations between capabilities need to be detected before institutionalising one. Although all capabilities have their upsides and downsides, consequences of capabilities need to be considered. Table 48 depicts an overview of the interrelations between capabilities that are encountered in the analysis of the interviews. Based on the research findings, a functional requirements are established regarding the objective of BDA embedment.

The framework must facilitate the Executive Manager in identifying interrelations between capabilities.

5.5.6. REQUIREMENT 6: TRADE-OFFS

This thesis walked through several steps in order to acquire a certain insight: the trade-offs between conflicting capabilities. Whereas these conflicts do not necessarily cause problems on higher organisational level, these will emerge when embedding BDA through developing capabilities on a lower organisational level. Before a project has actually started, these trade-offs are not visible yet as during implementation conflicts emerge.

A conflict between capabilities does not necessarily have to lead to difficult trade-offs. As is explained in the chapter 3, trade-offs are relatively easy to make when the choice is obvious. For instance, when one capability is appreciated more valuable than the other, there is a tendency to choose the most desired one. Therefore, it is important that these trade-offs are considered, by prioritising the capabilities that have conflicting interrelations based on their relative importance with respect to each another.

Based on the research findings, two functional requirements are established regarding the objective of BDA embedment. These are as follows:

The framework must guide the Executive Manager in assessing the perception on trade-offs by the different business units, so that the implications of trade-offs can be evaluated.

NON-FUNCTIONAL REQUIREMENTS

Next to the functional requirements, the framework should exhibit several other non-functional requirements.

- The framework should be walked through as a quick assessment of a project in perceiving trade-offs when embedding BDA.
- The framework should produce a manageable overview of the perception on trade-offs that can be easily interpreted.

5.6. SUMMARY

The aim of this thesis is to design a framework that facilitates the organisation to embed BDA in business operations. Based on the findings from the exploratory interviews, six coarse-grained requirements are defined for the design of this framework:

1. As there is a difference in perspective on what has to be done to embed BDA in business operations, actors from different business units need to be actively involved in the process.

2. It was found that, often, it is not clear what is aimed to be achieved by embedding BDA, therefore, there should be a clearly defined objective.
3. It is unclear how BDA resources need to be deployed efficiently, therefore, these should be planned for realising the objective set.
4. Ten important BDA related capabilities are encountered, therefore, these should define where the firm needs to be capable of by deploying of its BDA resources.
5. Both complementing as conflicting interrelations between capabilities are identified, thus, the framework should facilitate to identify these.
6. Eventually, conflicting interrelations between capabilities will lead to trade-offs, therefore, these should be perceived based on the relative importance of the involved capabilities.

IV. Design

6. DESIGN OF FRAMEWORK

This is the sixth chapter of this thesis, which is located in the fourth phase of the Design Science cycle as can be seen in Figure 29. The fourth Design Science phase focuses on designing a framework that overcomes the 'knowledge gap' and thereby addresses the problem definition and research objective.

In this chapter, subjects are discussed including:

- Introduction
- Design method
- Conceptual design
- Design of BORCIT framework
- **Sub-conclusion sub research question 4**

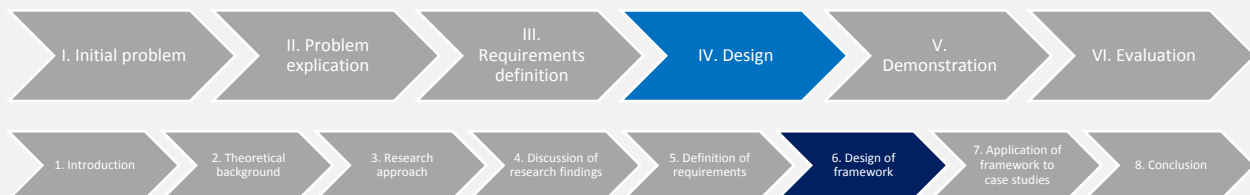


Figure 29: Sixth chapter of this thesis in the fourth Design Science phase.

6.1. INTRODUCTION

In chapter 5 the requirements are established that define the Design Space of the framework design. In this section, the design of the BORCIT framework is presented. The framework is applied to two different case studies in chapter 7 and evaluated in chapter 8.

FOR WHOM IS THIS FRAMEWORK?

As is already stated in the research objective in section 1.3, the framework facilitates the Executive Management of firms to define capabilities for embedding BDA in business operations. The Executive Management is a business unit from Mintzberg's Organisational Model that is in charge of the process of embedding BDA. This framework ensures that the research objective is realised whereby the research problem is overcome.

6.2. DESIGN METHOD

In Design Science, the logical step after definition of the requirements is the design of the artefact (Johannesson *et al.*, 2014). An artefact structures processes in order to achieve a desired outcome (Dym *et al.*, 1994). In this case, the artefact to be designed is a framework that structures the *process of embedding BDA in business operations* to fulfil a desired objective.

6.2.1. DIFFERENCE BETWEEN ENGINEERING DESIGN AND FRAMEWORK DESIGN

The books on designing that are related to in this thesis including Sage and Armstrong (2009), Little and Dym (1994) and Johannesson *et al.* (2014). However, as engineering design aims to design and develop a technological artefact that structures a process, this differs from designing a framework. The difference here is that in a framework design, requirements are perceived whereby a set of rules created in order to shape an organisational process (Bots *et al.*, 2012). As these organisational processes are intangible, no physical artefact is designed.

However, this does not necessarily mean that a framework design does not involve physical artefacts, as an implication of a framework design is that it can be supported by other technical artefacts as is asserted by Bots and van Daalen (2012). An artefact is the 'structure' that shapes 'processes' in order to achieve a certain goal. In case of an institutional artefact, there is an intangible 'structure' that shapes organisational processes towards a desired outcome. The difference between a physical artefact and an institutional artefact (e.g. framework) is noticeable due to the fact that requirements can be directly translated into design components. Therefore, there is one design component for each requirement.

This argument refers to the phenomenon that the requirements, as defined in chapter 5, are direct derivations which can be seen in Table 21. For instance, the requirement regarding the urge of involving different perspectives when initialising the embedment of BDA in business operations, is now directly represented by a 'phase'. This is the same for all other requirements, although each requirement comprises more sub-requirements, which subsequently also have to be fulfilled.

6.3. CONCEPTUAL DESIGN

6.3.1. EMPTY MORPHOLOGICAL CHART

For the conceptual design, a morphological chart is used, taken from the design methodology of Sage and Armstrong (2009), which is similar to the one from Little and Dym (1994). In this morphological, requirements are set out versus the features, which demarcate the Design Space (see Table 21). This Design Space tells where a design has to comply with and scopes out possibilities that are not within the boundaries. Within this Design Space, design components have to be thought through, which describe the features in order to satisfy the requirements. Notice that, these requirements are derived from empirical research including desk study and interviews and henceforth aim to solve the problem definition and realise the research objective (see section 1.2 and 1.3). For each chosen design component an explanation is required to underpin what the contribution is with regard to the requirements (Johannesson *et al.*, 2014).

Before a design component is chosen, key questions should be asked whether this component fulfils the requirement. These questions embody the underlying thoughts behind a requirement. In addition, chosen design components need to have a clear purpose regarding the contribution to the framework design.

After defining the key questions and defining the function of each component, the Design Space is considered. Firstly, a theoretical lens is chosen, which represents the theoretical perspective and validation of a component towards satisfying a requirement. As Johannesson asserts in his book on Design Science: "Specify the sources of the design of the artefact", which implies that every design component needs to fit in a theoretical framework. Therefore, a theoretical lens is chosen for each requirement. Although these lenses can be applied to multiple requirements in order to find satisfying design components, the framework design is a composition of different underlying theories that serve as a fundament for the overlying actions and outputs. Applicable frameworks using these validated theoretical lenses are commonly used, whereby they can be used as 'building blocks' that together compose a newly designed framework.

Next, the key actions and output need to be composed within the Design Space. Through execution of these key actions the desired outcome is achieved. These actions represent the function of the framework design and together form a roadmap towards the desired final output: 'perceiving of trade-offs' in order to consider them. However, each requirement leads to a certain output produced by execution of the key actions. These sub-outputs serve subsequently as an input for the realising the requirement.

In next sections, it is discussed how the Design Space is filled step-by-step with components while meeting the requirements (as is referred by in Table 21).

Requirement	R1. Business unit The actors of the different business units need to be actively involved in the process.	R2. Objective The objective of what is aimed to be achieved with BDA needs to be clearly defined and scoped, for each business unit.	R3. Resources The utilisation of the required resources need to be planned for realising that objective.	R4. Capabilities The capabilities that are important to acquire with these resources need to be defined.	R5. Interrelations The consequences of capabilities need to be considered by determining what interrelations there are between capabilities.	R6. Trade-offs The trade-offs that can emerge based on conflicting interrelations need to be perceived.
I. Key question (section 6.3.2)						
II. Function (section 6.3.3)						
III. Theoretical lens (section 6.3.4)						
IV. Key actions (section 6.3.5)						
V. Output (section 6.3.6)						

Table 21: Morphological chart that demonstrates the Design Space that needs to be filled with design components

6.3.2. KEY QUESTION

To make sure a design component satisfies a requirement, key questions need to be asked beforehand. Table 22 depicts these questions, which are briefly discussed in this section.

Firstly, it needs to be questioned what business units need to be involved for embedding BDA in business operations. BDA needs to be used by multiple business units from the organisation, therefore, it is required to involve them in the planning and realisation process. Besides, business units can also bring specific resources to the process (e.g. knowledge, skills, tools and expertise).

Secondly, it should be questioned what the firm wants to achieve by embedding BDA. Because embedding BDA on itself is not a goal. A objective should be formulated that also takes into account the interests of the different business units (e.g. monitoring erroneous transactions in ERP data). This is important for adoption of the final proposed solution.

Thirdly, once the objective is clearly defined, it should be questioned what resources are necessary for realisation of the objective. These resources form the basis of and therefore are important to make clear (e.g. knowledge, skills, tools and expertise).

Fourthly, it should be questioned where the firm must be capable of in order to achieve the objective. Also, it should be asked whether there is a difference in capabilities of the involved business units (e.g. the ability to interpret the data insights and derive conclusions).

Fifthly, it must be questioned if the capabilities have a interrelation with each other. Thus, does one capability has a positive (complementing), negative (conflicting) or no (neutral) impact on another capability (e.g. does the ability to derive conclusions hamper the ability to include large and complete amounts of data in the analyses)?

Sixth and lastly, before, choosing to develop specific capabilities by engaging resources, trade-offs need to be considered. These trade-offs have to be made when interrelations of capabilities are conflicting. These trade-offs need to be perceived by asking what capabilities are relatively more important for embedding BDA (e.g. how much more important is the ability to derive conclusions than the ability to involve large amounts of data in the analyses?)

Requirement	R1. Business unit	R2. Objective	R3. Resources	R4. Capabilities	R5. Interrelations	R6. Trade-offs
I. Key question	What business units need to be involved for embedding BDA?	What do we want to achieve by embedding BDA? Is this in line for the different business units?	What resource do we need for embedding BDA in our business operations ?	Where do we have to be capable of in order to achieve the objective? Does this differ per business unit?	Do capabilities have a specific impact on other capabilities? Is this positive, neutral or negative?	How much important do we find specific capabilities relative to each other capabilities?

Table 22: Key questions that must be asked when satisfying the requirements

6.3.3. FUNCTION

Functions describe what the purpose of a design component is with respect to a requirement. They provide an answer to the key question. Table 23 presents these functions, which are also shortly discussed in this section.

Firstly, to involve actors from different business units the interests of these business units should be assessed. They need to have a buy-in in the project, so they have to be interested in the proposed solution. This is important for preventing conflicts based on interests.

Secondly, the objective should be substantialised so that it is clearly known what is to be achieved. This should be derived from the interests of the involved business units (e.g. the Operational Management wants to increase the penetration rate of a product by using BDA insights).

Thirdly, the purpose of defining the required resources is that they form a basis of embedding BDA. Without these resources (e.g. knowledge, skills, tools and expertise) no capabilities can be created (e.g. the ability to engage insights data in business decisions).

Fourthly, it is important to define capabilities so that a firm know where it should be capable of. Once these are clear, the firm can make concrete steps to realise that. Notice that these capabilities are directed towards the objective (e.g. the objective of reducing erroneous transactions can be achieved when the ability of understanding and interpreting data insights is developed).

Fifthly, to make sure that capabilities have a positive impact with each other, the interrelations need to be assessed. These can be complementing, neutral or conflicting. Most important is that conflicting interrelations between capabilities are detected so that they can be traded off (e.g. the ability to derive conclusions hampers the ability to include large and complete amounts of data in the analyses). The disadvantage of developing two conflicting capabilities, is that they hamper each other. Therefore, a trade-offs should be made.

Sixth and lastly, when two capabilities have a negative impact on each other due to that they have a conflicting interrelation, a trade-off must be made. However, it should be known first what capability is relatively more important (e.g. how much more important is the ability to derive conclusions than the ability to involve large amounts of data in the analyses?). When their relative importance is known, the trade-off is perceived which means that they can be made by having considered all the advantages and disadvantages.

Requirement	R1. Business unit	R2. Objective	R3. Resources	R4. Capabilities	R5. Interrelations	R6. Trade-offs
II. Function	- Assessing interests of actors - Considering multi-actor perspective - Preventing intra-organisational conflicts	- Substantialising objective - Deriving objective from business unit's interests	- Determining what resources are required - Planning of resource utilisation	- Defining what capabilities work towards satisfaction of objective - Defining how resources are managed	Assessing consistency of strategic capabilities	Excluding strategic vulnerabilities of conflicts by making trade-offs

Table 23: The functions that the framework design should exhibit

6.3.4. THEORETICAL LENS

In Design Science every design component has to be underpinned by an underlying theory. Therefore, a theoretical lens is defined for each design component. Notice, these theories are already discussed in the chapter 2 of the problem explication.

Firstly, the business units that need to be involved in embedding BDA is perceived from the Organisational Theory of Mintzberg (1979). Translations are made to place the different business units in context. Here, the Strategic Management is renamed to Executive Management that supervises the process of embedding BDA on a high level. Middle-line Management is renamed to Operational Management which is owner of a specific business operation. Technical Staff is renamed to BDA Expert Team as it is comprised of experts that guide and execute the embedment process. Notice that now three large business units are selected, however, these can also be made smaller. This, however, makes the process more complex as more business units are then involved.

Secondly, for the objective the Resource Based View is used that finds its origins on another theory on Competitive Advantage (Barney, 1991; Porter, 1989). The idea is that a firm creates capabilities based on adequate management of resources whereby an objective is pursued. Although objectives can be very specific, these aim on creating complete advantage by increasing 'general performance'.

Thirdly and fourthly, the components of resources and capabilities are taken from the Resource Based View. Resources are essential assets of a firm whereby they form the basis for creating capabilities (Barney, 1991). These capabilities tell where a firm is capable of respective to its objective. As resources and capabilities are vague terms they are often confused. However, there is clear difference, resources are passively described with a noun (e.g. skills, expertise, governance, policy, technology) whereby capabilities are actively described with a verb (e.g. the ability to include large and complete amounts of data).

Fifthly, the impact that capacities can have on each other is in this research described with interrelations. Although this principle is not found by Dym et al., the technique of pairwise comparing two elements (in this case capabilities) is taken from them (1994). Here, all elements are listed in a matrix on both the horizontal and the vertical axis. Then, all the possible pairs are subsequently assessed. In this case the outcomes can be 1 (complementing), 0 (neutral) and -1 (conflicting). The amount of interrelations is calculated by: $\frac{n(n-1)}{2}$. Hence, in case of 10 capabilities, an amount of 45 interrelations need to be assessed.

Sixth and lastly, the trade-offs are assessed by using the Analytic Hierarchy Process (Saaty, 1987). It should be noticed however, that the phenomenon of a trade-off is not used from Saaty et al. The Analytic Hierarchy Process allows a firm to determine what capabilities are relatively more important. This is only done for the conflicting interrelated conflicts, as for these the trade-offs need to be perceived. This was also explained more thoroughly in section 3.3.3.

Requirement	R1. Business unit	R2. Objective	R3. Resources	R4. Capabilities	R5. Interrelations	R6. Trade-offs
III. Theoretical lens	Organisational configurations theory (Mintzberg, 1979)	Competitive advantage (Porter, 1989)	Resource Based View (Barney, 1991)	Resource Based View (Barney, 1991)	Pairwise comparison (Dym et al., 1994)	Analytic Hierarchy Process (Saaty, 1987)

Table 24: The theoretical lens that underpins the design component

6.3.5. KEY ACTIONS

Key actions describe what has to be executed in order to achieve an output that satisfies the requirements. Perhaps this is the most important part of the framework as these actions since these are performed on each case study (see chapter 7). Table 25 presents six key actions concisely explained below.

First, it is determined which business units need to be involved in the process of embedding BDA. They need to have a 'buy-in' in the project whereby also their interest are assessed. Notice that their interest can differ as they are involved in different operations and parts of the organisation (e.g. BDA experts are more interested in being able to perform analytics whereas operational managers are more interested in the contribution that the BDA solution has to their business).

Second, it is clarified what must be achieved by embedding BDA. As is mentioned in the findings, the objective is not 'embedding BDA'. Instead, this is the mean towards achieving the objective (e.g. the objective is to reduce the erroneous transactions made whereby BDA provides support in tracing these).

Third, the resources are determined that are necessary for achieving the objective by embedding BDA. These have come from different parts from the organisation. Hence, the business units play important role in providing them (e.g. Operational Management brings business knowledge and data whereas BDA experts provide analytics tools and software).

Fourth, the capabilities are established that tell where the firm need to be capable of. This can be defined on both corporate level and business unit level. Here, it is defined how resources are managed in order to be capable of achieving the firm's objective (e.g. analytics tools and business specific data are required for the ability to interpret and derive conclusions from data insights).

Fifth, the interrelations between each pair of capability is defined. This is done by using a pairwise comparison matrix. Interrelations can be complementing, neutral or conflicting (e.g. the ability to interpret and derive conclusions from data insights has a complementing interrelation with the ability to create, process and manage BDA activities)

Sixth and last, for conflicting interrelations between capabilities, trade-offs are perceived. This is done by deciding what capability is relatively more important than the others. Also it is said how much more important one is than another. There are five gradations to specify this including same importance, slightly more, moderately more, much more and extremely more important (e.g. the ability to create, process and manage BDA activities is extremely more important than the ability to include large and complete amounts of data).

Requirement	R1. Business unit	R2. Objective	R3. Resources	R4. Capabilities	R5. Interrelations	R6. Trade-offs
IV. Key actions	1. Determine which actors need to be involved and assess interests of their business units	2. Clarify what must be achieved by embedding BDA (derive from interests of business units)	3. Determine what resources need to be planned and used and why they are needed	4. Define where the organisation should be capable for reaching the objective and how resources are used	5. Assess interrelation of each pair of capabilities	6. Determine for each pair of conflicting capabilities which one is more important

Table 25: Key actions that must be performed to achieve the desired output

6.3.6. OUTPUT

The outputs are created by executing the key actions as defined in section 6.3.5. Subsequently, outputs from actions serve as inputs for the next action. Table 27 displays these outputs related to each requirement. Below, these are briefly enumerated along with an example.

After performing the first action, it is clear what business units are involved and what their interests are (e.g. BDA experts, operational manager of sales department, operational manager of purchase department, executive sales manager).

After performing the second action, it is clear what must be achieved by embedding BDA (e.g. optimising penetration rate of product sales by using BDA insights).

After performing the third action, an overview of the planned resources is established which can be used e.g. BDA tools, skills and dashboard, data extraction from sales ERP, data extraction from inventory ERP and sales-specific knowledge).

After performing the fourth action, it is clear what capabilities the firm needs to develop in order to achieve its objective (e.g. 1. the ability to create accurate, relevant and correct insights from analyses, 2. the ability to involve complete data in analyses and create complete insights).

After performing the fifth action, it is clear what capabilities are complementing, neutral and conflicting. Notice that only the conflicting interrelations are required for next action (e.g. capability 1 conflicts with capability 2 (the ability to create accurate, relevant and correct insights from analyses hampers the ability to involve complete data in analyses and create complete insights).

After performing the last action, it is clear how the trade-offs are perceived. Here, the trade-offs are displayed and visualised along with their difficulty. For each trade-off it is clear how 'difficult' it is to make the trade-off. When two capabilities of a conflicting interrelation are of same importance, it is a critical trade-off. However, when one capability is appreciated as extremely more important, the trade-off is very easy (e.g. capability 1 is moderately more important than capability 2, therefore, the trade-off is difficult).

Trade-off difficulty	Relative importance	Level
Critical	Same importance	1
Very difficult	Slightly more important	3
Difficult	Moderately more important	5
Easy	Much more important	7
Very easy	Extremely more important	9

Table 26: Overview of the difficulty of trade-offs based on the relative importance of the two conflicting capabilities

Requirement	R1. Business unit	R2. Objective	R3. Resources	R4. Capabilities	R5. Interrelations	R6. Trade-offs
V. Output	Involved business units with their interests	Objectives of the business units based on their interests	Planned and determined resources	Strategic capabilities that play key role for BDA embedment	Interrelations between capabilities which can be	Perceived trade-offs with their difficulty.

			required for execution		complementing, neutral or conflicting	
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Table 27: Outputs that need to be created to satisfy the requirements

6.3.7. FILLED-IN MORPHOLOGICAL CHART

In the last sections, the Design Space is filled in step-by-step in last sections. This produced the filled morphological chart, see in Table 51 in Appendix VIA. This filled-in morphological chart represents the blueprints of a framework. The BORCIT framework on itself, as presented in section 6.4 only shows the phases and actions. However, the framework on itself does not tell anything about how it is composed. The morphological chart give more insight about this.

6.4. DESIGN OF THE BORCIT FRAMEWORK

After filling the Design Space with components that satisfy the requirements, the preliminary design of the framework is created. According to Sage and Armstrong (2009), the preliminary design is a bridge of the gap between the conceptual design (as discussed in 6.3) and the detailed design. The detailed design can only be created through testing, evaluating and improving of the preliminary design. For this reason, it is not included in this thesis.

As the framework considers the requirements related to the aspects: *Business units*, *Objectives*, *Resources*, *Capabilities*, *Interrelations* and *Trade-offs*, the name BORCIT is given to it. It comprises six phases as is presented in Figure 30, each of which corresponding with one requirement as displayed of last section. Throughout section 6.3, the BORCIT phases have become clear. However, they are shortly presented in this section. In chapter 7 the BORCIT framework is applied to two case studies.

PHASE 1: INVOLVE BUSINESS UNITS

In this phase it is determined what actors should be involved from different business units across the organisations. As can be seen in Figure 30, there are three types of business units. However, within each one, smaller groups can be defined. The three business units are:

- Executive Management
- Operational Management
- BDA Expert Team

➤ See section 7.2.1 and 7.3.1 for a demonstration of this phase on the two case studies.

PHASE 2: CLARIFY OBJECTIVE

In this phase it is clarified what the objective is of embedding BDA. There are four main types of objectives for which BDA can be used, as is displayed in Figure 30. It can also be the case that an objective is a mix of different types. The four types of objectives are:

- Descriptive
- Diagnostic
- Predictive
- Prescriptive

➤ See section 7.2.2 and 7.3.2 for a demonstration of this phase on the two case studies.

PHASE 3: ESTABLISH RESOURCES

In this phase it is determined what resources need to be planned for embedding BDA. As is displayed by Table 38, many different specific resources can be defined. However, they can be derived to one of the three types of resources as is displayed in Figure 30. The three types of resources are:

- Physical (technical)
- Human
- Organisational

➤ See section 7.2.3 and 7.3.3 for a demonstration of this phase on the two case studies.

PHASE 4: DETERMINE CAPABILITIES

In this phase it is defined where the organisation should be capable of in order to achieve the objective. This can be established by the ten generic capabilities from interviews. Within a generic capability, capabilities can also be defined more specific, however, this is dependent on the context and objective of the case. The ten capabilities (see Table 16 for complete definitions) are:

- Data Availability
- Data Completeness
- Data Understandability
- Data Quality
- Manageability
- Autonomy and Flexibility
- Interoperability
- Security and Integrity
- Predictability
- Insights Engageability

➤ See section 7.2.4 and 7.3.4 for a demonstration of this phase on the two case studies.

PHASE 5: ASSESS INTERRELATION

In this phase the interrelations between each pair of capabilities is defined. Although there are three types of interrelations, as is displayed in Figure 30, eight prominent conflicting interrelations are encountered in the research (during the exploratory interviews). A cross-evaluation matrix can be used to assess them. The three types of interrelations are:

- Complementing
- Neutral
- Conflicting

➤ See section 7.2.5 and 7.3.5 for a demonstration of this phase on the two case studies.

PHASE 6: PERCEIVE TRADE-OFFS

In this phase the trade-offs of the conflicting interrelations are considered. This is done by prioritising the involved capabilities relative to each other. There are five types of trade-offs possible based on their difficulty as can be seen in Figure 30. It should be noticed that trade-offs lead to different consequences depending on the context and objective of a case. The five trade-off difficulties are:

- Critical
- Very difficult
- Difficult
- Easy
- Very easy

➤ See section 7.2.6 and 7.3.6 for a demonstration of this phase on the two case studies.

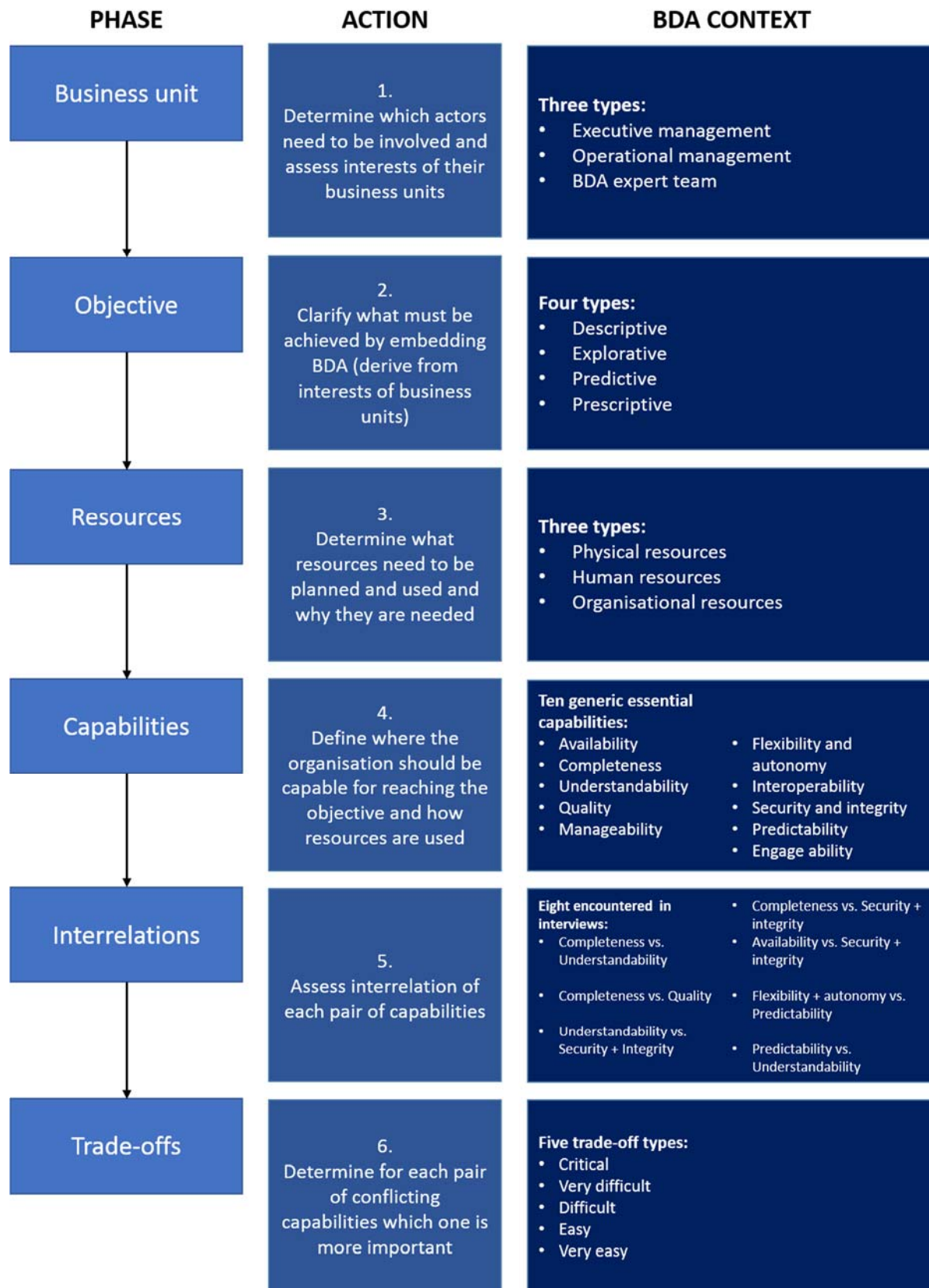


Figure 30: The BORCIT framework for perceiving trade-offs when embedding BDA in business operations

6.5. SUB-CONCLUSION OF SUB RESEARCH QUESTION 4

On this point, sub-question 4 can be answered.

4. *How does a framework look like that facilitates firms to perceive trade-offs?*

Based on the requirements which are henceforth based on the findings of the literature research and exploratory interviews, the BORCIT framework is designed. The BORCIT framework facilitates the Executive Management to perceive (from different perspectives in a firm) trade-offs between conflicting interrelated capabilities that are important to develop for embedding BDA in business operations. It produces an output whereby the trade-offs are perceived more complete from different business units. Based on this complete perception, trade-offs can be considered adequately, preventing unforeseen problems that may occur in later stages of embedding BDA. Six phases need to be walked through in order to perceive the trade-offs:

1. Involve **Business units** in the project team, which can be classified in three groups: Executive Management, Operational Management and the BDA Expert Team.
2. Clarify **Objective** that needs to be achieved by embedding BDA, which can be classified in four types: descriptive, diagnostic, predictive and prescriptive.
3. Establish **Resources** that are required, which can be divided in three groups: physical (technical), human and organisational resources.
4. Determine **Capabilities** need to be developed, which can be classified to ten generic capabilities: see Table 47.
5. Assess **Interrelations** between capabilities, which can be complementing, neutral and conflicting.
6. Perceive **Trade-offs** between eight encountered conflicting interrelated capabilities: see Table 50.

As can be seen, the BORCIT framework adds three perspectives to current literature that uses the Resource Based View: 1. Multi-actor perspective, as business units from across the organisation are involved, 2. Multi-capability perspective, as interrelations between capabilities are assessed, and 3. Multi-trade-off perspective, as the framework facilitates to perceive trade-offs between conflicting capabilities.

V. Demonstration

7. APPLICATION OF FRAMEWORK TO CASE STUDIES

This is the seventh chapter of this thesis, which is located in the fifth phase of the Design Science cycle as can be seen in Figure 31. The fifth Design Science phase focuses on demonstrating the framework design that is designed based on the requirements which are subsequently derived from the research findings. The framework is demonstrated and tested whether it overcomes the 'knowledge gap' and thereby addresses the problem definition and research objective.

In this chapter, subjects are discussed including:

- Case study 1: an employment agency
- Case study 2: a dairy producer
- **Sub-conclusion on sub research question 5**

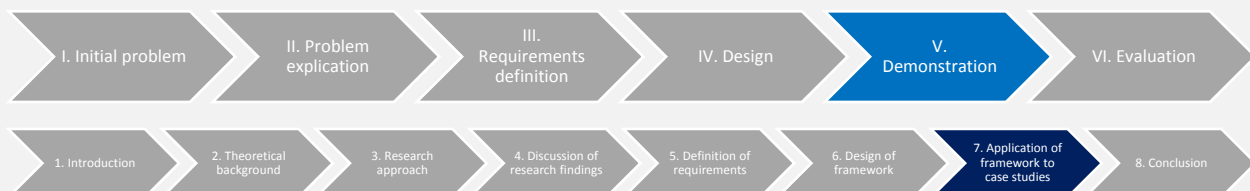


Figure 31: Seventh chapter of this thesis in the fifth Design Science phase.

7.1. INTRODUCTION TO THE CASES

In last chapter, a framework is designed that aims on achieving the research objective and addressing the research problem by bridging the knowledge gap. According to the Design Science cycle, it has to be demonstrated and evaluated (Johannesson *et al.*, 2014). In this chapter two case studies are briefly reported, where the BORCIT framework is applied to. Its six phases are walked through in order to perceive trade-offs that need to be considered when embedding BDA.

The first case study is about an employment agency that wants to optimise the timesheets process by using BDA in the organisation. The second case study is about a dairy producer that wants to detect the inefficient supply chains of farmers in the country by using BDA. Notice that the case-firms are anonymized due to the confidentiality agreements that KPMG has concluded with its clients. This, however, does not have impact on the outcomes of the case studies. Besides that, the case reports are also presented to the firms at matter afterwards.

7.2. CASE STUDY 1: AN EMPLOYMENT AGENCY

The employment agency is situated in the Netherlands and operates in countries all over the world. Its aim is to start using BDA to optimise processes. Hereby, costs need to be reduced, quality of information processes has to be kept high and it has to be made more time-efficient. A small part of the strategy concerning BDA is used in this case study to derive the objective for one country and one process; completing timesheets in Australia. The objective is: *"To optimise average lead times of the different types of timesheets used in the Australian part of the firm"*.

Currently, there are four types of completing timesheets that are used in the Australian part of the firm. After employees hired by the employment agency have finished their (periodical), they have to complete their timesheet to get paid. This is one of the main administrative processes of the employment agency. However, it can become complex due to the irregularities of the employees. For example, they have different wages, locations, types of job, expertise, function roles and working times. Based on the timesheets the client firms are billed, which forms the main revenue of the employment agency. In order to ensure correct billing, it is important to make this activity as efficient as possible. It has to be performed correctly, in time, and it should not take too much effort.

7.2.1. INVOLVE BUSINESS UNITS

There are four main actors. First, the supervising board of the firm is located in the Netherlands and aims on optimising timesheet processes in different countries in terms of time, costs and quality. On the same time regulations still have to be complied with. Second, the management of the Australian part of the firm aims on correct billing based on timesheet processes, and has to report that to the supervising board. Third, the internal audit team is also located in the Netherlands and supervise the auditing activities of the entire firm. Fourth, KPMG is engaged by the supervising board and has to support the internal audit team in their activities in conducting analytics, and looking for weaknesses and opportunities with respect to the objective. These can be mapped with the three business units of the BORCIT framework as presented by Table 28.

Business unit	Actor	Interest
Executive Management	Supervising board	Optimise timesheets processes Compliance with regulations
Operational Management	Australian management	Ensure correct billing with timesheets processes
BDA Expert Team	Internal audit team KPMG team	Conduct reliable analytics Control transaction data Check for weaknesses and opportunities

Table 28: Business units to involve

7.2.2. CLARIFY OBJECTIVE

The main objective is to optimise the timesheets process of the Australian part of the employment agency (see case description in section 7.2). As can be seen in Table 29, the objective applies to all the four objective types. First, it needs to be diagnosed what the lead time is of the different timesheets. Second, it needs to be explored why these lead times are low or high. Root causes need to be found behind these aspects. Third, it needs to be predicted how

these processes can be optimised by making changes in current process designs. Fourth, it needs to be prescribed what actions need to be executed to make these changes in the process designs. These four types of objectives stack on each other, whereby the prescriptive is the most difficult and diagnostic the easiest relatively.

Objective type	Purpose	Executive Management	Operational Management	BDA Expert Team
Diagnostic	Diagnose what the lead times are of the different timesheets	Secondary	Secondary	Primary
Explorative	Explore why these lead times are low or high	Secondary	Secondary	Secondary
Predictive	Predict what the future situation would in current state	Secondary	Primary	Primary
Prescriptive	Prescribe actions to optimise the future performance of the timesheets processes	Primary	Primary	Secondary

Table 29: Objective of embedding BDA aligned with the interests of the three involved business units

7.2.3. ESTABLISH RESOURCES

A list of resources is established that the employment agency should possess in order to create capabilities for embedding BDA. A combination of resources form a capability. These capabilities are subsequently needed for realising the objective. As is displayed in Figure 32 (and Table 52 in the Appendix), the resources are divided in three types: physical, human and organisational. A line is drawn from each resource to the capabilities where they are part of. It should be noticed that most resources form part of multiple capabilities.

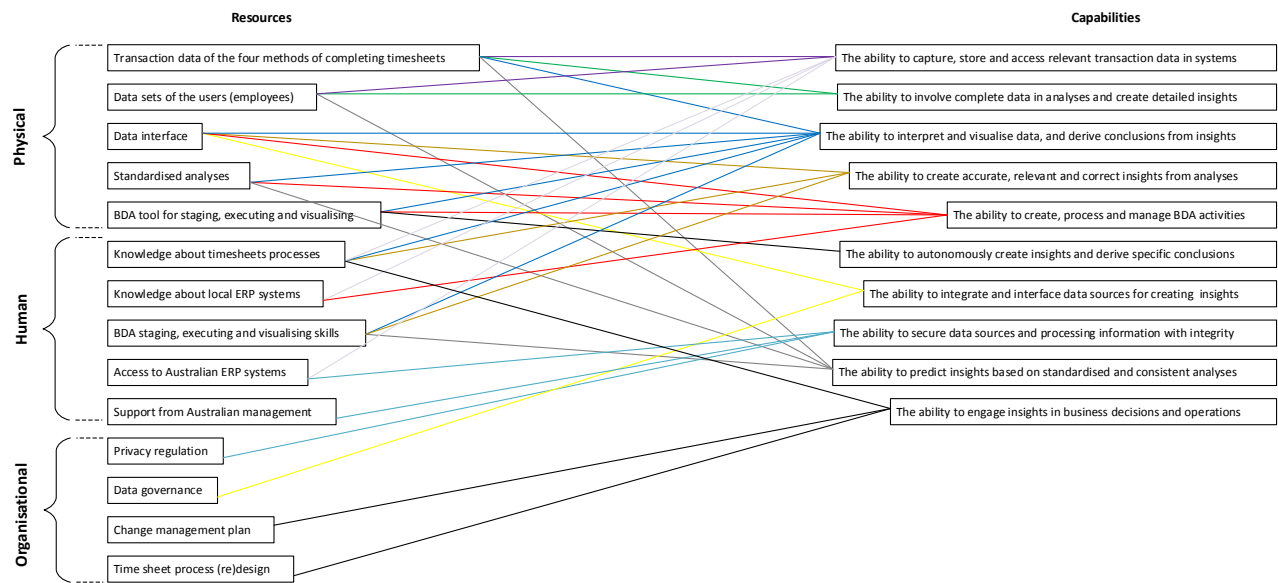


Figure 32: Overview of the resources and the capabilities where they form part of

7.2.4. DETERMINE CAPABILITIES

There are 10 generic capabilities in the BORCIT framework, which are applied in the context of the objective of the employment agency. These are presented in together with their purpose with respect to the case. As can be seen in Table 30 all capabilities play important role in realising the objective. These capabilities are created by combining the resources as displayed in Figure 32.

Capability name	Capability description	Executive Management	Operational Management	BDA Expert Team	Purpose in case context
Data availability	The ability to capture, store and access relevant	Secondary	Secondary	Primary	The Dutch supervising board needs to ensure that the internal audit team has access to the data resources

	transaction data in systems				The created BDA insights must be available to the Australian management KPMG needs to acquire an extraction of the data resources to develop the analyses
Data completeness	The ability to involve complete data in analyses and create detailed insights	Secondary	Secondary	Primary	In order to oversee what method of completing timesheets is most efficient, the internal audit team and the Australian management need to combine data sets from the different resources KPMG needs to acquire a complete extraction of the data resources
Data understandability	The ability to interpret and visualise data, and derive conclusions from insights	Primary	Primary	Secondary	KPMG needs to produce understandable BDA insights The supervising board needs to be able to understand the BDA insights
Data quality	The ability to create accurate, relevant and correct insights from analyses	Primary	Primary	Secondary	The internal audit team and the Australian management need to ensure that the data is of high quality KPMG needs to produce accurate, relevant and correct insights
Manageability	The ability to create, process and manage BDA activities	Primary	Primary	Secondary	The supervising board needs to be able to oversee the BDA activities The Australian management needs to be able to manage the BDA activities The internal audit team and KPMG need to be able to execute the BDA activities
Flexibility and autonomy	The ability to autonomously create insights and derive specific conclusions	Secondary	Secondary	Primary	The internal audit team and KPMG need to be able to autonomously perform BDA activities and come up with desired conclusions The supervising board and Australian management need to provide resources and support the internal audit and BDA expert team to achieve the objective
Interoperability	The ability to integrate and interface data sources for creating insights	Secondary	Secondary	Secondary	The Australian management and supervising board need to set data standards and system interoperability so that data is also interoperable The internal audit team needs to define requirements for data interoperability and perform controls for this
Security and integrity	The ability to secure data sources and processing information with integrity	Primary	Secondary	Primary	The supervising board and Australian management need to comply with the data protection acts and privacy regulation The internal audit team needs to control the compliance of security and integrity of data usage KPMG needs to stay within the boundaries of regulations when conducting BDA
Predictability	The ability to predict insights based on standardised and consistent analyses	Primary	Secondary	Primary	The supervising board and Australian management need to rely on the BDA solution so they can use it for their strategy Internal audit team and KPMG need to be able to make predictions and create consistent insights
Insights engage ability	The ability to engage insights in business decisions and operations	Primary	Primary	Secondary	The supervising board needs to be able to use the BDA solution in its strategy The Australian management needs to be able to make changes based on the BDA insights in the processes

Table 30: Capabilities of BDA embedment for the employment agency

7.2.5. INTERRELATIONS BETWEEN CAPABILITIES

Based on exploratory interviews with the actors of the different business units, eight conflicting interrelations are predefined in the BORCIT framework. The red lines represent those conflicts whereby a trade-off needs to be

considered. As is discussed in section 4.8, a conflict between two capabilities occurs when one capability hampers another. This means that the two capabilities cannot be realised by using the available resources (those which the firm currently possesses or is able to possess). For example, there is a conflict between Data Completeness and Data Understandability because with the current data sets, FTEs, human skills, management skills, time and money it is not possible to achieve both optimal Data Completeness and Data Understandability. In principle, every capability is important for the achieving of the objective, however, when one capability hampers (conflicts with) another capability, this implicates that it also hampers the realisation of the objective. This is explained in section 4.9.

These conflicts are considered to be the most prominent because they are mentioned during the exploratory interviews (section 4.8). However, more interviews with people from the organisation could have led to a more complete overview of conflicting interrelations. Figure 33 displays these conflicting interrelations. When an interrelation is conflicting, it means that one capability has a negative impact on another capability (see section 2.5). Then, a trade-off has to be considered by the Executive Management of the firm.

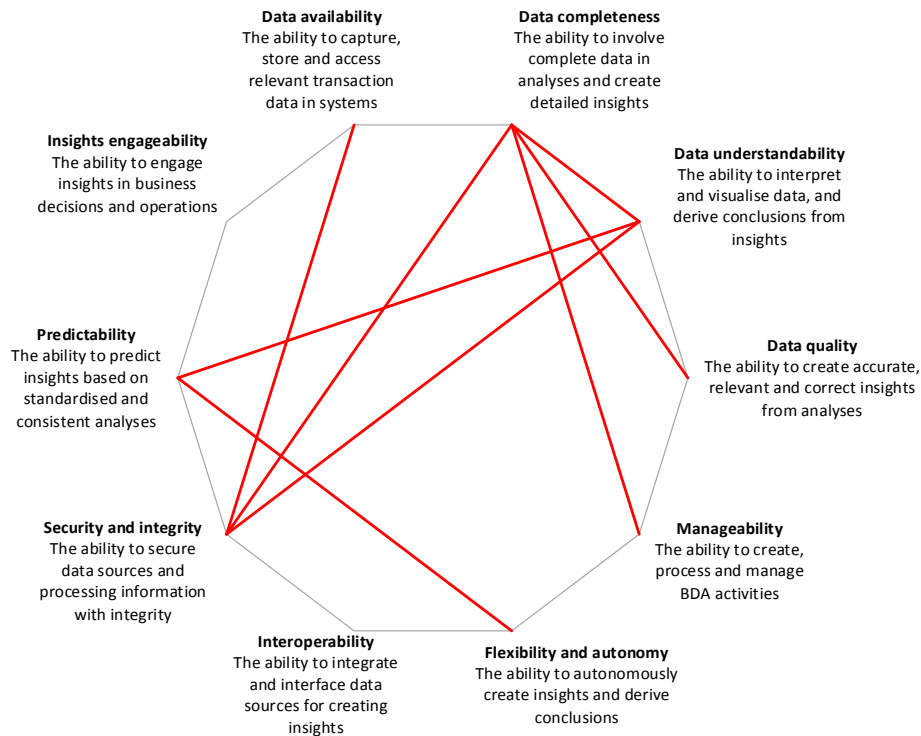


Figure 33: The conflicting interrelations between capabilities

7.2.6. PERCEIVE TRADE-OFFS

Three evaluation interviews are conducted with the actors from the Executive Management (supervising board), Operational Management (Australian management) and the BDA Expert Team (KPMG and internal audit team) in order to perceive the trade-offs that have to be considered. As can be seen in Table 53 in the Appendix and Figure 34, there is a large difference in perspective of the business units. The Executive Management perceives most trade-offs easier (under-perceived³) and distinctively (inconsistently⁴) with respect to the Operational Management and the BDA Expert Team do. Six trade-offs are under-perceived by the Executive Management as the other business units perceive them more difficult. Six trade-offs are inconsistently perceived by the Executive Management with respect to the other business units. Hence, there is a risk of erroneously considering for 7 of the 8 trade-offs. This can entail unforeseen problems implicating that objectives become unfeasible. This is illustrated with two case-

³ Underestimated trade-off: the Executive Management (decision-maker) perceives a trade-off easier than the other business units.

⁴ Inconsistently perceived trade-off: the Executive Management (decision-maker) perceives a trade-off distinctively than the other business units.

examples from Table 53 in the Appendix and Figure 34. The reasons of the perceptions on the trade-offs are discussed followed by their implications.

EXAMPLE 1 – DATA COMPLETENESS VS. DATA QUALITY

The Operational Management perceives Data Completeness vs. Data Quality as a critical trade-off (Table 53 in the Appendix and Figure 34). It cannot prioritise one capability before another because *“for optimisation of timesheet processes based on insights, the quality needs to be high, though the completeness also needs to be high”*. This can be explained by the fact that its interest is to ensure that the billing of the worked hours is done correctly and in time. To achieve this, both Data Completeness and Data Quality is of high importance because both lead to an increase of money billed. The Executive Management prioritises Data Completeness because *“acquiring detailed data is more important than its quality, which can be compensated when a data set is complete”* and perceives the trade-off as very easy. Its interest is to optimise the processes regarding the timesheets processes while complying with the regulations. With that perception, Data Completeness is more important and the Data Quality less because involvement of complete data and creation of detailed insights are essential for increasing accuracy and effectiveness of the timesheets. However, the BDA Expert Team prioritises the capability over Data Quality and perceives this trade-off as difficult because *“this objective is very specific, therefore, it is more important to create high quality insights instead of complete and very detailed insights”*. Its interest is to conduct reliable analytics, control transaction data and check for weaknesses and opportunities. To realise this, it is more important to be able to involve complete data in analyses and create detailed insights as in that case the change of missing out is reduced. As this regards billable hours that result in money, it has a high priority.

The encountered risk here is two-fold: the Executive Management 1. under-perceives this trade-off and 2. perceives it inconsistently with respect to the other business units. The Executive Management tends to choose for a high Data Quality, which entails the ensuring of accuracy and correctness and including of solely relevant insights. However, this also implicates that insights are basic, the overview is incomplete and there is a chance of missing information. The data analyses would become more complex hampering the ability to understand them. However, this weighs up against this complexity as it is very important that for optimising timesheets and being compliant at the same time. The risk of missing out data should be minimised as missing billable hours directly lead to missing revenues. Besides, complete data is required to ensure compliancy.

The BDA Expert Team tends to choose for a high Data Completeness, which entails detailed insights, a complete overview and in-depth information. However, this also implicates that the Data Quality is low which entails the increasing chance of containing errors on detailed level, the making of wrong assumptions due to wide scope and the enclosing irrelevant data. The amount of transaction data of the timesheets - that can be extracted from the ERP systems - is enormous. Findings on efficiency on the timesheets become less concrete when too much data is involved. To be able to derive actionable steps to improve this efficiency, it is required to aim on the ability of Data Understandability.

The Operational Management perceives both capabilities as equally important which is a critical situation (see section 4.9.2). This can be explained by the fact that its interests is situated on the interface between these two capabilities. However, it should be noticed that it is no option to not consider a trade-off. Because, the capabilities of Data Completeness and Data Understandability are hampering each other. This will eventually lead to problems in realisation of the objective because with the current resources (BDA tools and skills for staging, executing and visualising, change management plan and data governance) only one of the two capabilities is possible. Hence, either Autonomy and Flexibility or Predictability should be chosen.

EXAMPLE 2 – AUTONOMY AND FLEXIBILITY VS. PREDICTABILITY

The Executive Management perceives Autonomy and Flexibility vs. Predictability as an easy trade-off (Table 53 in the Appendix and Figure 34). The Operational Management and BDA Expert Team perceive it as a difficult trade-off. The Executive Management prioritises Autonomy and Flexibility because *“consistency in analyses and insights that allow predictions is more important as the timesheet optimisation is partially based on predictions”*. Its interest is to optimise the processes regarding the timesheets processes while complying with the regulations. With that perception, flexibility)and autonomy need to be granted to the analysts so that processes occur (tailored solutions)

effectively though within boundaries. The Operational Management prioritises Predictability as well since *“analyses need to be consistent to achieve predictive insights, they are modules stacked on each other whereby Autonomy and Flexibility should be limited”*. Its interest is to ensure that the billing of the worked hours is done correctly and in time. Therefore, consistent insights should be strived for whereby predictions can be made regarding the worked and billable hours. The BDA Expert Team prioritises Autonomy and Flexibility because *“Autonomy and Flexibility is more important to have in order to conduct constructive and useful analytics”*. Its interest is to conduct reliable analytics, control transaction data and check for weaknesses and opportunities. For this reason, it needs Autonomy and Flexibility in order to be able to tailor effective solutions addressing these weaknesses and opportunities.

The encountered risk here is two-fold: the Executive Management 1. under-perceives this trade-off and 2. Perceives it inconsistently with respect to the other business units. The Executive Management and the Operational Management tend to choose for high Predictability, which entails standardising analyses, creating consistent data outputs, corresponding insights and allowance for predictions and prescriptions. However, this also implicates the that insights are less specific, there is a low variation and flexibility in BDA activities and low resilience. As the case objective is specifically aimed on optimising the timesheets processes, consistency of insights is of high importance. Predictions are then based on these insights that would serve as building blocks. In this way, actionable steps can be derived that aim to increase effectiveness and efficiency of the timesheets. This would be limited when Autonomy and Flexibility is allowed, as it entails the risk of not being able to define actions or inconsistent predictions.

The BDA Expert Team tends to choose for high Autonomy and Flexibility, which entails that BDA solutions are tailored to the problem, analyses are specific, decisions are made ad-hoc and conclusions are individually derived and a high resilience. However, this also implicates that the data outputs can be inconsistent, there is a high variance in insights and predictions and prescriptions are not possible due to the variation (see section 4.9.2). The objective is to find ways how the timesheets processes can be improved compared to the current situation. This is a broad objective, whereby specific decisions need to be tailored. This outweighs the ability to make predictions because when predictions are not specific enough or incorrect, this has a direct negative effect on the revenues from billable hours.

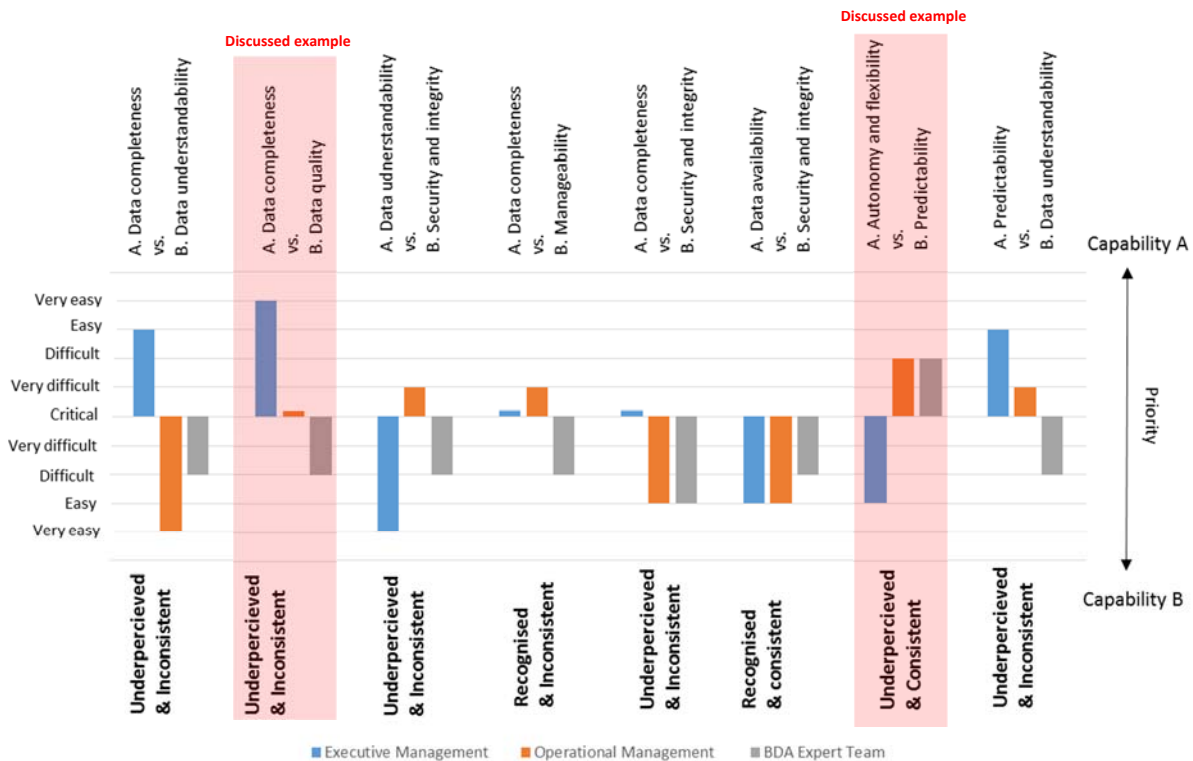


Figure 34: Overview of the perceived trade-off by the different business units (summary of Table 53 in Appendix)

As these both these trade-offs (as discussed in the two examples) are inconsistently perceived and under-perceived, this can mean that the Executive Management is not completely informed about the consequences that it has. This can lead to the erroneously considering of the trade-off whereby unforeseen problems can emerge in a later stage of the project. This also applies for the rest of the trade-offs as displayed in Figure 37 and Table 55 in the Appendix.

7.2.7. KEY FINDING STATEMENTS

As both of the trade-offs (as discussed in the two examples) are inconsistently perceived and under-perceived, this can mean that the Executive Management is not completely informed about the consequences that it has. This can lead to the erroneously considering of the trade-off whereby unforeseen problems can emerge in a later stage of the project.

Based on the application of the BORCIT framework to the case of the employment agency several key statements can be made. The objective of embedding BDA is: *"To optimise average lead times of the different types of timesheets used in the Australian part of the firm"*.

- There is a clear difference in perception between the different business units.
- The supervising board (Executive Management) under-perceives 6 of the 8 trade-offs compared to the other business units.
- The supervising board (Executive Management) perceives 6 of the 8 trade-offs with respect to the other business units.
- The supervising board (Executive Management) tends to perceive trade-offs easier and distinctively than the Australian management (Operational Management), internal audit team and KPMG (BDA Expert Team).
- The trade-off that are perceived as most difficult are:
 - Data Completeness vs. Manageability
 - Data Availability vs. Security and Integrity

7.2.8. IMPLICATIONS

There are 6 under-perceived trade-offs, which can be caused by the fact that supervising board is not completely informed about the (e.g. organisational and technological) complexities of the project. There are 6 inconsistently perceived trade-offs, which can be caused by the fact that the supervising board does not completely perceives the consequences of the trade-off. Therefore, there is a high risk is a high risk of erroneously considering 7 of the 8 trade-offs. As the objective is to optimise the timesheets processes of the employment agency, it regards mainly to billable hours. When trade-offs are taken erroneously, this can result in an inefficient, incorrect or inaccurate billing. Subsequently, this directly leads to missing revenues, exposing the firm to the making of losses. Hence, it is important to perceive these trade-offs from multiple business units before considering them.

To completely and consistently perceive trade-offs, involvement of the Australian management (Operational Management), the internal audit team and KPMG (BDA Expert Team) is of high importance when defining strategy for embedding BDA in the agency firm.

7.3. CASE STUDY 2: A DAIRY PRODUCER

The dairy producer is situated in the Netherlands and operates in several countries in Europe. There are many production lines from farmers to the factory in the Netherlands. However, its aim is to start using BDA to detect which production lines are beneficial and which ones are not. Also an explanation is searched by examining the root causes. Therefore, the objective of embedding BDA *“to determine which supply chains are underperforming and why”*.

Currently, there are various combinations how a production line can look like. As farmers have different locations, the distance and temperature play important roles. Most important is that the dairy products stay in good state hence that the quality is high. Besides that, the production times and costs need to be optimised. However, due to the large amount of different production-line combinations data becomes complex. It is difficult to monitor what lines are performing positively and negatively. Therefore, the dairy producer wants to use BDA to achieve insights that can be monitored and controlled when necessary. These insights need to lead to actions, as the firm wants to optimise its commercial position.

7.3.1. INVOLVE BUSINESS UNITS

Also in this case, there are four main actors. First, the management team of the firm, which is located in the Netherlands, aims to optimise the production lines of the dairy products. However, at the same time it aims to comply with the quality standards. Second, the production line manager is the process owner of the production from farm to the factory. It strives for complying with production quality, costs and time standards imposed by the management team of the firm. Third, the rayon manager coordinates the production, transport and processes of the dairy products from the factory to the wholesalers. Fourth, the KPMG team is engaged by the management team to support the production line manager. It leads the process of embedding BDA in order to assess the performance of each production line. These actors can be mapped with the three business units of the BORCIT framework as presented in Table 31.

Business unit	Actor	Interest
Executive Management	Management team	Comply with quality standards Optimise production lines
Operational Management	Production line manager Rayon manager	Comply with production quality, costs and time standards Coordinate produce, transport and process farmer's products Farmer's privacy
BDA Expert Team	KPMG team	Control transaction data Provide solution Check for weaknesses and opportunities

Table 31: Business units to involve

7.3.2. CLARIFY OBJECTIVE

The main objective is to detect what production lines are underperforming and investigate how this can be improved (see case description in 7.3.2). This objective can be applied to all the four objective types, as can be seen in Table 32. First, it needs to be diagnosed which production lines are underperforming. Second, it needs to be explored why this performance is high or low. Third, it needs to be predicted what changes can improve underperforming production lines. Fourth and last, it needs to be prescribed what actions need to be performed that realises a changes towards a higher performance.

Objective type	Purpose	Executive Management	Operational Management	BDA Expert Team
Diagnostic	Diagnose what production lines are underperforming	Primary	Secondary	Primary
Explorative	Explore why this production performance is high or low (root causes)	Secondary	Primary	Primary

Predictive	Predict what changes can improve the underperforming production lines	Secondary	Secondary	Secondary
Prescriptive	Prescribe actions that realise these changes towards higher performance	Primary	Primary	Primary

Table 32: Objective of embedding BDA aligned with the interests of the three involved business units

7.3.3. ESTABLISH RESOURCES

The dairy producer needs to possess a list of resources in order to create capabilities for embedding BDA. A combination of resources form a capability. These capabilities are subsequently needed for realising the objective. As is displayed in Figure 35 (and Table 54 in the Appendix), the resources are divided in three types: physical, human and organisational. A line is drawn from each resource to the capabilities where they are part of. Most resources form part of multiple capabilities, however, also combinations can be made.

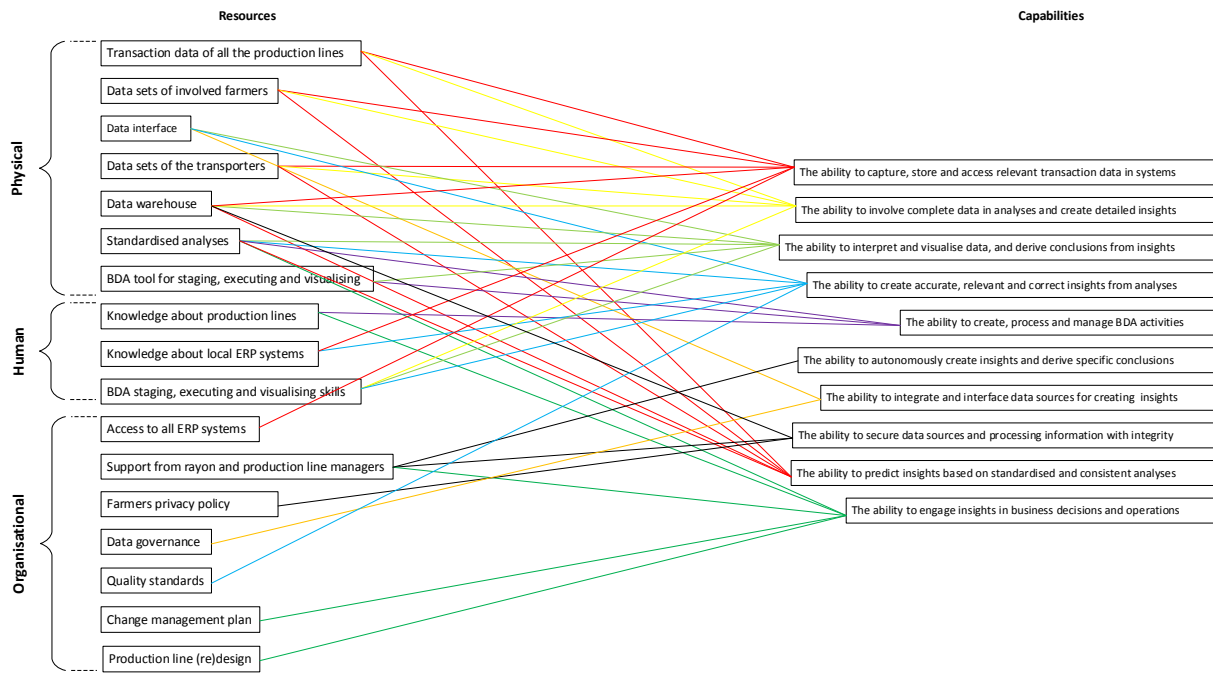


Figure 35: Overview of the resources and the capabilities where they form part of

7.3.4. DETERMINE CAPABILITIES

The BORCIT framework encloses 10 generic capabilities that are important to embed BDA in an organisation. In Table 33 the capabilities are applied to the context of the objective of the dairy producer. All capabilities play important role in realising the objective. These capabilities are created by combining resources as displayed in Table 33.

Capability name	Capability description	Executive Management	Operational Management	BDA Expert Team	Purpose in case context
Data Availability	The ability to capture, store and access relevant transaction data in systems	Secondary	Primary	Primary	The management team needs to ensure that KPMG has access to the data sources The create BDA insights must be available to the rayon managers and production line managers KPMG needs to acquire a transaction data extraction of the data sources to conduct the analyses
Data Completeness	The ability to involve complete data in analyses and create detailed insights	Primary	Primary	Secondary	The production line managers need to supplement their transaction data with data of the rayon managers KPMG needs to acquire a complete extraction of these different data sources

Data Understandability	The ability to interpret and visualise data, and derive conclusions from insights	Primary	Primary	Secondary	KPMG needs to produce understandable BDA insights that can be used by the rayon managers and the production line managers Insights need to be actionable (see objective description)
Data Quality	The ability to create accurate, relevant and correct insights from analyses	Primary	Primary	Secondary	KPMG needs to ensure that the quality of the insights is high Production line managers need to ensure that the transaction data is trustable
Manageability	The ability to create, process and manage BDA activities	Primary	Primary	Secondary	The management team needs to be able to oversee the BDA activities with respect to the production lines The production line managers need to be able to manage BDA activities towards their production goals KPMG needs to be able to execute the BDA activities
Autonomy and Flexibility	The ability to autonomously create insights and derive specific conclusions	Secondary	Secondary	Primary	KPMG needs to be able to autonomously produce BDA activities to come up with specific solutions Production line management needs to be able to create spin-offs of the BDA insights to get more specific insights with respect to the objective
Interoperability	The ability to integrate and interface data sources for creating insights	Secondary	Primary	Primary	The management team needs to set data standards of the different ERP systems so they interface with each other Rayon management and production line management need to be able to comply with these data standards
Security and Integrity	The ability to secure data sources and processing information with integrity	Primary	Secondary	Secondary	The management team needs to ensure that the organisation complies with the privacy regulations and data protection acts KPMG needs to stay within the boundaries of regulations when conducting BDA activities
Predictability	The ability to predict insights based on standardised and consistent analyses	Primary	Secondary	Primary	The management team need to be able to rely on the BDA insights in decision making and strategy definition Production line management and rayon managers need to trust the BDA insights as they drive actions KPMG needs to be able to make predictions and map actions (prescriptions) to these
Insights Engageability	The ability to engage insights in business decisions and operations	Primary	Primary	Secondary	The management team needs to be able to engage BDA in its strategy The production line management and rayon management needs to define actions based on the BDA insights that work towards change KPMG needs to be able to prescribe actions to reduce risks and realise opportunities

Table 33: Capabilities of BDA embedment for the dairy producer

7.3.5. INTERRELATIONS BETWEEN CAPABILITIES

Based on exploratory interviews with the actors of the different business units, eight conflicting interrelations are predefined in the BORCIT framework. The red lines represent those conflicts whereby a trade-off needs to be considered. As is discussed in section 4.8, a conflict between two capabilities occurs when one capability hampers another. This means that the two capabilities cannot be realised by using the available resources (those which the firm currently possesses or is able to possess). For example, there is a conflict between Data Completeness and Data Understandability because with the current data sets, FTEs, human skills, management skills, time and money it is not possible to achieve both optimal Data Completeness and Data Understandability. In principle, every capability is important for the achieving of the objective, however, when one capability hampers (conflicts with) another capability, this implicates that it also hampers the realisation of the objective. This is explained in section 4.9.

These conflicts are considered to be the most prominent because they are mentioned during the exploratory interviews (section 4.8). However, more interviews with people from the organisation could have led to a more complete overview of conflicting interrelations. Figure 36 displays these conflicting interrelations. When an interrelation is conflicting, it means that one capability has a negative impact on another capability (see section 2.5). Then, a trade-off has to be considered by the Executive Management of the firm.

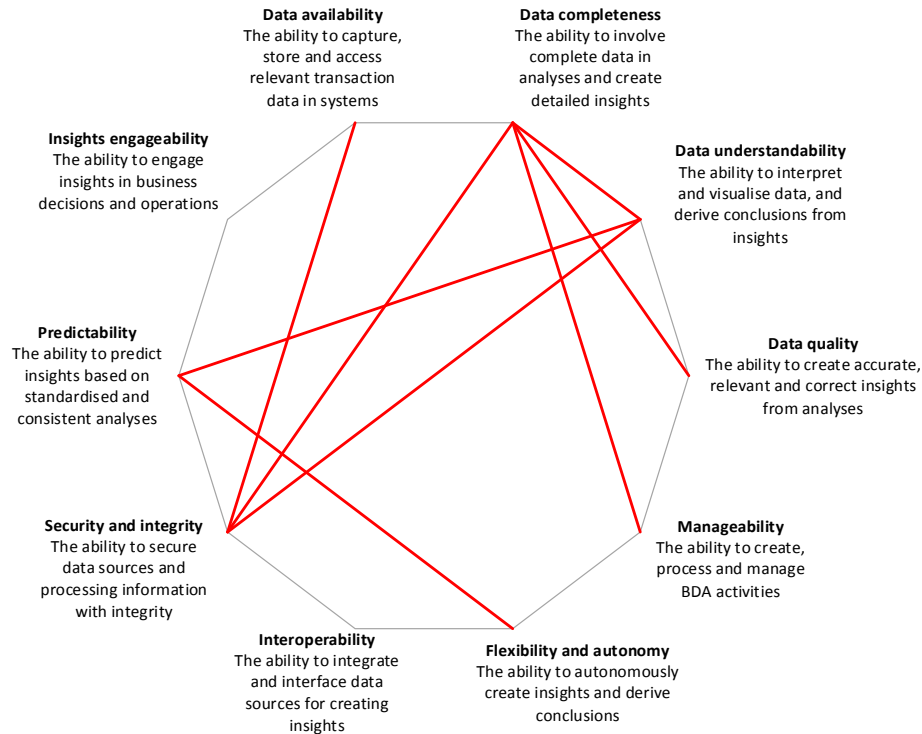


Figure 36: The conflicting interrelations between capabilities

7.3.6. PERCEIVE TRADE-OFFS

Three evaluation interviews are conducted with actors from the Executive Management (management team), Operational Management (production line management, rayon management) and the BDA Expert Team (KPMG team) in order to perceive the trade-offs that have to be considered. There is a large difference in perspective of the business units, which can be seen in Figure 37 and in Table 55 in the Appendix.

The Executive Management perceives most of the trade-offs easier (under-perceived⁵) and distinctively (inconsistently⁶) with respect the Operational Management and BDA Expert Team. Five trade-offs are under-perceived by the Executive Management as the other business units perceive them more difficult. Seven trade-offs are inconsistently perceived by the Executive Management with respect to the other business units. Hence, there is a risk of erroneously considering for 7 of the 8 trade-offs. This can entail unforeseen problems implicating that the objective becomes unfeasible. This is illustrated with two case-examples from Figure 37 and in Table 55 in the Appendix. The reasons of the perceptions on the trade-offs are discussed followed by their implications.

EXAMPLE 1 – DATA COMPLETENESS VS. SECURITY AND INTEGRITY

The trade-off of Data Completeness vs. Security and Integrity is perceived by the Executive Management as a very easy trade-off (Figure 37 and in Table 55 in the Appendix). It prioritises Data Completeness before Security and Integrity because *“the security and privacy capability does not regard to the production lines, as secret elements do*

⁵ Underestimated trade-off: the Executive Management (decision-maker) perceives a trade-off easier than the other business units.

⁶ Inconsistently perceived trade-off: the Executive Management (decision-maker) perceives a trade-off distinctively than the other business units.

not need to be included in performance numbers". Its interest is to optimise the production lines while complying with the quality standards. In order to achieve this, all relevant transaction data about the dairy production lines need to be involved in the analyses. The BDA Expert Team agrees upon the fact that Data Completeness is more important, however, it perceives this trade-off very difficult because *"it is more important to be able to involve high amount of data and then anonymise it, instead of leaving out data fields"*. Its interest is to control the transaction data about the production lines and provide a solution for creating efficiency. This necessitates extensive analyses with complete data about the production lines of the dairy products. This provides opportunities for encountering underperforming lines and its underlying reasons and exploring solutions for improving production line efficiency. The Operational Management does not agree on this, as it prioritises Security and Integrity before Data Completeness because *"the ability to ensure Security and Integrity of the (farmer and product) data can be maintained by anonymising data fields"*. Its interest is to comply with the production quality, cost and time standards. Besides, it aims on produce, transport and process the dairy products on the way from the farmer to the factory. Security and Integrity of this information is important, as the reputation of the farmers need to be disclosed and is resolved internally in the organisation.

The encountered risk here is two-fold: the Executive Management 1. under-perceives this trade-off and 2. perceive it inconsistently with respect to the other business units. The Executive Management and BDA Expert Team tend to choose for a high Data Completeness, which entails detailed insights, a complete overview and in-depth information. However, this also implicates that the Security and Integrity is low, which entails that derivations can be made to personal entities (of farmers) and personal sensitive information of (farmers) becomes visible. The data analyses and insights would be more prone on being exposed as the aim is to aim for a complete analysis. But, this is outweighed by the fact that insights on the production line performance are acquired on a more detailed level. The chance becomes bigger to find out which lines are underperforming and its underlying reason.

The Operational management tends to choose for a high Security and Integrity, which entails that data is protected, access to data sources is restricted and regulations is complied with. However, this also implicates that the Data Completeness is low, which entails that insights are basic and not in-depth, the overview is incomplete and information can be missing. The preserving of the privacy of the farmers hampers the ability to involve complete data sets and achieve detailed insights. This is an important aspect of the managing of the farmer's products. By filtering out the Data Completeness, still, actionable insights can be produced. The only problem, however, is that each production line is farmer-specific. This means that when data is anonymised or filtered out, it is not possible to determine on which specific production line needs to be intervened.

EXAMPLE 2 – DATA COMPLETENESS VS. MANAGEABILITY

The trade-off of Data Completeness vs. Manageability is perceived as an easy trade-off by the Executive Management because *"it is important that the BDA activities remain manageable, even though it hampers the ability to include large amounts of complete data, therefore we are forced to create focus"*. Its interest is to comply with quality standards and optimise production lines that are underperforming. For this reason, it is more important that the BDA activities and insights remain manageable so that they can be coordinated and controlled. This forces the firm to create a scoped focus for determining what production lines are underperforming and the underlying cause. This focus then also applies to the variety and completeness of the data sets that are involved. The Operational Management also perceives this trade-off as easy but prioritises Data Completeness before Manageability because *"with the current technology the ability to pursue completeness should not have to be a problem for the ability to manage the activities"*. Its interest is to comply with the production standards in terms of quality, time and costs, preserve the farmer's privacy and coordinate the production, process and transport from the farms to the factory. As there are many production lines involved from numerous farms to the factory, it is important that there is an ability to produce specific and detailed insights about that. Therefore, the firm should be able to involve varied and complete data extractions from the ERP systems in the BDA activities, regardless of the fact that they become more complex and less manageable. The BDA Expert Team perceives this trade-off as very difficult and prioritises Data Completeness before Manageability because *"manageability is always a more important aspect, although in this case the ability to pursue completeness is crucial to create insights of the performance of the production line"*. Its

interest is to control transaction data from the ERP systems about the production lines, provide BDA solutions to find and enhance the underperforming production lines. For that reason, the firm should be able to involve complete extractions from the ERP systems with transaction data about the different production lines. Even though the activities become more complex and less manageable, conceding on the ability of Data Completeness is no option when performance is assessed for every individual production line.

The encountered risk here is two-fold: the Executive Management 1. under-perceives this trade-off and 2. perceive it inconsistently with respect to the other business units. The Executive Management tends to choose for high Manageability, which entails adequate management of activities, agilely data staging and analysing, and high control on outputs. However, this implicates that the Data Completeness is low, which entails that insights are more basic, the overview is incomplete and information can be absent. More overview of the BDA activities would be created, which makes them easier to coordinate and to plan. Deployment of BDA would be more efficient as the throughput times would be smaller. Therefore, it would allow the firm more to adapt its production lines based on these insights as they are proposed more frequent. On the other side, however, the insights on themselves would not be complete or detailed. But, from the perspective of the Executive Management this would not be necessary for assessing of the performance of the production lines.

The Operational Management and BDA Expert Team tend to choose for a high Data Completeness, which entails detailed insights, a complete overview and in-depth information. However, this implicates that the Manageability is low, which entails that it is difficult to process and manage BDA activities, data staging and analysing become more complex and intensive, and there is low control on the outputs. Detailed and complete data insights would allow the firm to pursue its objective of assessing the performance for every individual production line, encountering the root causes and finding ways how to improve these specific production lines. As a consequence, the BDA activities would become more complex and less manageable. Insights would be produced with a lower frequency, which makes them less accurate and less relevant due to the rapidity of the transactions of the dairy production lines.

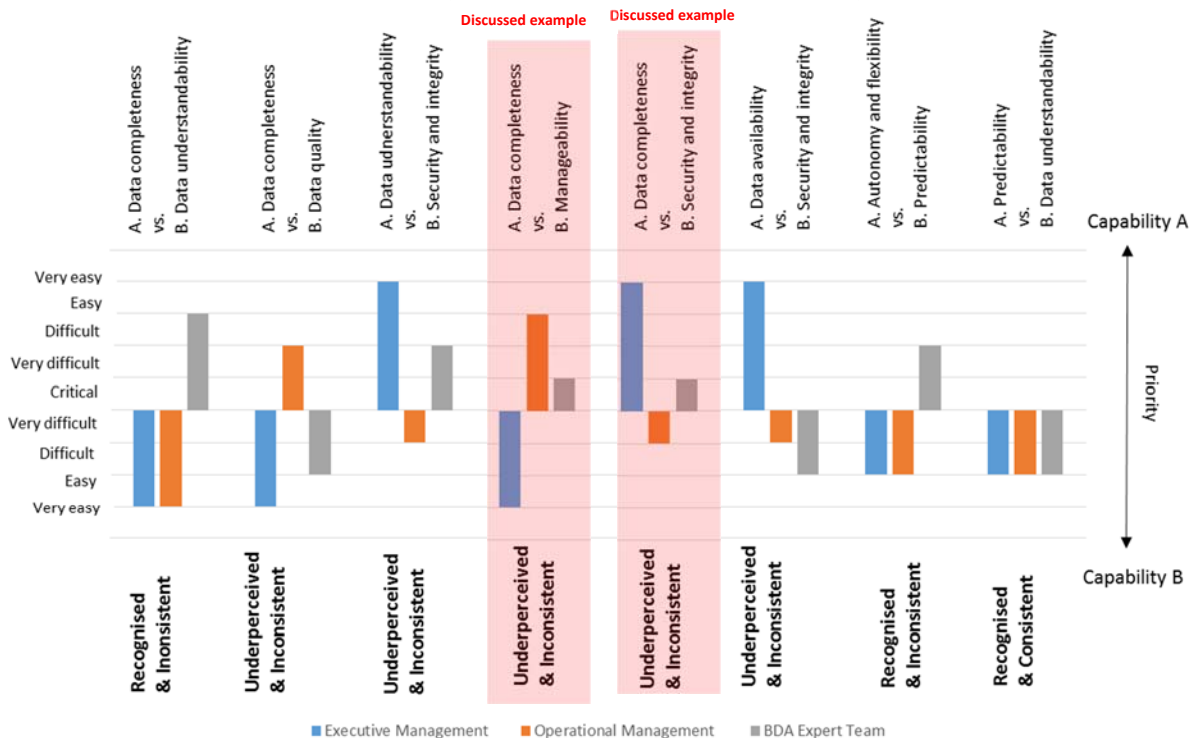


Figure 37: Overview of the perceived trade-off by the different business units (summary of Table 55: Perceived trade-offs of each business unit in Appendix)

As these both these trade-offs (as discussed in the two examples) are inconsistently perceived and under-perceived, this can mean that the Executive Management is not completely informed about the consequences that it has. This can lead to the erroneously considering of the trade-off whereby unforeseen problems can emerge in a later stage of the process. This also applies for the rest of the trade-offs as displayed in Figure 37 and Table 55 in the Appendix.

7.3.7. KEY FINDING STATEMENTS

Based on the application of the BORCIT framework to the case of the dairy producer several key statements can be made. The objective of embedding BDA *“to determine which supply chains are underperforming and why”*.

- There is a clear difference in perception between the different business units.
- The management team (Executive Management) under-perceives 5 of the 8 trade-offs compared to the other business units.
- The management team (Executive Management) perceives 7 of the 8 trade-offs with respect to the other business units.
- The management team (Executive Management) tends to perceive trade-offs easier and distinctively than the production line management, rayon management (Operational Management), and KPMG (BDA Expert Team).
- The trade-offs that are perceived most difficult are:
 - Autonomy and Flexibility vs. Predictability
 - Predictability vs. Data Understandability

7.3.8. IMPLICATIONS

There are 5 under-perceived trade-offs, which can be caused by the fact that supervising board is not completely informed about the (e.g. organisational and technological) complexities of the process. There are 7 inconsistently perceived trade-offs, which can be caused by the fact that the supervising board does not completely perceives the consequences of the trade-off. Therefore, there is a high risk is a high risk of erroneously considering 7 of the 8 trade-offs. In this case, the objective is on optimising the production lines that are underperforming. When trade-offs are taken erroneously, this can lead to incorrect decisions. Dairy products have a limited expiration date. When production lines are inefficient, this can result in the spoiling of the products or the failing to meet quality standards. This directly implicates that sales are partially missed whereby revenues go down, exposing the firm to the making of losses. Hence, it is important to perceive these trade-offs from multiple business units before considering them.

To completely and consistently perceive trade-offs, involvement of the production line management and rayon management (Operational Management), and the KPMG team (BDA Expert Team) is of high importance when defining strategy for embedding BDA in the dairy producer.

7.4. SUB-CONCLUSION OF SUB RESEARCH QUESTION 5

On this point, sub-question 5 can be answered.

5. *How are trade-offs perceived for the case studies by applying the designed BORCIT framework?*

Application of the BORCIT framework demonstrates how firms can completely perceive trade-offs more complete between conflicting capabilities when embedding BDA in their organisation. In both case studies the Executive Management tends to under-perceive and inconsistently perceive the majority of the trade-offs with respect to the other business units.

Trade-offs can be considered erroneously because they are under-perceived or they are inconsistently perceived with respect to the other business units. Under-perception means that the Executive Management perceives the trade-off easier than the Operational Management and the BDA Expert Team. A reason for this is that the they are not completely informed about the (e.g. technical or organisational) complexities of the project. Inconsistent perceiving of trade-offs means that the Executive Management prioritises capabilities in the trade-offs distinctively than the Operational Management and the BDA Expert Team. A reason for this is that they do not completely perceive the consequences of the trade-off.

Trade-offs cannot be avoided, they have to be considered sooner or later. When they are not completely perceived, it can be the case that they are considered erroneously or too late. Unforeseen problems can emerge implicating that objectives can become unfeasible. In that case, still, these trade-offs have to be considered. But then they lead to the making of changes in a later stage of the project. This is more expensive and takes more effort as the implementation of the project has already started. Therefore, trade-offs have to be considered before starting the implementation of the project. To achieve this, different business units in the organisation need to be involved in order to completely perceive the trade-offs before actually considering them.

In both case studies, the majority of the trade-offs is underestimated, which can be caused by the fact that the Executive Management is not completely informed about the fact the (e.g. organisational and technological) complexities of the project. In addition, also the majority of the trade-offs are perceived inconsistently, which can be caused by the fact that the Executive Management does not completely perceive the consequences of the trade-off.

For the first case, the objective is to optimise the timesheets processes of the employment agency, so it regards mainly to billable hours. When trade-offs are taken erroneously, this can result in an inefficient, incorrect or inaccurate billing. Subsequently, this directly leads to missing revenues, exposing the firm to the making of losses. Hence, it is important to perceive these trade-offs from multiple business units before considering them.

For the second case, the objective is to optimise the underperforming production lines. Dairy products have a limited expiration date. When production lines are inefficient, this can result in the spoiling of the products or the failing to meet quality standards. This directly implicates that sales are partially missed whereby revenues go down, exposing the firm to the making of losses. Hence, it is important to perceive these trade-offs from multiple business units before considering them.

For both cases **not all business units recognised all the trade-offs** that are proposed to them. This is mainly caused by the fact that their perception is not sufficient because they do not oversee the implications or challenges from their perspective. To consistently and more completely perceive trade-offs, involvement of the Operational Management, and the BDA Expert Team is of high importance when defining strategy for embedding BDA in the business operations of both cases.

VI. Evaluation

8. CONCLUSION

This is the eighth and last chapter of this thesis, which is located in the sixth and last phase of the Design Science cycle as can be seen in Figure 38. The sixth Design Science phase focuses on evaluating the framework design on its performance on the case studies where it is applied to. The framework is evaluated whether it overcomes the 'knowledge gap' and thereby addresses the problem definition and research objective. Besides, the research questions are synthesised whereby the final conclusion is composed.

In this chapter, subjects are discussed including:

- Answer to main research question
- Conclusion
- Reflection
- Recommendations for future research

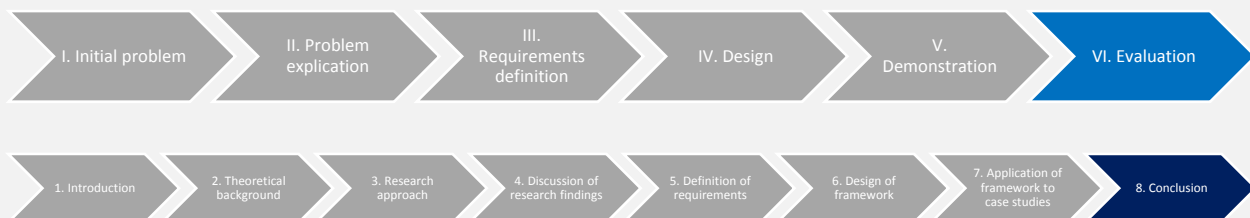


Figure 38: Eighth chapter of this thesis in the sixth and last Design Science phase.

8.1. ANSWER TO MAIN RESEARCH QUESTION

Throughout the thesis all the research sub-questions have been answered. In this section they are synthesised in order to create an answer to the main research question. It is discussed that current Resource Based View-related literature claims that firms should define capabilities in order to embed BDA in business operations. Embedded BDA is a recipe for turning BDA projects into a success whereby their full potential is achieved. However, current literature has its shortcomings, as they assume that capabilities can always be combined. In case capabilities are conflicting, they have a negative interrelation with each other whereby they hamper to achieve the objective. Then, a choice must be made by determining what capability entails the most benefits. In this thesis it is asserted that firms need to perceive trade-offs between those conflicting capabilities. When this is not the case, unforeseen problems can emerge in later stages of the process of embedding BDA. The implications of those unforeseen problems can backfire a project and even cause failure to achieve the objective. After walking through this thesis, the main research-question can be answered.

How can firms perceive trade-offs between capabilities to successfully embed Big Data Analytics into their business operations?

Firms can perceive trade-offs to successfully embed BDA into their business operations by taking in account the six aspects. These aspects can cause failure when neglected, though they can translate success when cherished.

First aspect is that the developed 'BDA solution' needs to be engaged in decision-making or supporting the operations of the business units from the organisation. When they are not involved in the development of the solution, this can cause the misalignment of expectations and interests. This aspect adds a multi-actor perspective to the literature on embedding BDA.

Second aspect is that it has to be clear what objective needs to be achieved. As can be reasoned, when many data sources are involved from several systems of the organisation, the BDA solution can become very complex and difficult to engage in decisions. This aspect is already mentioned in literature on embedding BDA.

Third aspect is that the resources of BDA need to be clearly established and planned so they can be deployed when necessary. Many firms are unable to deploy the expensive BDA resources, because of their complexity. This aspect is already mentioned in literature on embedding BDA.

Fourth aspect is that the firm should know where it needs to be capable of in order to achieve the specified objective. These so-called capabilities tell where a firm is capable of by managing and deploying its resources. This aspect is already mentioned in literature on embedding BDA.

Fifth aspect is that the firm should know what interrelations the capabilities have with each other. When this is unknown, it is unclear whether capabilities solely bring benefits or also entail difficulties with respect to a specified objective. This aspect adds a multi-capability perspective to the literature on embedding BDA.

Sixth aspect is that a firm should perceive the trade-offs between conflicting interrelations. When a firm is not able to adequately perceive a trade-off, series of unforeseen problems may emerge in later stages of the process of embedding. Especially in late process stages, problems are very expensive to solve due to the investments in resources that already have been made. This aspect adds a multi-trade-off perspective to the literature on embedding BDA.

These six aspects are incorporated in the BORCIT framework, which is designed throughout this thesis based on empirical research. Executive Managers of firms can use the framework to perceive trade-offs so that they can be considered before initialising the process of embedding BDA. The six phases of the framework are as follows.

1. Involving actors from different **business units** from the organisation.
2. Defining a clear **objective** what is to be achieved by embedding BDA.
3. Establish **resources** that can be deployed.
4. Defining **capabilities** that tell where the firm should be capable of in order to achieve the objective.
5. Assess which **interrelations** between capabilities are conflicting.
6. Perceiving **trade-offs** by allocating relative importance of each pair of capabilities.

Application of the BORCIT framework allows firms to expand their strategy with a multi-actor, multi-capability and multi-trade-off perspective. Consequently, firms can perceive trade-offs more complete between conflicting capabilities when embedding BDA in their organisation.

8.2. CONCLUSION

Regardless of the fact that more than 90% of Fortune 1000 firms have invested in BDA projects, the majority of them have not been able to get the full potential out of these projects. Current literature asserts, which takes the Resource Based View standpoint, that this full potential can be achieved by embedding BDA in business operations (LaValle *et al.*, 2011). Firms should define capabilities, which they can develop by acquiring the right BDA resources. For example, the ability to capture, store and access relevant transaction data in systems. In this thesis, we claim that current literature has its shortcomings because they do not take conflicting capabilities into account. This research shows that capabilities can be conflicting, thereby they may hamper each other. When this is the case, unforeseen problems can emerge in later stages of the project, which may have a negative impact on the reachability of the objectives. Three typical examples of unforeseen problems are briefly described below.

Firstly, the business problem can become obscure because the business units are not involved, objectives are not commonly defined, resources are not delivered throughout the organisation or the BDA solution is not accepted or engaged in decision-making and business operations. This can happen when, for example, the trade-off of 'Data Completeness' and 'Insights Engageability' is not perceived adequately. Imagine that a BDA team needs to develop a BDA dashboard for the sales and HR units. The team specified an objective by themselves and designed the dashboard by including all the facts, values and data they thought was relevant. The dashboard has become very complex now as specific insights are difficult to relate and conclusions hard to derive. As a consequence, the dashboard is not engaged in decisions and business operations because the sales and HR units thought it took too much time to look the insights up and involve them in their operations. They probably will continue to work like they did before using the dashboard, and will still make decisions based on their gut feeling. Besides that, the dashboard has become very expensive, and the development took more time than planned. Although the dashboard was finalised, the scope was exceeded and the final dashboard was left unused. Investments have been made in the resources of the capability 'Data Completeness', which now seem to be redundant because there is 'too much data' in the dashboard. When the management executive would have perceived this before initialising the project, it could have changed its strategy. You could have chosen to develop the capability of 'Insights Engageability' instead.

Secondly, the firm can become non-complaint because laws are not obeyed, regulations are not followed, the firm's policy is unclear or not taken into account, and privacy and security can be breached. This may happen when, for example, the trade-off of 'Data Availability' and 'Security and Integrity' is not perceived adequately. Imagine that Germany different laws and regulations apply on personal transaction data than in the Netherlands. For example, in Germany strict laws and regulations apply on personal / privacy sensitive data. This implies that data cannot leave the German grounds. When the strategy is to collect all the data from different establishments of an organisation and conduct the analyses in the Netherlands, it may encounter the unforeseen problem of breaking the German law. However, investments already have been made in the related resources to develop the capability of 'Data Availability'. Now, these resources seem to be redundant with as a consequence, projects has gone beyond scope (e.g. budget, time). Sanctions and fines can then backfire the project whereby it may need to be reversed. When the management executive would have perceived this before initialising the project, it could have changed your strategy. It could have chosen to develop the capability of 'Security and Integrity' instead.

Thirdly, the process of embedding BDA can be plagued with technical complexities because the data contains errors and inconsistencies, data is not available real-time, data quality is lacking, or information overload may occur due to the large data volumes. This may happen when, for example, the trade-off of 'Data Completeness' and 'Manageability' is inadequately perceived. Imagine that Russia has a relatively slow internet connection directly with western Europe. A Dutch firm that also operates in Russia wants to create an operational dashboard with live BDA insights. To achieve this, they have to continuously gather the data from the Russian establishments of the firm. The problem, however, is that more transaction data is produced than can be transferred by the internet each time unit.

When the strategy was to create a dashboard and transfer the data continuously from Russia to the Netherlands, the firm may encounter the unforeseen problem that the actuality and completeness of the data is too low. As a consequence, the BDA objective is not met and because the dashboard is driven by expired data and hence not completely up to date. Now, investments already have been made in the resources (e.g. real-time data transfer system) of the capability 'Data Completeness', which now seem to be redundant. When the management executive would have perceived this before initialising the project, it could have changed your strategy. It could have chosen to develop the capability of 'Manageability' instead.

For these three typical examples of unforeseen problems, it is the case that investments have already been made in resources that suddenly seem to be redundant. As a consequence, costs may elevate and deadlines may be missed, and in some cases (e.g. legal infringements) the project can be shut down. When these trade-offs would be perceived beforehand, different choices could have been made in an early stage. In this way, perhaps, redundancy of resources could have been prevented.

Firms should perceive trade-offs between those conflicting capabilities so they can consider them before initialising the BDA embedding process and investing in resources. The BORCIT framework that we designed throughout this thesis can support firms to prevent these unforeseen problems. It is a three-sided contribution to the Resource Based View-related literature in the field of embedding BDA: we aimed to add the multi-actor, multi-capability and multi-trade-off perspective. Our framework forms the fundament of perceiving trade-offs between conflicting capabilities. The assumption that capabilities are always complementing is thereby put aside. Executive managers, who are the strategy-makers of firms, need to think through what their firm needs to be capable of, by using BDA resources. However, one step further, they should take into account the **multi-capability perspective** and determine whether or not these capabilities have a positive (complementing) impact on each other. When this is not the case, and this interrelation is conflicting, they should think about what capabilities contribute the most. Most important is that this **multi-trade-off perspective** is involved before initialising the project of embedding. In that way, they can consider the trade-offs in an early stage, limiting them from causing unforeseen problems in later stages of the project. This means the project management is preventing that problems may occur, instead of reactively trying to solve the problem, or even worse, to scope down the objectives.

In addition, the **multi-actor perspective** that our framework facilitates is essential in the perceiving of trade-offs. As was demonstrated in the case studies, the Executive Management perceived trade-offs easier and distinctively than the other business units. This can imply that the Executive Management is better in making these decisions. However, it also can imply that they do not see the consequences that trade-offs have or the complexities that they entail. In order to perceive these trade-offs as complete as possible, we suggest that Executive Managers involve actors from different business units across the organisation. In this way they can extend their perception on the trade-offs with expertise, experience, skills and interests from these business units. Consequently, they can consider these trade-offs underpinned by a more robust and complete perception.

With the knowledge acquired from this thesis, we can make three concluding statements. In this thesis we emphasised the importance of perceiving trade-offs when embedding BDA in business operations.

- We claim that capabilities do not solely entail benefits towards achieving an objective. Instead, they can also have a conflicting impact on other capabilities whereby they hamper to achieve this objective (multi-capability perspective). When capabilities are conflicting, the Executive Management of firms needs to consider a trade-off by asking itself which capability contributes more to the objective.
- We emphasise that trade-offs differ per case and therefore should be considered in an early stage. As they cannot be avoided, they should be perceived adequately (multi-trade-off perspective). When the Executive Management does not perceive a trade-off, unforeseen problems can emerge in later stages of the project. Solving these problems is more expensive and more intensive due to former investments in resources and work done. As a consequence, objectives become unfeasible.
- We assert that it is important to involve multiple actors from different business units from the organisation when embedding BDA (multi-actor perspective). Then, a more complete perception can be achieved which

prevents the Executive Management to under-perceive (easier than other business units) or inconsistently perceive (distinctive than other business units) trade-offs.

Thus, embedding BDA in business operations is more than only defining capabilities and resources, which claimed by current Resource Based View-related literature. We contributed to this literature by explicating that firms should take the multi-capability, multi-actor, multi-trade-off perspectives into account. They can realise that by using our BORCIT framework before initialising the BDA embedding process. Thereby, this study is valuable in trimming down the percentage of failing BDA projects⁷ as it contributes to support firms to get the full potential out of their BDA projects.

8.3. REFLECTION ON CHOICES MADE AND LIMITATIONS

During the research of this thesis several choices were made that have direct influence on the findings. Besides, also a couple of limitations became clear. Therefore, this section is dedicated for reflecting these choices and limitations.

This report has become very long

First reflection point, which is a limitation of this thesis, is that this report has become very long. From the start, the Design Science approach is used, which serves as a roadmap and bringing structure. However, as the subject of this research is abstract and tends to be complex, this was at the expense of the conciseness of the report.

- This limitation was partially resolved by placing much material to the Appendix, in order to increase readability and conciseness.

There are other reasons why BDA projects fail than BDA embedding (sub question 0)

To keep the scope and objective of this research clear, 'embedded BDA' is perceived as one of the possibilities of successful implementation and utilisation of BDA in a firm's business processes to improve performance. However, in literature several other reasons are mentioned that explain why BDA projects 'fail'. Embedded BDA is one of the most mature levels where a firm is capable of using its resources in an adequate way whereby it can achieve its performance objectives. Many other articles were found about the planning and execution of BDA, though this is different from the embedding of BDA.

- This choice was made because 'embedding BDA' addresses the entire process of BDA; from initialising to frequent implementation and engaging BDA insights.

There are other theoretical lenses than the Resource Based View (sub question 1)

The theoretical lens of this thesis is the Resource Based View, which are reviewed in **Appendix IIA**. Although this choice was not made beforehand, many authors in the field used it to define the existence of 'BDA capabilities'. After studying tens of articles that use this view, it became clear why these capabilities are so important for achieving success with BDA. There are numerous technological tools available for performing BDA, as well as the technological skills and the policy models. However, what creates a capability is the unique blend between these different resources and how they are managed. The Resource Based View provides an excellent explanation for this phenomenon. Besides, it supports to create understanding what trade-offs between capabilities are. Therefore, this view was taken as a basis for this research.

- This choice was made because the Resource Based View provides a comprehensive underpinning for the explanation for: 1. embedding BDA in business operations and 2. trade-offs between capabilities.

Business units from Mintzberg's Organisational Model are not specific enough (sub question 1)

Three business units were chosen wherefore Mintzberg's Organisational Model was taken as theoretical framework. These business units were renamed slightly to place them in context of BDA embedding. Strategic management was renamed to Executive Management, middle management was renamed to Operational Management, and the technical staff was renamed to BDA Expert Team. During the planning of the interviews and case study, however, these business units were not specific enough compared with the practical business units. The reason for that is,

⁷ Although one should always be careful with percentages, according to several articles the percentage of firms that do not achieve success of their BDA projects is between 50-70%. (Buhl et al., 2013; Clavier et al., 2012; Grant, 2016; Gupta et al., 2016; Hannula et al., 2003; Olszak, 2016)

that in practice business units are often not completely placeable in one of the theoretical units. Instead, they can be a blend of technical staff and Operational Management, which was the matter with the case studies. For example, the BDA Expert Team of KPMG has also several operational managers (junior/senior managers) and two executive managers (partners).

- This limitation was taken into account by making a mapping between KPMG business units and the theoretical business units.

Genericity versus specificity of capabilities (sub question 2)

In literature different perspectives on capabilities for BDA embedment was encountered. Some mention the 'BDA capability' as one generic capability whereas others mention very specific capabilities that are related to BDA. However, in the perspective of embedding them, there are more than only technological capabilities required. The question is how specific need the capabilities to be. Initially, from literature 54 specific capabilities were found, but those were too specific and too many. Also this increases the chance that capabilities are missed out. Therefore, these specific capabilities were grouped whereby a list of 10 more generic capabilities was formed. However, it can also be reasoned that these generic capabilities are not including every other specific capability.

- This choice was made because 10 generic capabilities, whereby all encountered specific capabilities are classified, entails a smaller risk of missing out specific capabilities.

The way capabilities are defined can change its interpretation (sub question 2)

Capabilities are vague phenomenon and difficult to grasp, especially when they are formulated on a generic level. They need to be placed in context to fully understand them. In the beginning a capability was aimed to be formulated in one or two words. However, this could be interpreted in various ways. During feedback meetings with supervisors this was frequently mentioned. Therefore, the capabilities were redefined in a short sentence (e.g. "The ability to interpret insights and derive conclusions").

- This choice was made to increase understanding of the capabilities and scope down its interpretation.

Capabilities were to grasp and confused with resources (sub question 2)

Similar to last point, the phenomenon of capabilities was difficult to grasp by the interviewees. Often, they were confused with resources, which can be seen in the transcriptions of the interviews. It was important that during the interviews the right information was gathered, however, the chance remains that interviewees did not interpreted the capabilities correctly. Besides, there were too many specific capabilities to discuss them all, especially as there was a serious time constraint during the interviews of 60 minutes.

- This limitation was taken into account by adding a sentence of context with an example to the interview protocol and reducing the amount of capabilities.

Interviewees did not recognised all the trade-offs, thus only a selection is discussed(sub question 3)

As in theory one capability has an interrelation with each other capability, there are many possible trade-offs that needed to be discussed during the explorative and evaluation interviews. The plan was to structure the interviews with a self-interaction matrix. However, as there was a time constraint of 60 minutes per interview, it was not possible to discuss each interrelation. In the given time, only several conflicting interrelations could be discussed. Therefore, the list of trade-offs is not completely covering each situation.

- This limitation was taken into account by letting the interviewees choose the most relevant conflicting interrelations for discussion.

Interviewees from different business units mentioned different resources, capabilities and trade-offs (sub question 2, 3 and 5)

A difference in perspective was encountered between the answers of the interviewees from different business units. The interviewees mentioned different resources, capabilities and trade-offs. Whereas this can be seen as a limitation it is also an interesting findings. However, the sample of interviewees is too small to derive hard conclusions from

this. Besides, within the business units, the interviewees mentioned different trade-offs. This implies that a more covering view is required, by taking a higher data sample within each business unit by more or longer interviews.

- This limitation can be taken into account by organising interviews with a large sample group of interviewees, which can be an agenda point for future research.

BORCIT framework is engaged in practice and evaluated afterwards (sub question 4)

A limitation that many theses have is that the functionality of the design is not tested sufficiently in practice. Only an ex-ante validation was done in the evaluation interviews. This could be improved by doing ex-post validation interviews after engaging the BORCIT framework in practice in different firms for different industries.

- This limitation can be translated to an agenda point for future research by engaging the BORCIT framework in practice and organising ex-post validation interviews.

Time and quality needed to be considered in the case studies (sub question 5)

A common dilemma was encountered by performing the case studies by considering time and quality. To do a case study in depth, it takes a lot of time. Though, to do this within time, the findings can be less worthy.

- This limitation was taken into account by choosing to perform two case studies with less depth, instead of doing only one case study.

Case studies were more complex, they could easily be divided up into more case studies (sub question 5)

Similar to last point mentioned above, is that the case studies concern large scale projects with high stakes and many objectives. Therefore, a general objective was chosen during the case studies in this thesis. However, these cases are big enough to divide them into more smaller in-depth case studies.

- This choice was made because the in-depth case studies would have led to more complex trade-offs. Besides, there was limited time available for interviews.

Trading off larger networks of conflicting capabilities (sub question 5)

Trade-offs are detected whereby two capabilities have conflicting interrelation. However, here networks of capabilities can exist whereby no optimal solution can be found. This is called 'cycling'. For example, when capability $A > B$ and $C > A$. Then, logically said $C > B$. However, when the respondent would say that $C < B$, then there would be no optimal solution. Analytic Hierarchy Process method is used to define the relative importance between two conflicting capabilities. This prevents that entire networks between capabilities need to be evaluated.

- This choice was made in order to prevent the effect of 'cycling' whereby no optimal outcome can be found.

Capabilities on a high level do not conflict with each other, but on a low level they do (sub question 5)

The statement on interrelated conflicts between capabilities can be criticised. It can be said that on a high level, capabilities are not conflicting, but on a low level they do. Therefore, it should be clear where these trade-offs occur in the organisation. In this thesis, the phenomenon of trade-offs is approached from Mintzberg's Organisational Model from different business units. However, it is not specified on what concrete level of implementation they occur.

- This limitation can be researched in future studies: 'on what organisational level do trade-offs occur?'

Under-perceiving of trade-offs

As is demonstrated in the case studies, the Executive Management under-perceives and inconsistently perceives the trade-offs. Although it is not tested whether their choice or perception is correct, the meaning of under-perceiving and inconsistently perceiving is that they differ from the rest of the business units (Operational Management and BDA Expert Team).

- This limitation is a matter of terminology, and therefore is added to the terminology list.

Can the main question be answered completely? (main question)

This question emerged when the conclusion was being written. However, it can be said that the answer is 'no'. There can be numerous other factors that have influence on the successfully embedding BDA. Besides, embedding on itself does not necessarily guarantee achieving objectives nor improving performance. The BORCIT facilitates to define what capabilities a firm should possess and what trade-offs need to be perceived. But there can be more problems than only the trade-offs. The choice was made that BORCIT framework focuses on the involvement of different Business units, define a common Objective and Resources that are necessary to create Capabilities. However, it does only address the Interrelations that capabilities can have whereby eventually Trade-offs need to be taken.

- This choice was made put the scope on pro-actively considering the negative effects that capabilities can have by trading them off.
- Coping with these trade-offs is not included in the scope and is an agenda point for future research in section 8.4.

8.4. AGENDA FOR FUTURE RESEARCH

Several recommendations for future research are shortly introduced in this section. One of the questions that emerged (to me and my supervisors) is how these trade-offs can be coped with. During the interviews already much information was given by the interviewees how they coped with the trade-offs. This could have been used to investigate what strategies can be applied to cope with them. However, as the objective of this research was to perceive the trade-offs, this was not within scope.

- Future research would be investigating how firms can cope with these trade-offs.

Eight trade-offs are encountered as a result of the exploratory interviews. The perception on these trade-offs is subsequently assessed by evaluation interviews with interviewees from different business units. However, limited information was available to go into depth on each trade-off for each case study. Besides, not enough time was available to talk about more trade-offs between conflicting capabilities during the interviews.

- Future research would be to shed light on each of these trade-offs in depth.
- Future research would be to investigate which additional trade-offs are important to perceive.

As is already mentioned in Appendix IIA, the theory referring to the Dynamic Capability Framework and Maturity entails opportunities for new research. Regarding the Dynamic Capability Framework, it is discussed that dynamic capabilities are needed for sensing new opportunities and seizing resources to realise that and transform the organisation. This, however, is not taken into account in the research of this thesis because the goal is to design a model that perceives trade-offs between conflicting interrelated capabilities.

- Future research would be to enrich the BORCIT model so that also trade-offs can be perceived between conflicting dynamic capabilities.

Regarding the Maturity Models, it is discussed that capabilities can be too generic, whereas there is no target 'stage'. The Maturity Model can supplement the Resource Based View here, whereby each capability can be divided in five level. As can be reasoned, the capability of 'Data Understandability' can be expressed by a value from 1 to 5. Whereas level 1 would be a poor developed capability, level 5 would be a highly developed capability. Regardless, it should be questioned how capability maturity levels can be measured.

- Future research would be to apply the Maturity Models theoretical lens to the Resource Based View, whereby each capability can be divided in several maturity levels.

The BORCIT framework is not applied in practice, whereby its functionality is not tested. Only an ex-ante validation was done in the evaluation interviews. This could be improved by doing ex-post validation interviews after engaging the BORCIT framework in practice (with distinct types of firms and different industries).

- Future research would be engaging the BORCIT framework in practice in different industries and with different types of firms, and evaluating the framework by organising ex-post validation interviews.

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Appendix

I. APPENDIX: INTRODUCTION

A. RESEARCH OVERVIEW

The outline of the master's thesis can be visualised in summarised form to clarify the flow of the project. As can be seen in Figure 12, the Design Science cycle is used from Johannesson and Perjons (2014).

The process flow can be elaborated into a more detailed outline of the master's thesis project, as presented in the table below. Here, the Design Science phases are mapped with the chapters, sub-questions, deliverables, research objective and method and data collection method.

Design Science phase	Chapter	Sub-question	Deliverable	Research strategy and method	Data collection method
I. Initial problem	1. Introduction	0. Why do BDA embedment projects fail?	• Problem statement • Objective • Knowledge gap • Research questions • Scope	• Literature survey	• Literature articles
II. Explicate problem	3. Theoretical Background	1. How can the Resource Based View of a firm be used to define capabilities that are important for embedding Big Data Analytics in business operations? How do capabilities relate to the pulling forces of Mintzberg's Organisational Model?	• Literature review of the RBV in context of BDA embedment strategies • Areas of conflicts in Mintzberg Model with their corresponding process cycles	• Literature review	• Literature articles
	4. Research Approach		• Method • Interview questions • Interview support tool	• Method defining • Interview preparation	• Supervisors' feedback
III. Define requirements	5. Discussion of research findings	2. What capabilities are important and where in the organisation can potential conflicts be encountered?	• Longlist of capabilities • Interrelations of capabilities	• Literature survey • Discourse analysis • Cross evaluation	• Literature articles
	6. Trade-offs Between Conflicting Interrelating Capabilities	3. What trade-offs between capabilities need to be considered when embedding Big Data Analytics into business operations?	• Trade-offs between conflicting interrelated capabilities • Conditions for trade-offs	• Case study • Discourse analysis	• Interviews • Documents
IV. Design and develop artefact	7. Framework Design	5. How does a framework look like that facilitates the assessment of trade-offs between interrelated capabilities?	• Actionable framework for identification trade-offs	• Design	• Creative methods
V. Demonstrate artefact	8. Identification of Trade-offs	6. How can firms identify trade-offs between capabilities when defining a Big Data Analytics embedment strategy?	• Demonstration of application of framework in case study context	• Case study	• Documents • Interviews
VI. Evaluate artefact	10. Conclusion and Recommendation		• Conclusion • Recommendation • Limitation	• Synthesis	• Findings from conducted research

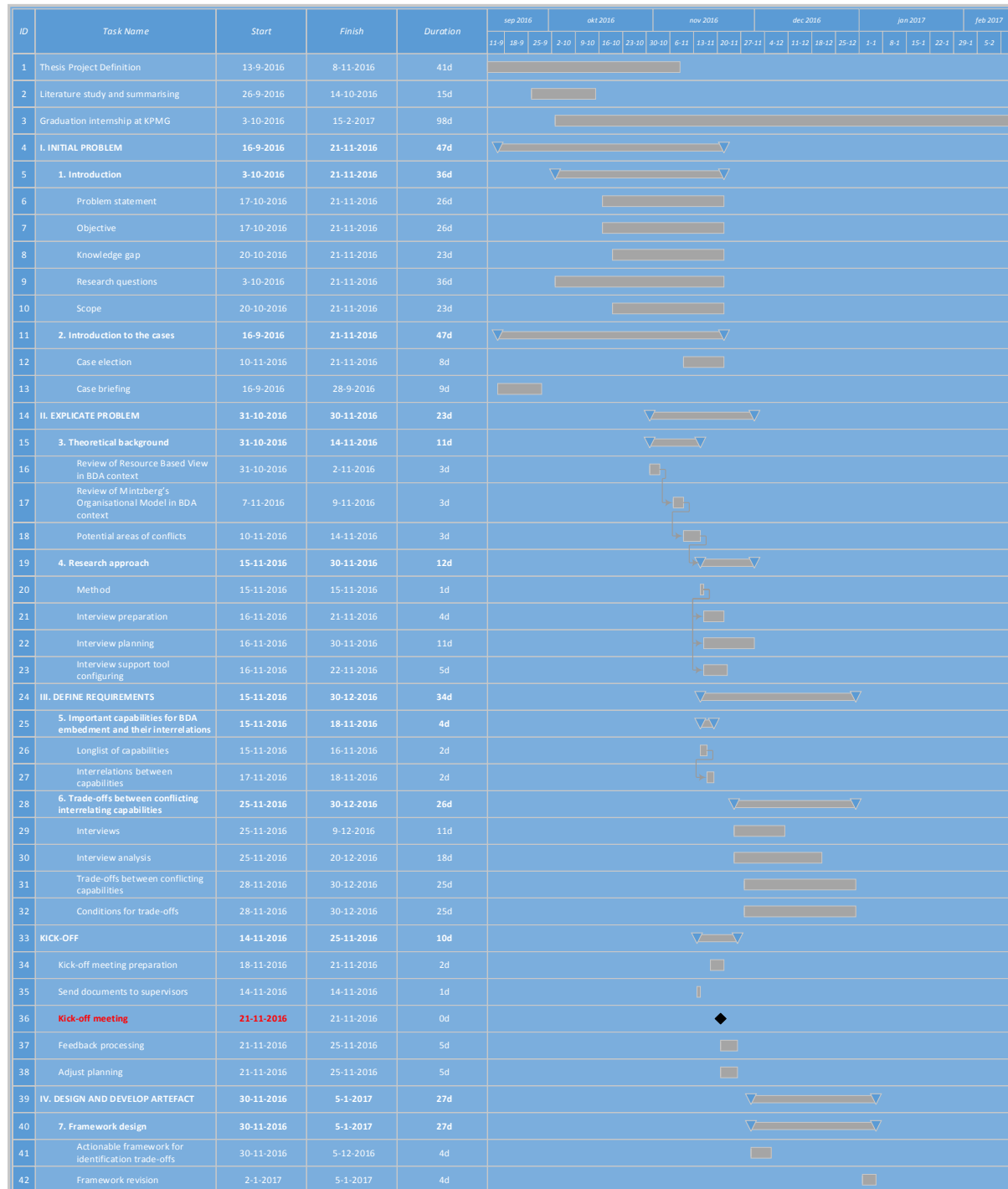
Table 34: Design Science method framework adapted to the research questions of this thesis

B. TIME SCHEDULE OF THE PROJECT

The time schedule that is maintained during the conducting of this research and writing of this master thesis is presented below.

The total time span of the thesis project is the fall semester of the TU Delft which runs from the beginning of September 2016 until the end of January 2017. Therefore, the thesis should be handed in around the 15th of January 2017. The take-off meeting has been planned on the 22nd of November, although we agreed with my supervisors that around that time we have to deliver chapters 1 and 2 already. Once the take-off meeting is approved by both supervisors (André Teixeira and Haiko van der Voort), the chair professor (Marijn Janssen) and my manager-supervisor from KPMG (Koen Klein Tank), we are ready to work towards the end deliverable. On the date of the (successful) take-off meeting, we will plan a new date for the green-light meeting and the final presentation.

The time schedule within the timeframe as mentioned, a Gantt chart is composed on activity level but also related to a chapter (when possible), see Figure 39.



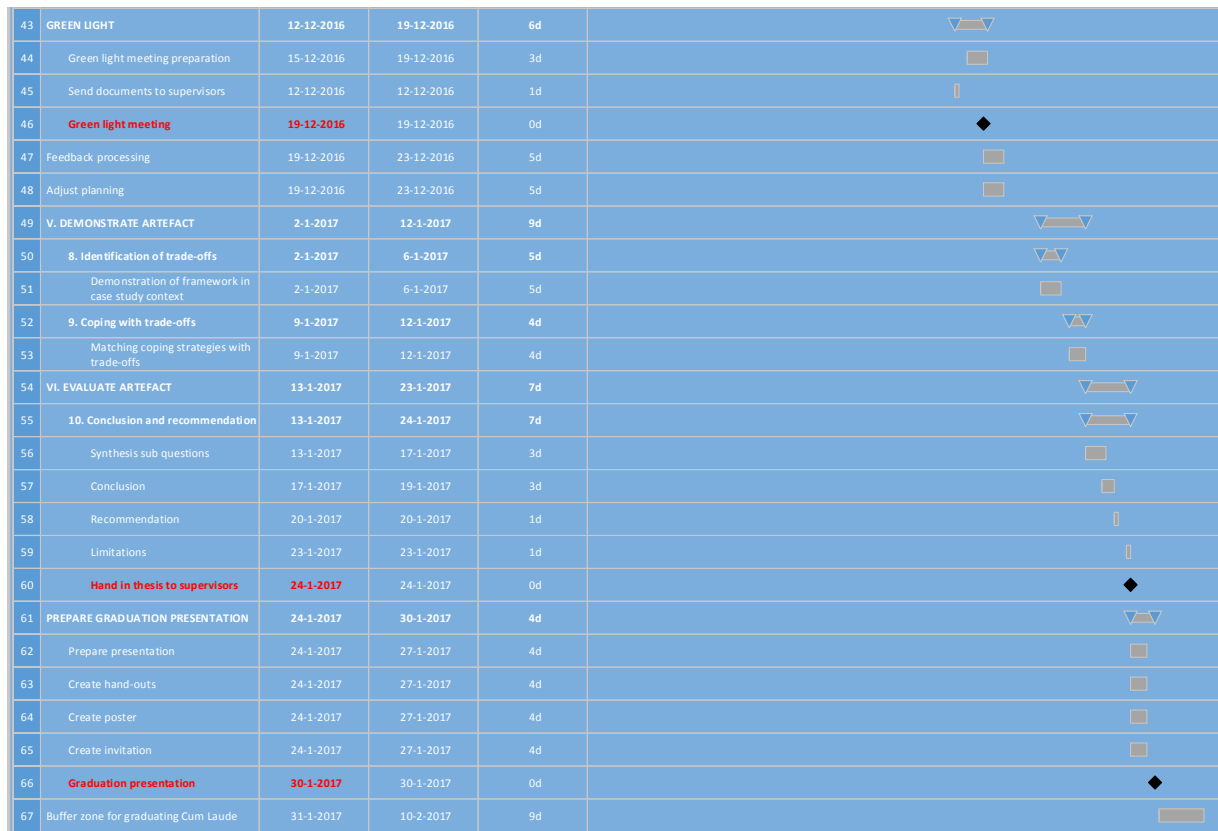


Figure 39: Detailed Gantt chart on deliverable level of the graduation thesis project

II. APPENDIX: THEORETICAL BACKGROUND

For the sake of readability, this part has been omitted in the body text, and therefore is displayed as reference work.

A. ALTERNATIVES FOR THE RESOURCE BASED VIEW

In section 2.2.5, it is concisely discussed that the Resource Based View has its shortcomings. For that reason, this section is dedicated to discussing two alternatives of the Resource Based View: the Dynamic Capability Framework and the Maturity Model. Although there are multiple different other theoretical lenses, these two are chosen because they are discussed on a large scale in the context of embedding BDA in business operations.

DYNAMIC CAPABILITY FRAMEWORK

The Dynamic Capability Framework is initially proposed by Teece et al. (1997) jumps in on the shortcomings of the capabilities of the Resource Based View. According to Teece, normal capabilities are needed for being able to conduct normal business operations of a firm. Capabilities concern the abilities to manage physical, human and organisational resources such as tools, techniques, rules, policy, knowledge and expertise (Wernerfelt, 1984). However, they are 'too static' whereby a firm misses opportunities due to ignorance of external factors. They are not critical for creating competitive advantage to a firm, but transform VRIO resources into competitive advantage. Dynamic capabilities assume that the market, the competitive environment, the technological environment and the context change continuously and disrupt the capabilities of a firm. When firms do not have the capability to adapt to these changes, they have a risk of losing competitive advantage. Therefore, dynamic capabilities are defined as: 'the ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments' (D. J. Teece et al., 1997). Dynamic capabilities include knowledge, learning and absorptive capacity whereby opportunities are seized based on new knowledge and trends. Although dynamic capabilities apply to unstable and repetitive processes, they are important to keep innovating as a firm.

Dynamic capabilities are classified in three groups: 1. *Sensing*: which means identifying and assessing opportunities from outside, 2. *Seizing*: mobilising your resources to capture value from those resources and 3. *Transforming*: continuous renewal of resources and iterating adaption processes (D. Teece, 2013). Firms are resistant to change when the current status quo is performing positively. However, dynamic capabilities foster 'new thinking' in organisations that drives innovation and organisational change (Braganza et al., 2017).

However, this does not imply that the capabilities from the Resource Based View are entirely unnecessary. On the contrary, they are necessary to keep the firm going. When placed into context of embedding BDA, normal capabilities are more useful to optimise operations by using BDA insights. As the resources of BDA are not 'new' anymore, the stadium of dynamic capabilities has past. Regardless, they are still necessary for sensing new opportunities and seizing the resources related to experimenting with BDA, but they are not critical for embedding of BDA. This thesis assumes that there are opportunities to be achieved with BDA, and therefore, BDA is aimed to be embedded in the business operations. Embedding BDA means that it has to be made part of the organisation, therefore, it is required to develop a set of normal capabilities to realise that. Table 35 present an overview of the Resource Based View compared with the Dynamic Capability Framework.

Hence, a combination of both dynamic and static capabilities is required. Since this thesis aims on perceiving trade-offs between the interrelated conflicts that capabilities can have with each other, the static capability approach is chosen that uses the theoretical lens of the Resource Based View.

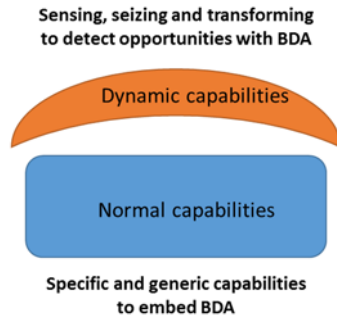


Figure 40: Visualisation of the difference between the dynamic capabilities and normal (static) capabilities

MATURITY MODELS

Olszak et al. published an article that reviews twelve Maturity Models in the context of BDA (2016). They define the term maturity as "the state of being complete, perfect, or ready, whereas to reach this state of maturity a path from an initial to a target needs to be progressed". There are several levels, normally five, that define the progress of this 'path' towards the target situation. In each level, several categories explicated where an organisation can find itself in.

Two of the most popular Maturity Models are shortly discussed. The first is of Gartner that serves as a mean to assess the maturity of an organisation's effort regarding BDA and how mature these need to become in order to reach the business goals (Olszak, 2016). There are five levels: 1. Unaware, 2. Tactical, 3. Focussed, 4. Strategic and 5. Pervasive (Sallam et al., 2011).

The second Maturity Model, which is very popular, is of Davenport and Harris. They also define five levels: 1. Analytically impaired, 2. Localised analytics, 3. Analytical aspirations, 4. Analytical companies and 5. Analytical competitors (Davenport et al., 2013).

A big difference between Maturity Models, as discussed above, and the Resource Based View is that with capabilities there are no differences in stages. When BDA capabilities are defined, either specific or generic, they do not tell something about the different stages that have to be walked through. Neither does it discuss the setting of a specific target that has to be pursued. As Maturity Models define different levels of progress, a firm can set a specific target that it can pursue. Then, it is also clear what has to be done in order to attain that target. However, a disadvantage of this is that the measurement is subjective. It is difficult to say to what extent a level is achieved. Compared with capabilities, there is no measure define either.

This implies that the Maturity Models can be a good supplement for the Resource Based View. As in principle, every capability can be mapped with a maturity level. In this way, more action is entailed to the capabilities that are important for embedding BDA. In principle, a capability can be divided in five levels of maturity, as is displayed in Figure 41. Then, a firm could set a target and aim on pursuing that target by developing a capability to that level. However, in that case the question would emerge how the different levels are defined.

Nevertheless, this thesis aims to perceive trade-offs between capabilities when embedding BDA. This should not be confused with the aim on identifying all the trade-offs, as that would be the second step. As can be reasoned, trade-offs can also occur on different maturity levels. In theory, capabilities can conflict on specific levels and not on other levels. This would enrichen this research, but it is not within this scope. Therefore, it is included in the agenda for future research in section 8.4.

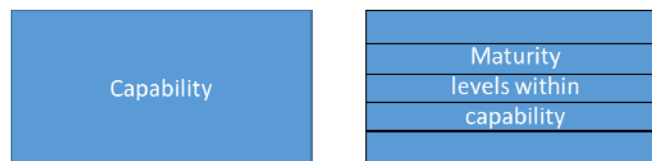


Figure 41: Schematic visualisation of maturity levels of a capability

	Resource Based View	Dynamic Capability Framework	Maturity Models
Goal	Creating competitive advantage	Creating competitive advantage	Achieve a target situation by walking down a path
Method	Specific and generic (static) capabilities	Sensing, seizing and transforming (dynamic) capabilities	Maturity levels from 1 (immature) to 5 (mature)
Replacement for RBV?	Not applicable	Supplement the RBV	Supplement the RBV
Advantages	- Managing resources adequately - Define where a firm needs to be capable of - Capabilities can be defined specific and generic	- Adapting to dynamic environment - Find and create opportunities - Drive towards innovation	- Work towards a higher level of maturity - Smaller actionable steps - Specific factors or milestones
Disadvantages	- Capabilities too static, organisation not adaptive to change - Missing opportunities - Undefined steps	- Not able to serve as 'standalone' framework - Difficult to grasp - Not specific, but only generic	- Assumes that opportunities are already clearly perceived - There is only one roadmap - Difficult to measure
Perceive trade-offs?	No	Not applicable	No
Within scope for research	Yes	No	No

Table 35: Overview of the two alternatives referring to the Resource Based View in the context of embedding BDA

B. EXECUTIVE MANAGEMENT PROCESS CYCLE

Although corporate strategies are created in various ways depending on the firm's characteristics, according to Johnson et al. a general process cycle can be drafted (2008). This cycle comprises five steps: 1. Evaluating current strategy and assessing the firm's performance, 2. Organising the firm in order to reinforce strategy, structure and systems, 3. Carrying out the strategy in practice and involving different parts of the organisation, 4. Leading the organisation to convert strategy into strategic change and 5. Processes of strategy defining which is a mix of deliberate and emergent decisions.

Firstly, in order to evaluate a current strategy, the firm's performance is assessed on economic performance and organisational effectiveness (Johnson et al., 2008). Plenty of tools are available for this including PESTEL, Porter's Five Forces model, defining strategic groups, assessing the value chain and defining strategic capabilities. The latter one, defining strategic capabilities, is where this thesis is aimed at. This also implies that a corporate strategy is more than solely defining strategic capabilities. Regardless, these tools support the executive board to assess the organisation and its environment in order to detect opportunities and risks. Eventually, this contributes to the detection of the 'gap' between the status quo and the desired state is detected.

Secondly, strategy needs to be successfully implemented, for which organisation of structures and systems is required. Whereas the structure of an organisation comprises lines of control and hierarchy it focuses on the roles and responsibilities that individuals have in the organisation. They all contribute to the implementation of the strategy whereby they need systems. Systems are the means of carrying out the structure. Hence, as the structures can be perceived as the 'skeleton', the systems are perceived as the 'muscles' of the organisation (Johnson et al., 2008). These form the basis of strategic planning before actually executing the change. Organising aims on structuring and dividing resources in order to make the firm ready for strategic change.

Thirdly, practicing strategy mainly entails the taking charge of the involvement of actors within the firm, which can be mapped on Mintzberg's Organisational Model (Johnson et al., 2008; Mintzberg, 1979). These actors are situated in business units and pursue their own goals. In the context of BDA embedment, especially the BDA experts of the 'technical staff' and the operational managers of the 'middle management' are involved. For the Executive Management is important to know 'who' is on board and is dedicated to do 'what' for a reason 'why' based on their internal interests. This also implies that organisational support plays key role.

Fourthly, the defined strategy design needs to be carried out to achieve strategic organisational change (Johnson *et al.*, 2008). One of the most important aspects of this activity is that leadership is required to bring over the strategy design to the employees in the organisation. Eventually strategic capabilities need to make a transition from the designing table towards the employees in the organisation. Mintzberg's Organisational Model is used to explain why this activity is crucial to get organisational support (1979). Also the VRIO principles proposed by Wernerfelt *et al.* underpin this statement, as capabilities need to be valuable, rare, inimitable and have organisational support (1984). Without organisational support strategies will not lead to strategic change. An important issue, however, is that the organisation is divided in different organisational areas or business units (Porter, 1989). These have their own objectives and goal whereby they can also have different supportiveness of the corporate strategy, see section 2.5..

Fifthly, the process of strategy implementation is clarified which shows that a realised strategy is comprised of deliberate and emergent strategy (Johnson *et al.*, 2008). Deliberate strategy can subsequently be divided in a planned and unplanned part. Even though a series of tools and frameworks is followed strictly, not all facets of strategy can be planned internally. Main reason for this, is that a firm is influenced by its environment whereby it needs to take into account externally imposed strategies by for example influential stakeholders. Emergent strategy explains the phenomenon of strategy evolving based on a series of decisions contributing to a larger strategic component. Strategies evaluate over time as incorrect decisions can be made and are changed in a later stage of the process. Even though later decisions are undesired, they cannot be prevented completely.



Figure 42: Executive Management: corporate strategy cycle (Johnson *et al.*, 2008)

C. OPERATIONAL MANAGEMENT PROCESS CYCLE

Numerous different business process management cycles are available varying in the level of detail and context, although they tend to have five steps in common. The model of IBM Inc. provides a summarised version, that can be applied in any context (IBM, 2008). It comprises the following steps: 1. Envision business goal divided up in a set of Key Performance Indicators, 2. Assess current state of organisation, 3. Define the future state of the organisation, 4. Execute the project by working towards to future situation and 5. Optimise the process architecture through testing and evaluation against the KPIs. The business process management cycle is presented in Figure 43.

Firstly, the business goals of the firm need to be defined precisely and need to be well understood (IBM, 2008). A set of Key Performance Indicators (KPIs) is determined that provide insights on the business performance of the firm. These can be translated into requirements that are to be realised. Operational strategy is defined in this step that serves as a guide in upcoming stages.

Secondly, the current state of the enterprise is assessed in the context of the goals, which correspond with the KPIs (IBM, 2008). Organisational structure, application ownership, governance and development and application

portfolios enable the provision of insights what is to be done to achieve the goals and pursue the strategy as defined in step one. Besides, current organisational capabilities are assessed that are required for a successful execution of the project.

Thirdly, the future state of enterprise is defined in the context of the goals, which also correspond with the KPIs (IBM, 2008). Resources of human, organisational and technological nature are planned in second and third step represents a gap that is to be bridged by the design. This gap serves as an input to create a structural and dynamic view of the firm's processes at hand and create a roadmap.

Fourthly, the roadmap is followed and the project is executed whereby processes are either designed or redesigned, processes are aligned with resources, processes are simulated and monitored, and processes are evaluated against the KPIs which represent the initial goal (IBM, 2008). Important to notice, is that the process designs need to fit in the existing architecture and need to be integrated. According to the design, the organisational, human and physical resources are deployed and integrated in operations and transformed into capabilities.

Fifthly and lastly, the process design is monitored during deployment whereby is searched for improvements (IBM, 2008). Performance is evaluated against the KPIs periodically and iteratively so that the firm's processes remain on course. When a design is not completely satisfiable, the process management cycle can be run over again whereby it is redesigned partially until the KPIs are met and goals achieved.

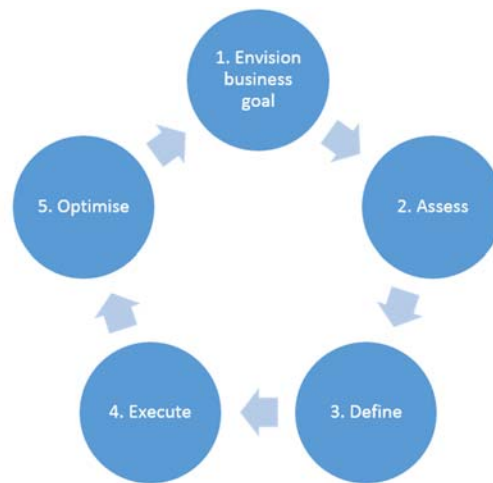


Figure 43: Operational Management: process management cycle (IBM, 2008)

D. BIG DATA ANALYTICS EXPERT TEAM PROCESS CYCLE

Through summarising literature articles in the field of BDA project implementation, Dutta et al. defined a BDA implementation cycle (2015). This cycle is taken as a basis for the BDA Expert Team on Mintzberg's Organisational Model. Figure 44 presents a simplified version of this process cycle whereby some steps were merged. Eventually, five general steps are included: 1. Defining the data analytics goal, 2. Data collection and preparation, 3. Data modelling and analysis, 4. Insights communication and 5. Operationalise.

Firstly, it is determined what needs to be realised by the BDA project by assessing the situation and defining the problem. Research is performed to achieve a preliminary understanding of the problems and organisation (Flyvbjerg, 2013). Gupta et al. mention that this step is absolutely crucial to be executed correctly, as here the strategic groundwork is done (2015). For this reason, it needs to be clear what insights need to be acquired from the BDA analysis and for what purposes it is meant. A project roadmap is created that elaborates the tasks to be performed, deliverables and milestones to be worked towards and deadlines to be met (Viaene et al., 2011).

Secondly, resources are organised that are necessary for execution of the BDA project. This includes the data collection from the right sources, the data staging and preparation, and appointing key actors across the organisation (Baars et al., 2008). Unstructured data is examined on its quality, sources are combined to enrich the data set and meta data is added (Dutta et al., 2015). Notice that, especially in this stage, involvement of the different business

units of Mintzberg's Organisational Model is important as resources need to be managed adequately (Schikora et al., 2003).

Thirdly, the actual analytics part is performed comprising data analysis, modelling and insights creation and visualisation. Both quantitative and qualitative techniques are performed to extract insights from the structured data. This is done by analysing and modelling data and aiming to understand the underlying reasons. The latter can be achieved through visualisation of data whereby relations, patterns, dependencies and clusters can be detected in an intuitive manner (Dutta et al., 2015; Rao, 2003). Insights are acquired and translated into business measures so that they have a meaning by bringing them into context (LaValle et al., 2011).

Fourthly, the obtained insights need to be communicated to the actors across the organisation. This is the reason why during the first stages, involvement of these actors is crucial. The insights have to provide a solution to the problem as defined in the first stage and, therefore, has to satisfy the actors that are problem owners (Schikora et al., 2003).

Fifthly and lastly, the models, trends and visualisation tools that are deployed during former stages need to be integrated in existing IT systems and embedded in business operations. BDA insights provide key information that should be engaged in operations to improve business performance, but can differ per operation (Bose, 2009; Dutta et al., 2015). Therefore, it is important that the right information is delivered to the right actor at the right time. For instance, this can be realised by a dashboard whereby insights can be accessed.



Figure 44: BDA Expert Team: Big Data Analytics implementation cycle adopted from (Dutta et al., 2015)

E. CONFLICTS INSIDE A STRATEGY

Various different tools are disposable to define strategy based on a goal that one business unit has. Whether this strategy is defined on corporate level or business unit level, decisions need to be made on the way (Johnson et al., 2008). This implies that these decisions on themselves already were trade-offs between different outcomes. Objectives altogether included in a strategy, can already enclose conflicts between values, interests and goals. Bozeman et al. mention that, here, a vast barrier is encountered (2007). Namely, this implies that strategies made by decision-makers of a particular business unit already enclose a series of conflicts. When subsequent conflicts between strategies of different business units (as is discussed in F and G) are encountered where trade-offs need to be made, these thus already comprise implicit conflicts inside a strategy. Due to this, Steenhuisen et al. reason that trade-offs between conflicts lead to impossible situations as each decision hampers an outcome in any way (2009).

With regard to acquiring capabilities in business unit strategies, it is important that interrelations between capabilities are taken into consideration in order to prevent conflicts within a strategy (Leonard-Barton, 1992). This would denote a capability X of business unit 1 conflicting with capability Y of business unit 1. For instance, the capability of data collectability through entry could hamper the capability of process agility for the Operational Management ('middle line management'). Here, a trade-off needs to be made in strategy forming, based on the

underlying conflicts in values and interests of a single business unit. Figure 45 depicts a visualisation of these internal strategic conflicts mapped on Mintzberg's Organisational Model.

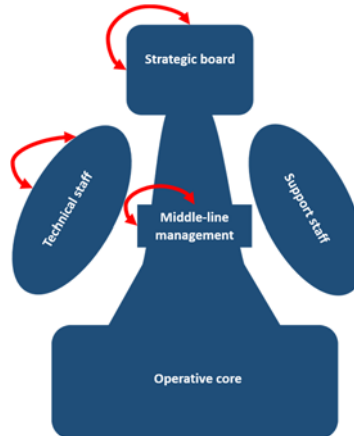


Figure 45: Conflicts within a single strategy (Mintzberg, 1979)

F. CONFLICTS BETWEEN STRATEGIES OF DISTINCT BUSINESS UNITS

Several studies have been published about conflicting strategies between business units, even though they are situated in the same firm (Thomas, 1992). Especially, in corporate firms, where business units are relatively autonomous, they have their own objectives to achieve and have to deal with consequences when these are not achieved (Porter, 1989). For this reason, business units tend to appreciate their own interests higher than other interests when defining their own (O'Brien, 2015). These competing values can cause friction in an organisation which inevitably and implicitly lead to trade-offs for decision-makers (Steenhuisen, 2009).

With regard to acquiring capabilities in strategies of business units, it is reasonable that these conflicts also can occur between capabilities of business units. This would denote that a capability X of business unit 1 could hamper the capability Y of business unit 2. For instance, the capability of security of data of the BDA Expert Team ('technical staff') can hamper the capability accessibility to insights by Operational Management ('middle line management'). Here, a trade-off needs to be made in strategy forming, based on the underlying conflicts in values and interests between the two business units. Figure 46 depicts a visualisation of this conflict between the strategy of two business units which is mapped on Mintzberg's Organisational Model.

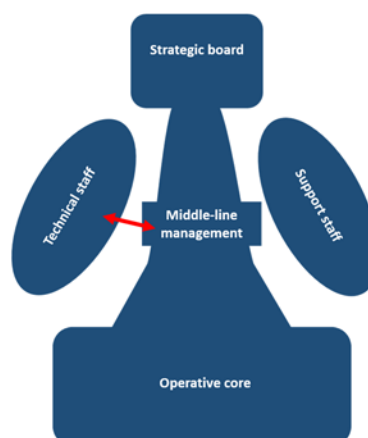


Figure 46: Conflicts between strategy of two business units (Mintzberg, 1979)

G. CONFLICTS BETWEEN CORPORATE STRATEGY AND BUSINESS UNIT STRATEGY

Porter published an article explaining why competitive advantage of a firm does not per se define a consistent corporate strategy (1989). Diversified firms have a two level strategy: business unit strategies and a corporate

strategy. A corporate strategy is what makes the firm more than the sum of the values created in the business units. This can also create conflicts between these strategies. For instance, a firm has a corporate strategy aiming on accomplishing their main goal, but whereas every business unit has their own interests and values they also have defined a strategy to accomplish their goals. Theoretically, business unit-level strategies should complement each other whereby they embody the corporate strategy. In practice, however, this corporate strategy can become unrealistic when there are internal conflicts. Hence, it is important that business level strategies inside the corporate strategy are aligned to create optimal competitive advantage.

With regard to acquiring capabilities in a corporate strategy, it is important to investigate what conflicts with other capabilities of business level strategies have. This would denote that a capability X of the corporate strategy could conflict with capability Y of a business unit. For instance, the corporate capability of supervise ability of operations could hamper the capability of autonomy of business units. Figure 47 depicts a visualisation of these conflicts between corporate strategy and business units mapped on Mintzberg's Organisational Model.

Important to notice is that a corporate strategy defined by the Executive Management has to highest priority. Based on this strategy, the business units can define their strategy as is claimed by Johnson et al. (2008). Hence, the Executive Management first define their strategy, then business unit level strategies are defined. This, however, does not imply that no trade-offs have to be taken by the Executive Management. As can be seen in the corporate strategy cycle depicted in Figure 42, in the first step the current strategy on both levels is evaluated in order to improve the new, to be designed, strategy (Johnson et al., 2008; Porter, 1989).

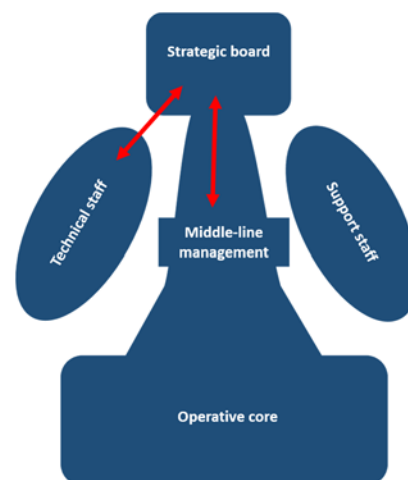


Figure 47: Conflicts between business unit strategy and corporate strategy (Mintzberg, 1979)

III. APPENDIX: RESEARCH APPROACH

A. INTERVIEW PROTOCOL EXPLORATORY INTERVIEWS

The following interviewing protocol is used for the exploratory (round 1) interviews. As can be seen it is structured in six aspects:

I. BUSINESS UNITS

1. What is your educational background?
2. Do you have work experience with Big Data or Data Analytics projects?
3. What other people (from which departments) need to be involved in the project?

II. OBJECTIVES

4. Can you name some objectives that were important for the project?

III. RESOURCES

5. What resources did you need for executing a Big Data and Data Analytics project? (Such as systems, skills, employees, knowledge, plans, protocols)
6. What were your tasks in this project?

IV. CAPABILITIES

7. How did you want to realise these objectives?
8. Where needed your organisation be capable of by using Big Data and Data Analytics?

V. INTERRELATED CONFLICTS

9. Were there some objectives not feasible?
10. What issues came up with regard to the aspects from Table 36.

11. TRADE-OFFS

12. Who was responsible to solve these issues?
13. How did these issues got resolved?

Capability	Context
Data Availability	The availability of data to employees through systems at any time
Insights completeness	Complete and detailed data for specific insights with no missing fields or information
Insights understandability	Understandable data insights, easy to visualise and derive conclusions for employees
Data Quality	High quality, accurate and up to date data with minimal incorrect data fields
Coordinate ability	Easy to process and monitor the data and manage or supervise the information flows
Autonomy and Flexibility	Agile autonomous deriving of conclusions and making decisions at decentralised level for increasing resilience and flexibility
Interoperability	Highly accessible data with highly interoperable and mature information systems on a high scale

Security	Highly secured data with strong authentication and audit controls with periodical backups for reducing data-related risks
Predictability	Standardising information flows and insights in order to predict outcomes and create stability

Table 36: Capabilities discussed during interviews

B. INTERVIEW PROTOCOL EVALUATION INTERVIEWS

The following interviewing protocol is used for the exploratory (round 1) interviews. Only the trade-offs are discussed, sorted on difficulty and the involved capabilities are prioritised.

1. Which of the two capabilities is most important, and how much more important?

For example:

- Data Understandability is much more important than Manageability.
- Data Completeness is of same importance as Data Understandability

Capability 1	Capability 2	More important	How much more important?
Data Completeness High quantity, complete and detailed data that allow specific insights	Data Understandability Easy understandable data insights, easy to visualise and derive conclusions.		• Same importance • Slightly more important • Moderately more important • Much more important • Extremely more important
Data Completeness High quantity, complete and detailed data that allow specific insights	Data Quality High quality, accurate and up to date data with minimal incorrect data fields		• Same importance • Slightly more important • Moderately more important • Much more important • Extremely more important
Data Understandability Easy understandable data insights, easy to visualise and derive conclusions.	Security and Integrity Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy.		• Same importance • Slightly more important • Moderately more important • Much more important • Extremely more important
Data Completeness High quantity, complete and detailed data that allow specific insights	Manageability Easy to process and monitor the data processes and engage insights in decisions and changes		• Same importance • Slightly more important • Moderately more important • Much more important • Extremely more important
Data Completeness High quantity, complete and detailed data that allow specific insights	Security and Integrity Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy.		• Same importance • Slightly more important • Moderately more important • Much more important • Extremely more important
Data Availability Easy capturing of data and access to systems and platforms	Security and Integrity Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy.		• Same importance • Slightly more important • Moderately more important • Much more important • Extremely more important
Autonomy and Flexibility	Predictability		• Same importance • Slightly more important

Agile and autonomous deriving of conclusions and making decisions for increasing resilience and flexibility	Standardised analyses and information flows to predict outcomes and performance		- Moderately more important - Much more important - Extremely more important
Predictability Standardised analyses and information flows to predict outcomes and performance	Data Understandability Easy understandable data insights, easy to visualise and derive conclusions.		- Same importance - Slightly more important - Moderately more important - Much more important - Extremely more important

2. Which of the following trade-offs are the most difficult to make?

For example:

- *Data Completeness vs. Data Understandability* 1 (most difficult)
- *[Capability 1 vs. Capability 2]* [2-7]
- *Predictability vs. Autonomy and Flexibility* 8 (least difficult)

Capability 1	Capability 2	Citation	Rank From 1 to 8
Data Completeness High quantity, complete and detailed data that allow specific insights	Data Understandability Easy understandable data insights, easy to visualise and derive conclusions.	"The more data sources you use, the more complex it gets"	
Data Completeness High quantity, complete and detailed data that allow specific insights	Data Quality High quality, accurate and up to date data with minimal incorrect data fields	"You can never achieve 100% correct data when you use a lot of data sources"	
Data Understandability Easy understandable data insights, easy to visualise and derive conclusions.	Security and privacy Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy.	"When (personal) data is easy understandable, privacy of individuals becomes in dispute"	
Data Completeness High quantity, complete and detailed data that allow specific insights	Manageability Easy to process and monitor the data processes and engage insights in decisions and changes	"It is difficult to manage data analytics projects and engage insights in governing, when a large series of data sources is used"	
Data Completeness High quantity, complete and detailed data that allow specific insights	Security and privacy Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy.	"As (personal) data becomes more complete, derivations can be made that can trace back individuals"	
Data Availability Easy capturing of data and access to systems and platforms	Security and privacy Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy.	"When data is easy to access and available for analysis, this is at the expense of the systems security and privacy"	
Autonomy and Flexibility Agile and autonomous deriving of conclusions and making decisions for increasing resilience and flexibility	Predictability Standardised analyses and information flows to predict outcomes and performance	"It is difficult to predict the performance/outcome of flexible analyses and autonomous derivation of conclusions"	

Predictability Standardised analyses and information flows to predict outcomes and performance	Data Understandability Easy understandable data insights, easy to visualise and derive conclusions.	"When insights are not understood, they are trusted and cannot be used for predictions"	
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C. INTERVIEWEE SELECTION

This table depicts an overview of the selected interviewees for the exploratory interviews and the evaluation interviews.

#	Interviewee	Firm/case	Type of service	Department	Function role	Date of interview	Duration	Round
1	"Mock interviewee 1"	KPMG	IT advisory	Risk consulting	Intern	23-11-2016	40 min	1
2	"Mock interviewee 2"	KPMG	IT advisory	Risk consulting	Intern	23-11-2016	40 min	2
4	"Executive manager 1"	KPMG	IT advisory	Risk consulting	Senior manager		60 min	1
5	"Operational manager 1"	KPMG	IT advisory	Data and Analytics	Senior consultant	02-12-2016	60 min	1
6	"BDA expert 1"	KPMG	IT advisory	Data and Analytics	Manager	05-12-2016	60 min	1
7	"Executive manager 2"	KPMG	IT advisory	Data and Analytics	Partner	06-12-2016	60 min	1
8	"Operational manager 2"	KPMG	IT advisory	Risk consulting	Manager	02-12-2016	60 min	1
9	"BDA expert 2"	KPMG	IT advisory	Forensic	Consultant	09-12-2016	60 min	1
10	"Executive manager 3"	Employment agency (case 1)	Internal audit	Internal audit under CIO	Manager	15-12-2016	60 min	2
11	"Operational manager 3"	Employment agency (case 1)	IT advisory	Risk consulting	Manager	15-12-2016	60 min	2
12	"BDA expert 3"	Employment agency (case 1)	Data analytics	Data analytics department	Associate	15-12-2016	60 min	2
13	"Executive manager 4"	Dairy producer (case 2)	IT advisory	Risk consulting	Senior consultant	14-12-2016	60 min	2
14	"Operational manager 4"	Dairy producer (case 2)	IT advisory	Risk consulting	(Senior) consultant	16-12-2016	60 min	2
15	"BDA expert 4"	Dairy producer (case 2)	IT advisory	Big Data team	Consultant	16-12-2016	60 min	2

Table 37: Interviewee selection according to the selection criteria

D. REFLECTION ON DATA COLLECTION

LACKING OF UNDERSTANDING OF RESEARCH OBJECTIVE

During the interviews it was noticed that there is a lacking understanding of the objective of this thesis. This had not necessarily anything to do with their expertise in their field, but was consequence of the complex and abstract topic of this thesis. As the goal of this research is to identify trade-offs between capabilities, understanding of this phenomenon is required. Therefore, in each interview the first ten minutes were dedicated to introduction of the thesis. In addition, as can be seen in the interview protocol, the questions were semi-structured. Hence, these were adjusted according to the proceeding of the interview. Afterwards, with the coding of the text for preparation of the

quantitative analysis, their responses were captured in thematic networks. This method worked, as arguments from respondents could be related to the more abstract terminology, which is necessary for deriving conclusions with regard to this research.

INTERVIEWS DIFFICULT TO STRUCTURE

Interviews were difficult to structure as interviewees tended to go into detail on less relevant subjects, whereby sometimes it was difficult to derive conclusions from their answers. Therefore, it was necessary to interrupt them kindly, and ask ad-hoc questions to anticipate and guide towards the desired direction. Interviewees with higher hierarchical function roles, such as partners and senior managers, were most challenging to guide. However, enthusiasm was present during the interviews, which allowed to acquire loads of in-depth information.

Initially it was planned to use a very structured interviewing strategy, in which cross-evaluation of capabilities was planned to do in order to detect all conflicts, which is commonly used in requirements engineering. This approach, however, was discouraged by supervisors from both the university and KPMG. The reason for this, is that no back-up argumentation would have been acquired in the limited time of interviews. It would have been a more quantitative approach whereas a qualitative approach was aimed, especially because research done on trade-offs between capabilities has (probably) not been performed yet. Besides, it would have been possible that interviewees could not make the cross-evaluation due to their lack of understanding of the terminology of capabilities. Therefore, the more open and exploratory approach was used. Here, a natural selection of capabilities and trade-offs was made by the interviewees themselves as they were asked to talk about the most impactful capabilities and prominent conflicts. A disadvantage of this exploratory, less structured, approach is that not all trade-offs could be detected and discussed. An advantage is, however, that this led to plenty of argumentation per answer leading to a better understanding of the situation.

This research could have been underpinned by quantitative survey where the cross-evaluation matrix could be used. A large amount of respondents would then be necessary, in order to get insights in the difference in perspectives. This, however, should be preceded by exploratory research.

GAP BETWEEN LITERATURE AND PRACTICE

A clear gap between literature and practice was encountered during both the desk study as the interviews. Abstract terms including capabilities, resources and trade-offs were perceived and therefore used differently in management letters and interviews than literature using the Resource Based View. This led to ambiguity concerning the validity of the research, as this specific theory is maintained to work towards concrete research findings. As these terms can be broadly interpreted, without context it is difficult to grasp what they mean. Therefore, during interviews the focus was on acquiring a lot of information with much detail.

Surprisingly, these theoretical terms are also used differently in literature. However, this problem was easy to overcome, as generally, articles that specifically mention that they take the Resource Based View to define either capabilities or resources, have consistency in the use of this terminology. This was an important criteria during the documents search. This gap was overcome, during the coding and analysis of the documents and interviews, the mapping of theoretical terms with statements were then made manually to overcome with issue.

INTERVIEWEES THINK IN SOLUTIONS NOT IN PROBLEMS

In the answering of questions during the interviews, the interviewees tended to think in solutions and not in problems. As the objective of the interviews is to identify trade-offs between capabilities, interviewees came up with actionable solutions to anticipate trade-offs. An explanation for this is that all interviewees are either engineers or technological consultants whose work is to provide solutions for acknowledged problems.

However, this barrier could be overcome by always asking 'why' interviewees came up with a specific argument. In this way, most of the times they provided the reason behind their thoughts. This was very functional during the coding and analysis of the transcriptions.

LIMITED TIME AND AVAILABILITY OF ASSETS

During the data collection, a large amount of information is aimed to gather in a limited amount of time. With regard to the desk study, this was not necessarily an issue as loads of information were available. This information could be

analysed at any time and therefore be planned easily. For interviews, however, human assets are required where meetings need to be scheduled which requires time from employees that are busy with their job. As BDA is also a trending topic in practice, where KPMG Netherlands works at high level, many interviewees were often abroad for longer projects. Therefore, the human assets were the largest concern when planning the data collection.

Fortunately, KPMG provided a list with people with relevant expertise within the firm who were open for interviews. Most of the employees that were approached, replied and around two-third of the responses led to an interview.

Clients were more difficult to interview, as they generally are hesitant to share confident information for case studies. Agreements were made that firm names must be blanked out and information must be anonymised completely. As a result it became possible to organise the case studies and have client interviews for evaluation of the model design, which is discussed in section 3.3.3. This, however, needed to take place in a shorter time frame, whereby time was used most efficient as possible.

IV. APPENDIX: RESEARCH FINDINGS

A. BUSINESS UNITS TO INVOLVE WHEN EMBEDDING BIG DATA ANALYTICS

This is the thematic network of the arguments related to the business units that need to be involved when embedding BDA. These arguments were mentioned during the exploratory interviews.

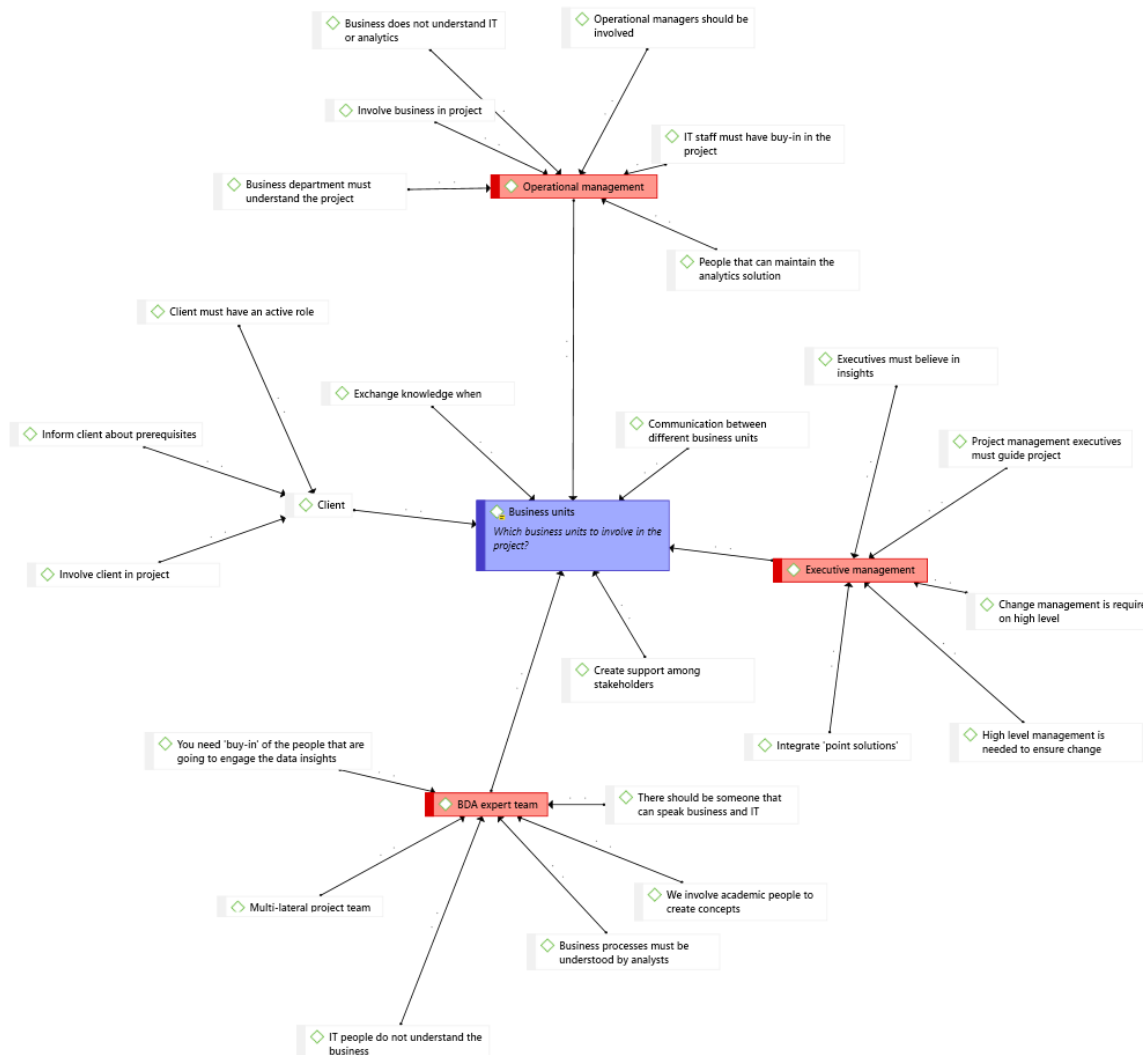


Figure 48: Thematic network of the business units (red) to involve when embedding BDA with their related arguments (white)

B. OBJECTIVES RELATED TO EMBEDDING BIG DATA ANALYTICS

This is the thematic network of arguments related to the objectives for which embedding BDA can be used. These arguments were mentioned during the exploratory interviews.

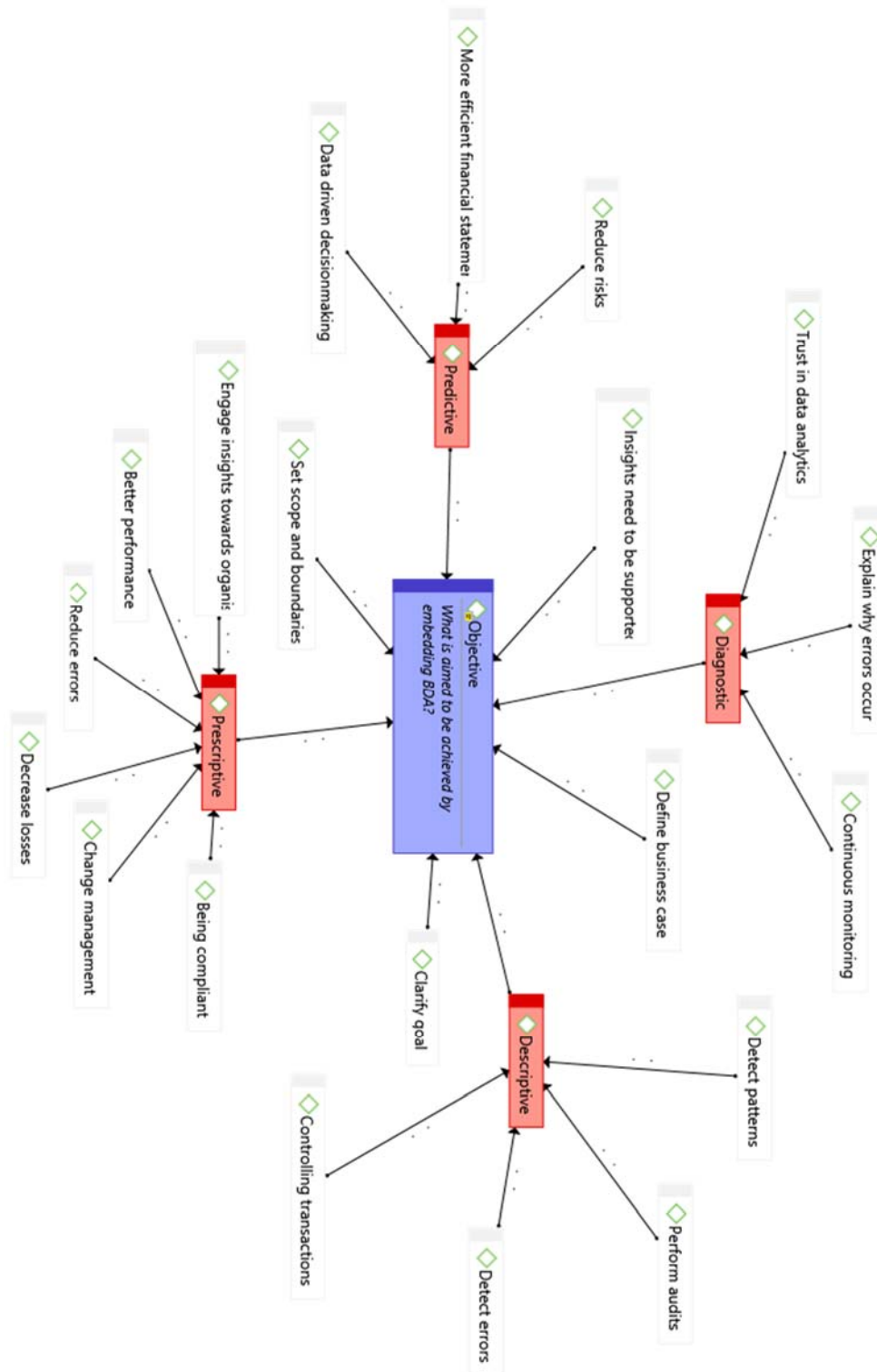


Figure 49: Thematic network of different objectives (red) and their applications (white) to be achieved by embedding BDA

C. RESOURCES FOR EMBEDDING BIG DATA ANALYTICS

THEMATIC NETWORK

This is the thematic network of arguments related to the resources that are necessary for embedding BDA. These arguments were mentioned during the exploratory interviews.



Figure 50: Thematic network of the necessary resources (white) for embedding BDA mapped with the resource types from literature (red)

TABLE OVERVIEW WITH QUOTATIONS

The table presents an overview of the resources and the quotations related to them. Only the resources that had more than 4 arguments are included in this table.

Resource	Example quotation	Interviewee	Resource type
Analytic skills	"Allocate employees in your team that know what analysis fits with the objective"	Manager at KPMG, Data and Analytics	Human
Business process knowledge	"You need people that know the ins and outs of the business process"	Consultant at KPMG, Forensic F Tech	Human
Data governance policy	"To embed data analytics in daily, weekly or monthly processes you will need data governance"	Senior manager at KPMG, Data and Analytics	Organisational
Data staging skills	"The right people with skills is difficult to acquire"	Manager at KPMG, Data and Analytics	Human
IT architecture	"Good IT systems are the fundament of retrieving structured data"	Senior consultant at KPMG, Data and Analytics	Physical
IT knowledge	"Best is to engage people with knowledge about the IT system landscape"	Consultant at KPMG, Forensic F Tech	Human
Strategic management skills	"Strategic managing skills for guiding the project"	Senior consultant at KPMG, Data and Analytics	Human
Trust in data	"It is important that people from the business trust in the data"	Partner at KPMG, Data and Analytics	Organisational
Strategy for engaging insights	"Without telling how to act based on the insights, there is no effective change"	Senior consultant at KPMG, Data and Analytics	Organisational
Good data	"Good data is a pre-condition of starting any data analytics project"	Partner at KPMG, Data and Analytics	Physical
Project contracts	"When defining a management proposal, it is essential that good contracts are set up to clarify scope and demarcate scope"	Senior consultant at KPMG, Data and Analytics	Organisational
Analytical tools	"Nowadays, there are many useful analytical tools that can be directly used from Microsoft, Oracle and SAP"	Partner at KPMG, Data and Analytics	Physical
ERP system	"When there is an ERP system, the data is automatically structured, which saves a lot of time"	Senior manager at KPMG, Data and Analytics	Physical
Security policy	"Even though there is high security on the ERP system, when security is lacking when a data analyst takes all the data to analyse it"	Manager at KPMG, Data and Analytics	Organisational
Standardised analyses	"Structured data allows us to execute a standardised set of analyses, to create initial insights"	Consultant at KPMG, Forensic F Tech	Organisational
Documentation of knowledge	"Important is that specific knowledge is documented so that when employees leave the knowledge is not gone"	Consultant at KPMG, Forensic F Tech	Organisational

Table 38: Overview of the mentioned resources that are important for embedding BDA

D. CAPABILITIES ESSENTIAL FOR BIG DATA ANALYTICS EMBEDMENT

The research for finding essential capabilities of BDA embedment is conducted in two parts: desk study of literature articles and explorative interviews. Findings of both parts are matched and used for supplementing each other.

DESK STUDY THEMATIC NETWORK

This is the thematic network of specific capabilities related to the generic capabilities that are necessary for embedding BDA. These arguments were encountered in articles during the desk study.

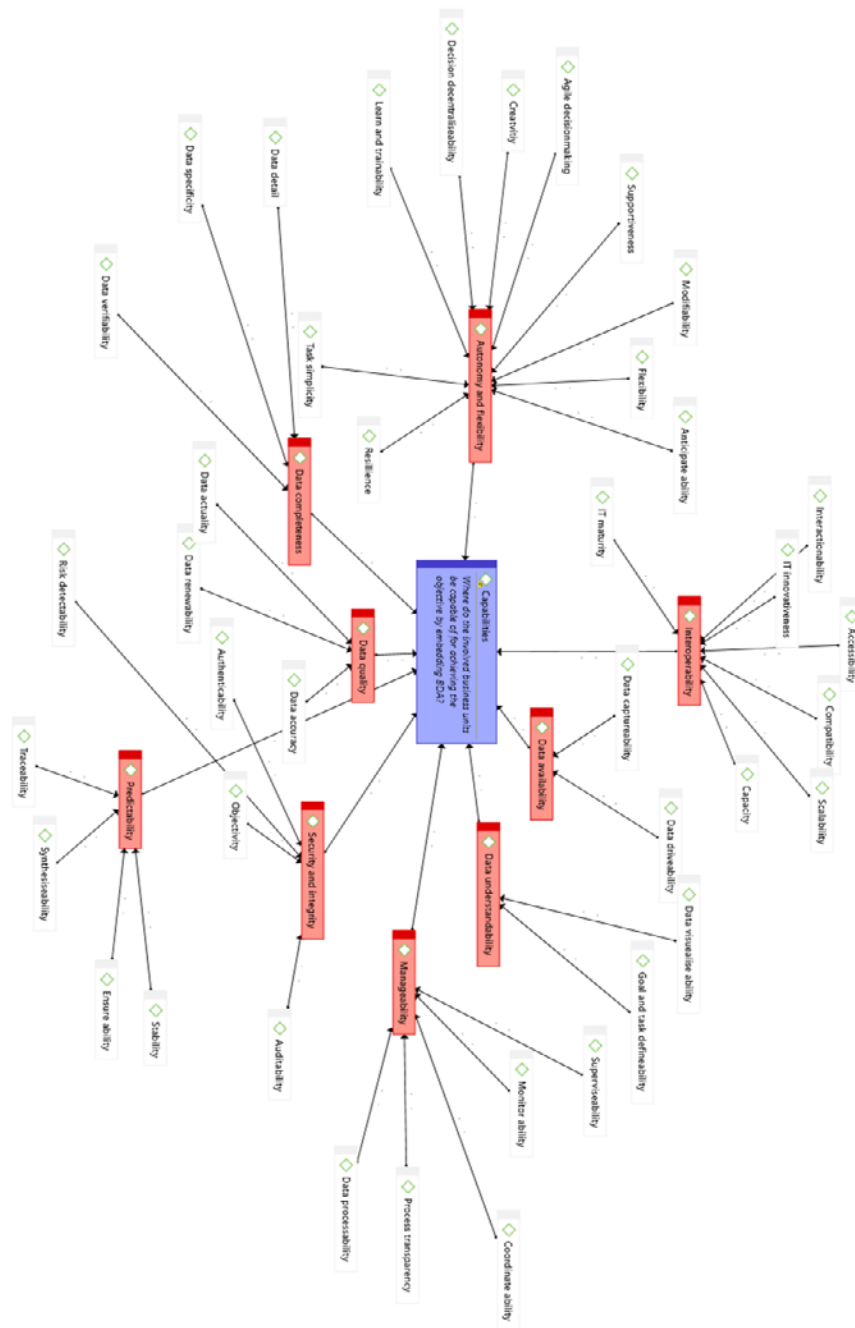


Figure 51: Thematic network of important capabilities according to literature (white) mapped with generic capabilities (red) in order to create the capability of BDA embedment (blue)

DESK STUDY TABLE OVERVIEW

This is an overview of the specific capabilities and how they are related to a generic capability, which are important when embedding BDA. These arguments were encountered in articles during the desk study.

Generic capability name	Capability description	Specific capability name	Reference
Data Availability	The ability to capture, store and access relevant transaction data in systems	Data captureability Data driveability Semantic driveability	(Chawda <i>et al.</i> , 2016; Chen <i>et al.</i> , 2012; Clavier <i>et al.</i> , 2012; Davenport <i>et al.</i> , 2013; Dutta <i>et al.</i> , 2015; Gupta <i>et al.</i> , 2016; Ross <i>et al.</i> , 2013; Tan <i>et al.</i> , 2016)
Data Completeness	The ability to involve complete data in analyses and create detailed insights	Data specificity Data verifiability Data detail	(Buhl <i>et al.</i> , 2013; Isik <i>et al.</i> , 2011; Kowalczyk <i>et al.</i> , 2014; Kwon <i>et al.</i> , 2014; Zack, 2007)
Data Understandability	The ability to interpret and visualise data, and derive conclusions from insights	Data visualise ability Goal and task definability	(Akter <i>et al.</i> , 2016; Chawda <i>et al.</i> , 2016; Clavier <i>et al.</i> , 2012; Davenport <i>et al.</i> , 2013; Dutta <i>et al.</i> , 2015; Elbashir <i>et al.</i> , 2008; Gupta <i>et al.</i> , 2016; Olszak, 2016)
Data Quality	The ability to create accurate, relevant and correct insights from analyses	Data renewability Data actuality Data accuracy	(Davenport <i>et al.</i> , 2013; Isik <i>et al.</i> , 2011; Janssen <i>et al.</i> , 2012; Kwon <i>et al.</i> , 2014; Loebbecke <i>et al.</i> , 2015; Pospiech <i>et al.</i> , 2012; Tan <i>et al.</i> , 2016)
Manageability	The ability to create, process and manage BDA activities	Supervise ability Coordinate ability Data processability Process transparency Inform ability Monitor ability Standardise ability	(Akter <i>et al.</i> , 2016; Buhl <i>et al.</i> , 2013; Davenport <i>et al.</i> , 2007; Dutta <i>et al.</i> , 2015; Gupta <i>et al.</i> , 2016; Keller <i>et al.</i> , 2012; Kwon <i>et al.</i> , 2014; McAfee <i>et al.</i> , 2012; Pospiech <i>et al.</i> , 2012; Watson <i>et al.</i> , 2007)
Autonomy and Flexibility	The ability to autonomously create insights and derive conclusions	Decision decentralise ability Learn and trainability Supportiveness Creativity Task simplicity Anticipate ability Decision-making agility Resilience Flexibility Modifiability	(Davenport <i>et al.</i> , 2007; Dutta <i>et al.</i> , 2015; Elbashir <i>et al.</i> , 2008; Gupta <i>et al.</i> , 2016; Kiron <i>et al.</i> , 2011; LaValle <i>et al.</i> , 2011; Olszak, 2016; Pettit, 2008; Tan <i>et al.</i> , 2016; Watson <i>et al.</i> , 2007)
Interoperability	The ability to integrate and interface data sources for creating insights	Insights accessibility Interactionability Capacity Compatibility Scalability IT innovative ability IT maturity	(Arnott <i>et al.</i> , 2008; A. Bharadwaj <i>et al.</i> , 2013; Chawda <i>et al.</i> , 2016; Davenport <i>et al.</i> , 2013; Gantz <i>et al.</i> , 2011; Gupta <i>et al.</i> , 2016; Isik <i>et al.</i> , 2013; Janssen <i>et al.</i> , 2012; Kowalczyk <i>et al.</i> , 2014; Pospiech <i>et al.</i> , 2012; Radaelli, 2000; Tan <i>et al.</i> , 2016; Wamba <i>et al.</i> , 2016)
Security and Integrity	The ability to secure data sources and processing information with integrity	Risk reducibility Auditability Risk detectability Authenticability Privacy Objectivity Data recoverability	(Akter <i>et al.</i> , 2016; Davenport <i>et al.</i> , 2013; Gantz <i>et al.</i> , 2011; Janssen <i>et al.</i> , 2012; Kowalczyk <i>et al.</i> , 2014; Loebbecke <i>et al.</i> , 2015; Tan <i>et al.</i> , 2016; Wamba <i>et al.</i> , 2016)
Predictability	The ability to predict insights based on standardised and consistent analyses	Ensure ability Synthesisability Traceability	(Arnott <i>et al.</i> , 2008; A. S. Bharadwaj, 2000; Davenport <i>et al.</i> , 2013; Dutta <i>et al.</i> , 2015; Elbashir <i>et al.</i> , 2008; Goodhue <i>et al.</i> , 1992; Isik <i>et al.</i> , 2011; Isik <i>et al.</i> , 2013; Janssen <i>et al.</i> ,

		Stability	2012; Kowalczyk et al., 2014; Kwon et al., 2014; LaValle et al., 2011; Zack, 2007
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Table 39: Overview of the capabilities extracted from literature articles

EXPLORATORY INTERVIEWS THEMATIC NETWORK

This is the thematic network of arguments related to the capabilities that are necessary for embedding BDA. These arguments were mentioned during the exploratory interviews.

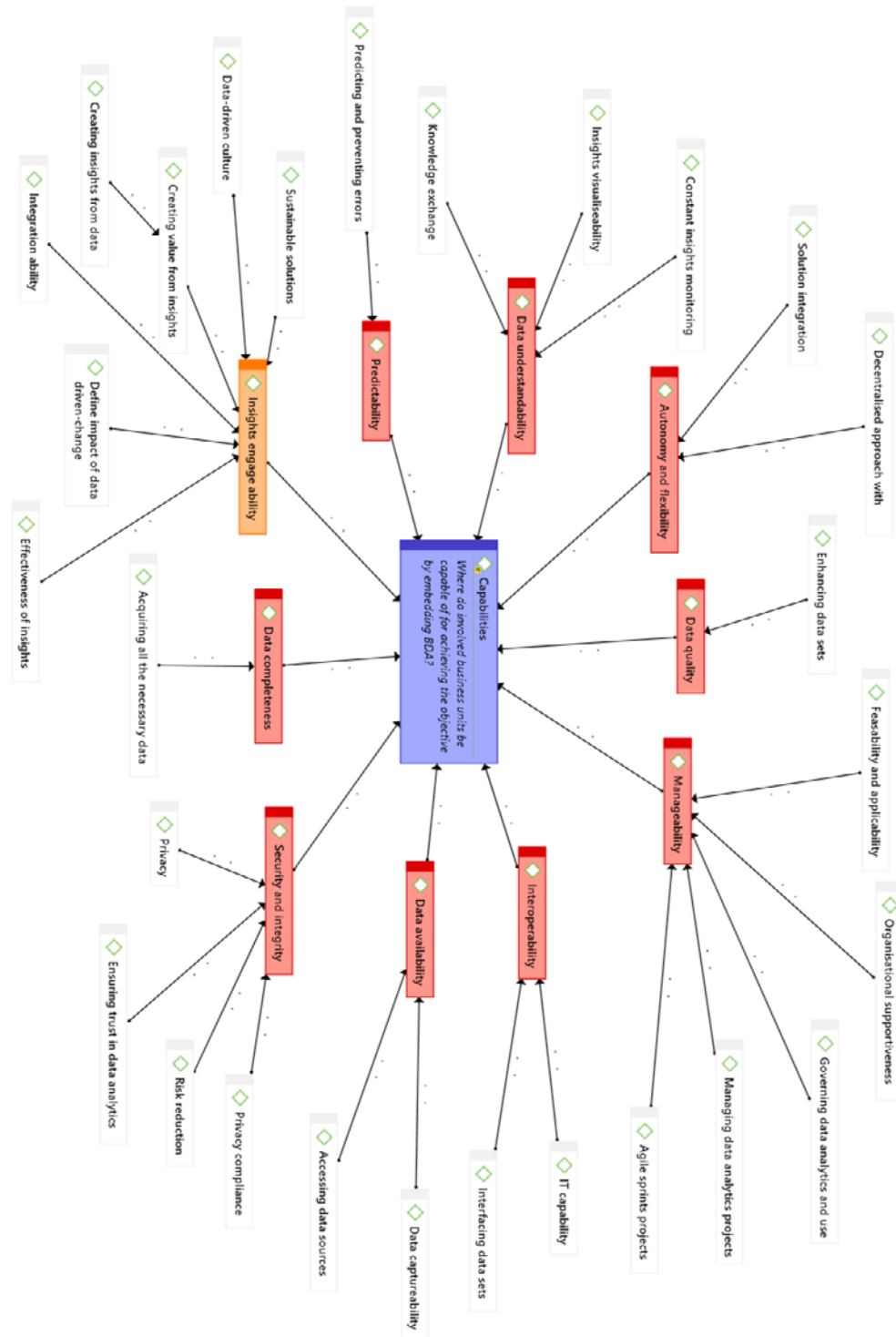


Figure 52: Thematic network of important capabilities encountered in exploratory interviews (white) mapped with generic capabilities (red) in order to create the capability of BDA embedment (blue)

EXPLORATORY INTERVIEWS TABLE OVERVIEW

The table presents an overview of the generic capabilities that are encountered in the exploratory interviews. Also the amount of times that there is referenced to is displayed along with the amount of in degree specific capabilities that are related to the generic capability.

Generic capability name	Amount of times referenced to	Amount of in degree specific capabilities	Capability description	Purpose
Data Availability	14	3	The ability to capture, store and access relevant transaction data in systems	Access to data sources and readily available insights.
Data Completeness	8	2	The ability to involve complete data in analyses and create detailed insights	Acquisition and provision of a complete overview and specific insights.
Data Understandability	9	4	The ability to interpret and visualise data, and derive conclusions from insights	Acquisition and provision of understandable and practical insights.
Data Quality	10	2	The ability to create accurate, relevant and correct insights from analyses	Acquisition and provision of high quality insights that are correct, relevant and up to date.
Manageability	20	6	The ability to create, process and manage BDA activities	Good coordination and planning of BDA related activities.
Autonomy and Flexibility	10	3	The ability to autonomously create insights and derive conclusions	Agile and autonomous decision-making that increase the flexibility and resilience of BDA related activities.
Interoperability	17	3	The ability to integrate and interface data sources for creating insights	Easy to combine data sets in analyses from multiple sources.
Security and Integrity	11	5	The ability to secure data sources and processing information with integrity	Compliance with the data protection acts and privacy regulations. Protection of sensitive firm information from being exposed.
Predictability	4	2	The ability to predict insights based on standardised and consistent analyses	Acquisition and provision of realistic predictions and insights.
Insights Engageability	13	7	The ability to engage insights in business decisions and operations	Intervention based on data insights to improve performance and realise objectives.

Table 40: Overview of the generic capabilities and the quantities that they are encountered in the interviewees' arguments

E. INTERRELATIONS BETWEEN CAPABILITIES

As is discussed in the research findings, three types of interrelations are distinguished: complementing, neutral and conflicting. However, the neutral interrelations are not displayed as this is outside the scope. Thus, this appendix is divided in two parts: the complementing interrelations and the conflicting interrelations.

CAPABILITIES THAT COMPLEMENT EACH OTHER

This is the thematic network of arguments related to the complementing interrelations between capabilities that can be encountered when embedding BDA. These arguments were mentioned during the exploratory interviews.

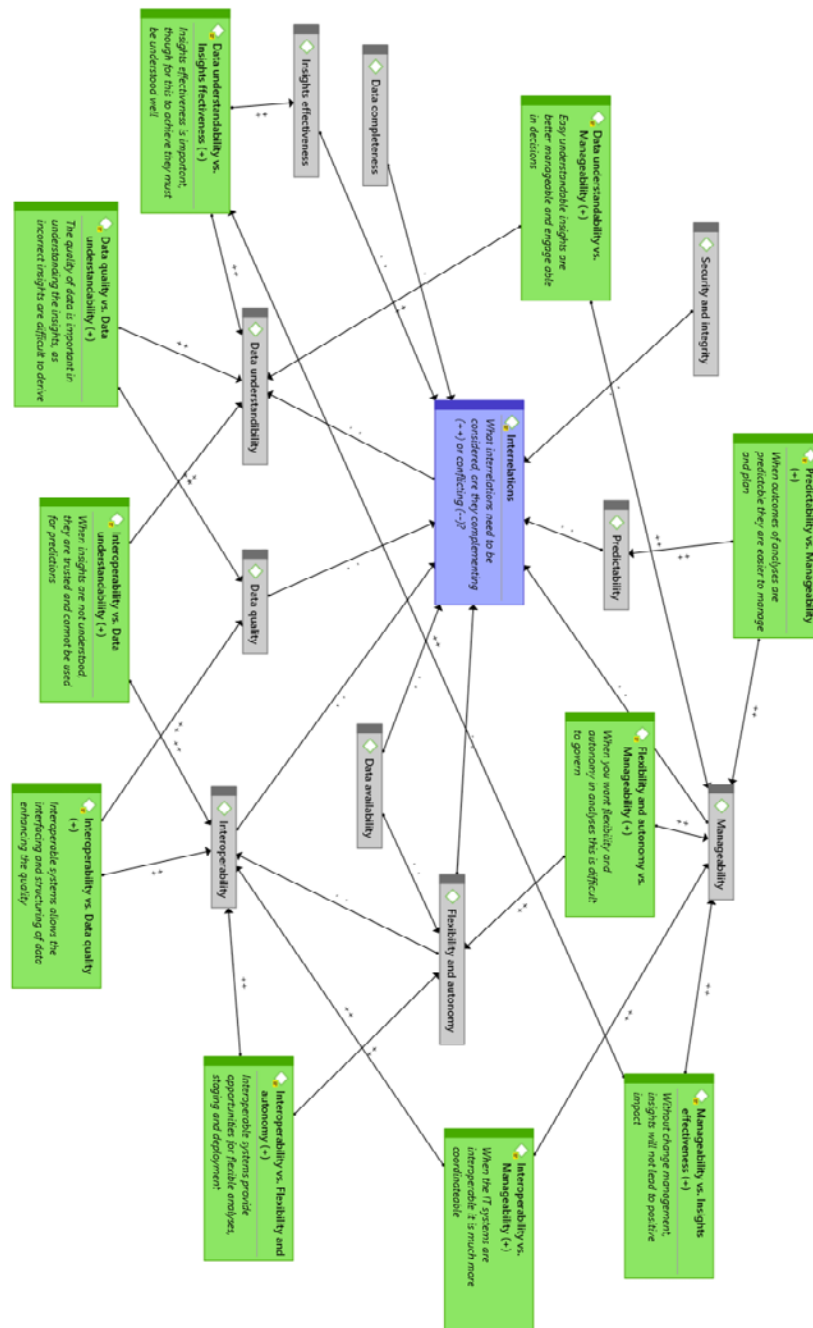


Figure 53: Thematic network of the capabilities (grey) and how they complement (green) each other

A table is presented with all the conflicting capabilities that are mentioned by the interviewees along with a quotation. However, in almost all cases, interviewees from multiple business units did mention them. However, the most interesting quotation is selected.

Capability 1	Capability 2	Example citation
Data Quality	Data Understandability	"The quality of data is important in understanding the insights, as incorrect insights are difficult to derive"
Data Understandability	Manageability	"Easy understandable insights are better manageable and engage able in decisions"
Interoperability	Data Quality	"Interoperable systems allows the interfacing and structuring of data enhancing the quality"
Predictability	Manageability	"When outcomes of analyses are predictable they are easier to manage and plan"
Interoperability	Manageability	"When the IT systems are interoperable it is much more coordinate able"
Interoperability	Autonomy and Flexibility	"Interoperable systems provide opportunities for flexible analyses, staging and deployment"
Autonomy and Flexibility	Manageability	"Supervision is easier when analysts can make autonomous decisions and can perform flexible analyses"
Interoperability	Data Understandability	"When data is standardised and has interoperable format, it is easier to understand and interpret"

Table 41: Overview of the complementing interrelations between capabilities

CAPABILITIES THAT CONFLICT WITH EACH OTHER

This is the thematic network of arguments related to the complementing interrelations between capabilities that can be encountered when embedding BDA. These arguments were mentioned during the exploratory interviews.

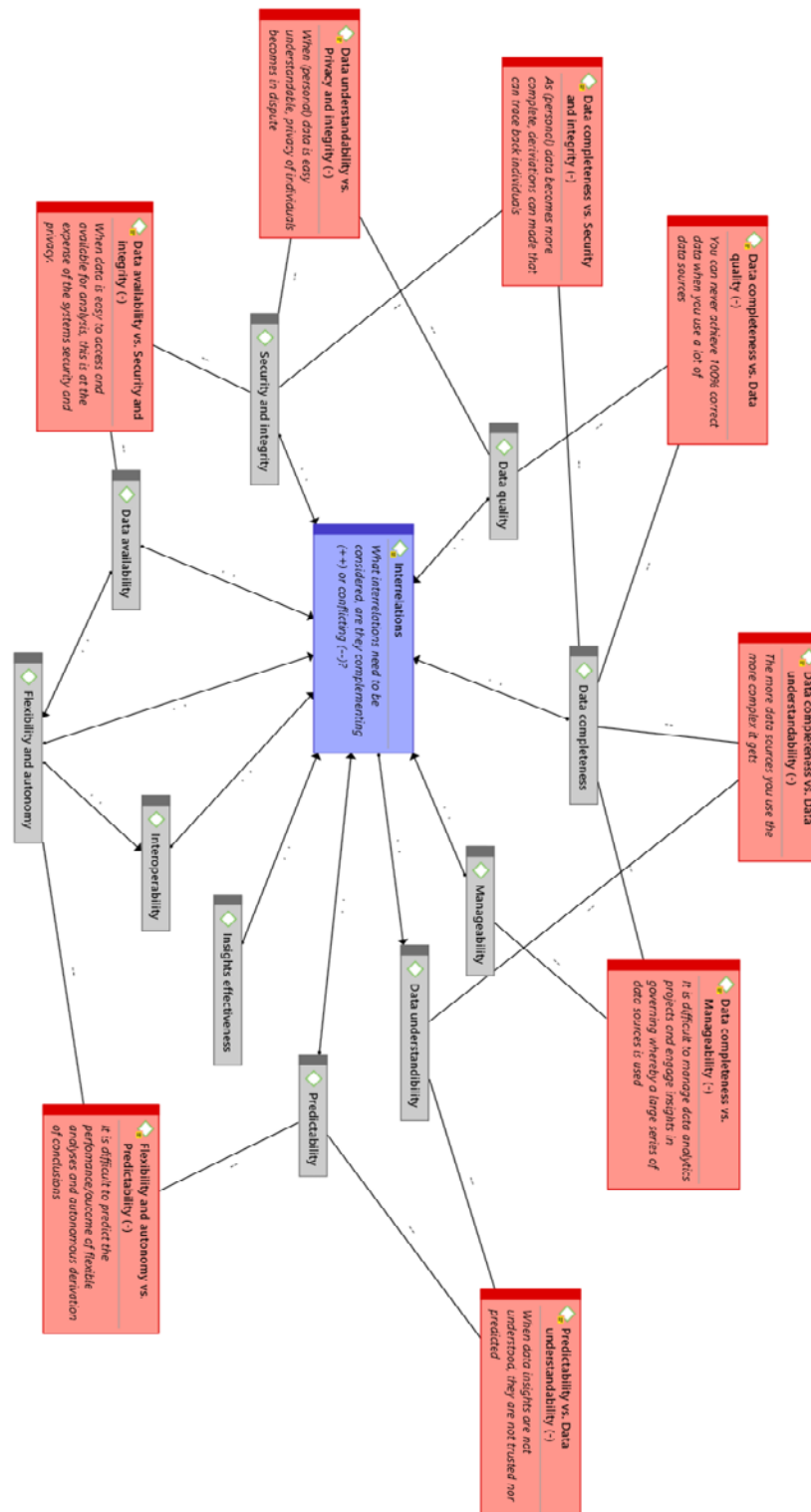


Figure 54: Thematic network of the capabilities (grey) and how they conflict (red) with each other

A table is presented with all the conflicting capabilities that are mentioned by the interviewees along with a quotation. However, in almost all cases, interviewees from multiple business units did mention them. However, the most interesting quotation is selected.

Capability 1	Capability 2	Example citation
Data Completeness	Data Understandability	"The more data sources you use, the more complex it gets"
Data Completeness	Data Quality	"You can never achieve 100% correct data when you use a lot of data sources"
Data Understandability	Security and Integrity	"When (personal) data is easy understandable, privacy of individuals becomes in dispute"
Data Completeness	Manageability	"It is difficult to manage data analytics projects and engage insights in governing, when a large series of data sources is used"
Data Completeness	Security and Integrity	"As (personal) data becomes more complete, derivations can be made that can trace back individuals"
Data Availability	Security and Integrity	"When data is easy to access and available for analysis, this is at the expense of the systems security and privacy"
Autonomy and Flexibility	Predictability	"It is difficult to predict the performance/outcome of flexible analyses and autonomous derivation of conclusions"
Predictability	Data Understandability	"When insights are not understood, they are trusted and cannot be used for predictions"

Table 42: Overview of the conflicting interrelations between capabilities

F. TRADE-OFFS BETWEEN CONFLICTING CAPABILITIES

As is mentioned in previous appendix, for each conflicting interrelation between capabilities, a trade-off needs to be made. These are presented in the table, based on the exploratory interviews. Notice, that the outcome of a trade-off depends on the context and objective of a case.

Direction 1	Direction 2
Data Completeness - High quantity, complete and detailed data that allow specific insights. - Data insights difficult to understand or visualise. Deriving conclusions take longer time due to the high quantity and variety.	Data Understandability - Easy understandable data insights, easy to visualise and derive conclusions. - Limited quantity and less complete and detailed data whereby insights are less specific but better to understand.
Data Completeness - High quantity, complete and detailed data that allow specific insights. - Lower quality and less accurate data as Data Quality decreases when more sources are used.	Data Quality - High quality, accurate and up to date data with minimal incorrect data fields. - Limited quantity and less complete and detailed data whereby insights are less specific.
Data Understandability - Easy understandable data insights, easy to visualise and derive conclusions. - Non-anonymised data with lower security measures.	Security and privacy - Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy. - Difficult understanding of data insights due to anonymization and security measures.
Data Completeness - High quantity, complete and detailed data that allow specific insights - Due to large quantity and complete data, the projects become bigger and less manageable.	Manageability - Easy to process and monitor the data processes and engage insights in decisions and changes. - Lower quantities and less specific data making the project more manageable.

Data Completeness - High quantity, complete and detailed data that allow specific insights. - Less secured and anonymised data as complete and multi-dimensional view is created of specific entities.	Security and privacy - Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy. - Less complete data as personal entities are omitted whereby data is secured and privacy is complied with.
Data Availability - Easy capturing of data and access to systems and platforms. - Poor security and privacy as data is easily captured, collected and accessed.	Security and privacy - Highly secured data with strong authentication and audit controls. Anonymised data for defend privacy. - Less available data due to stricter policies making systems less accessible.
Autonomy and Flexibility - Agile and autonomous deriving of conclusions and making decisions for increasing resilience and flexibility. - Lower predictability due to a uncertain outcome of the flexible analyses on decentralised level.	Predictability - Standardised analyses and information flows to predict outcomes and performance. - Less Autonomy and Flexibility due to strict and standardised analyses.
Predictability - Standardised analyses and information flows to predict outcomes and performance. - Due to the high predictability, the insights become less recognisable and is trusted less.	Data Understandability - Easy understandable data insights, easy to visualise and derive conclusions. - Understandable insights that are recognised in context but less predictions are made.

Table 43: Trade-offs that need to be made when embedding BDA in business operations

Capability 1 name	Capability 1 description	Capability 2 name	Capability 2 description
Data Completeness	The ability to involve complete data in analyses and create detailed insights	Data Understandability	The ability to interpret and visualise data, and derive conclusions from insights
Data Completeness	The ability to involve complete data in analyses and create detailed insights	Data Quality	The ability to create accurate, relevant and correct insights from analyses
Data Understandability	The ability to interpret and visualise data, and derive conclusions from insights	Security and Integrity	The ability to secure data sources and processing information with integrity
Data Completeness	The ability to involve complete data in analyses and create detailed insights	Manageability	The ability to create, process and manage BDA activities
Data Completeness	The ability to involve complete data in analyses and create detailed insights	Security and Integrity	The ability to secure data sources and processing information with integrity
Data Availability	The ability to capture, store and access relevant transaction data in systems	Security and Integrity	The ability to secure data sources and processing information with integrity
Autonomy and Flexibility	The ability to autonomously create insights and derive specific conclusions	Predictability	The ability to predict insights based on standardised and consistent analyses
Predictability	The ability to predict insights based on standardised and consistent analyses	Data Understandability	The ability to interpret and visualise data, and derive conclusions from insights

Table 44: Trade-offs between conflicting capabilities encountered in the exploratory interviews

V. APPENDIX: DEFINITION OF REQUIREMENTS

In this appendix, the requirements are presented that are a translation of the research findings as presented in Appendix IV.

A. WHAT BUSINESS UNITS NEED TO BE INVOLVED?

Business unit	Requirement
Executive Management	An executive manager should be engaged on the project who has understanding of both the business process and BDA.
Operational Management	One or more operational managers should be involved who ensure that the business interests are represented in the project framework.
BDA Expert Team	Several BDA experts should be involved so that their interests are represented in the project framework.

Table 45: The three business units that need to be involved in the project of embedding BDA

B. WHAT RESOURCES ARE NECESSARY?

Based on the amount of times the resources are mentioned during the exploratory interviews, the priority of the resource mentioned can be established.

Resource
Analytic skills
Business process knowledge
Data governance policy
Data staging skills
IT architecture
IT knowledge
Strategic management skills
Trust in data
Strategy for engaging insights
Good data
Project contracts
Analytical tools
ERP system
Security policy
Standardised analyses
Documentation of knowledge
Time
Data mapping interface
Tailored analyses
Data mining techniques
Collaboration with universities
Knowledge base
Business use case
Compliance policy
Dashboard
Data warehouse
Documentation policy
Visualisation tools

Table 46: Overview of the resources that need to be planned when defining strategy for BDA embedment

C. WHAT CAPABILITIES SHOULD BE DEVELOPED?

Capability	Requirement
Data Availability	The ability to capture, store and access relevant transaction data in systems
Data Completeness	The ability to involve complete data in analyses and create detailed insights
Data Understandability	The ability to interpret and visualise data, and derive conclusions from insights
Data Quality	The ability to create accurate, relevant and correct insights from analyses
Manageability	The ability to create, process and manage BDA activities
Autonomy and Flexibility	The ability to autonomously create insights and derive specific conclusions
Interoperability	The ability to integrate and interface data sources for creating insights
Security and Integrity	The ability to secure data sources and processing information with integrity
Predictability	The ability to predict insights based on standardised and consistent analyses
Insights Engageability	The ability to engage insights in business decisions and operations

Table 47: Overview of the capabilities that need to be defined and considered when defining strategy for BDA embedment

D. WHAT INTERRELATIONS ARE THERE BETWEEN CAPABILITIES?

INTERRELATIONS THAT ARE ENCOUNTERED

In the table below, the interrelations that are encountered are presented. However, to achieve a more complete overview of the interrelations, all a cross-evaluation matrix should be walked through. This matrix structures the process of determining interrelations, and is presented below.

Capability 1	Capability 2	Interrelation
Data Completeness	Data Understandability	Conflicting
Data Completeness	Data Quality	Conflicting
Data Understandability	Security and Integrity	Conflicting
Data Completeness	Manageability	Conflicting
Data Completeness	Security and Integrity	Conflicting
Data Availability	Security and Integrity	Conflicting
Autonomy and Flexibility	Predictability	Conflicting
Predictability	Data Understandability	Conflicting
Data Quality	Data Understandability	Complementing
Data Understandability	Manageability	Complementing
Interoperability	Data Quality	Complementing
Predictability	Manageability	Complementing
Interoperable	Manageability	Complementing
Interoperability	Autonomy and Flexibility	Complementing
Autonomy and Flexibility	Manageability	Complementing
Interoperability	Data Understandability	Complementing

Table 48: Overview of the interrelations that need to be evaluated when defining strategy for embedding BDA in business operations

	Data Availability	Data Completeness	Data Understandability	Data Quality	Manageability	Autonomy and Flexibility	Interoperability	Security and Integrity	Predictability	Insights Engageability
Data Availability								✗		
Data Completeness			✗	✗	✗			✗		
Data Understandability				✓	✓		✓	✗	✗	
Data Quality							✓			
Manageability						✓	✓		✓	
Autonomy and Flexibility							✓		✗	
Interoperability										
Security and Integrity										
Predictability										
Insights Engageability										

Table 49: Not all interrelations between capabilities are discussed whereby not all trade-offs are determined

E. WHAT TRADE-OFFS NEED TO BE CONSIDERED (WHEN APPLIED TO A CASE STUDY)?

Based on the exploratory interviews, the following eight trade-offs are detected. However, when the cross-evaluation matrix of Table 43 is walked through, more trade-offs can be encountered which provides a more complete overview. However, for the case studies in this thesis, only the following eight are used.

Direction 1	Direction 2
Data Completeness	Data Understandability
Data Completeness	Data Quality
Data Understandability	Security and Integrity
Data Completeness	Manageability
Data Completeness	Security and Integrity
Data Availability	Security and Integrity
Autonomy and Flexibility	Predictability
Predictability	Data Understandability

Table 50: Trade-offs that need to be considered by the framework

VI. APPENDIX: FRAMEWORK DESIGN

A. FILLED-IN MORPHOLOGICAL CHART

Below the morphological chart with the filled in design space is presented. How this was done is step by step explained in the Design section.

Requirement	R1. Business unit	R2. Objective	R3. Resources	R4. Capabilities	R5. Interrelations	R6. Trade-offs
I. Key question	What business units need to be involved for embedding BDA?	What do we want to achieve by embedding BDA? Is this in line for the different business units?	What resource do we need for embedding BDA in our business operations?	Where do we have to be capable of in order to achieve the objective? Does this differ per business unit?	Do capabilities have a specific impact on other capabilities? Is this positive, neutral or negative?	How much important do we find specific capabilities relative to each other capabilities?
II. Function	- Assessing interests of actors - Considering multi-actor perspective - Preventing intra-organisational conflicts	- Substantiating objective - Deriving objective from business unit's interests	- Determining what resources are required - Planning of resource utilisation	- Defining what capabilities work towards satisfaction of objective - Defining how resources are managed	Assessing consistency of strategic capabilities	Excluding strategic vulnerabilities of conflicts by making trade-offs
III. Theoretical lens	Organisational configurations theory (Mintzberg, 1979)	Competitive advantage (Porter, 1989)	Resource Based View (Barney, 1991)	Resource Based View (Barney, 1991)	Pairwise comparison (Dym et al., 1994)	Analytic Hierarchy Process (Saaty, 1987)
IV. Key actions	1. Determine which actors need to be involved and assess interests of their business units	2. Clarify what must be achieved by embedding BDA (derive from interests of business units)	3. Determine what resources need to be planned and used and why they are needed	4. Define where the organisation should be capable for reaching the objective and how resources are used	5. Assess interrelation of each pair of capabilities	6. Determine for each pair of conflicting capabilities which one is more important
V. Output	Involved business units with their interests	Objectives of the business units based on their interests	Planned and determined resources required for execution	Strategic capabilities that play key role for BDA embedment	Interrelations between capabilities which can be complementing, neutral or conflicting	Institutionalised trade-offs with their difficulty.

Table 51: Morphological chart with the filled Design Space

VII. APPENDIX: APPLICATION OF FRAMEWORK TO CASE STUDIES

A. RESOURCES CASE STUDY 1

The resources that are necessary for embedding BDA in case study 1 are displayed in the table.

Resource type	Specific resources	Purpose
Physical	Transaction data of the four methods of completing timesheets	Data Completeness, Data Availability
	Data sets of the users (employees)	
	Data interface	
	Standardised analyses	
	BDA tool for staging, executing and visualising	
Human	Knowledge about timesheets processes	
	Knowledge about local ERP systems	
	BDA staging, executing and visualising skills	
Organisational	Access to Australian ERP systems	
	Support from Australian management	
	Privacy regulation	
	Data governance	
	Change management plan	
	Timesheet process (re)design	

Table 52: Resources to establish

B. TRADE-OFFS CASE STUDY 1

The perceived trade-offs of the second case study are displayed in the table below.

Capability 1	Capability 2	Executive Management	Operational Management	BDA Expert Team	Conclusion
Data Completeness	Data Understandability	Easy (1). Only the audit team has to understand the data. They are experts and can deal with Data Completeness and complexity better. Insights are not used by other business units (yet).	Very easy (2). Too large amounts of data become complex. When the amount of available FTEs is limited, the project should start small.	Difficult (2). Although both are important, in this case, it is more important to create a particular insight that is understandable instead of making it as complete as possible.	Under-perceived Inconsistent
Data Completeness	Data Quality	Very easy (1). Acquiring detailed data about the timesheets is more important than its quality. Quality can be compensated when the set is complete.	Critical (?). For optimisation of the timesheet process based on insights, the quality needs to be high. Though, the completeness is of same importance.	Difficult (2). This objective is very specific, therefore, the ability to create high quality insights is important. The ability to create complete and detailed insights is less important, because of the objective's level of specificity.	Under-perceived Inconsistent
Data Understandability	Security and Integrity	Very easy (2). As the firm possess HR data related to individuals important is to pursue Security and Integrity. By anonymization of data and insights the objective can also be achieved.	Very difficult (1). With a low ability to understand the data and derive conclusions the objective becomes at risk. Security and Integrity for an employment firm is also essential.	Difficult (2). Security and Integrity is a capability that should be possessed at all times, though it should hamper the ability to understand the insights minimally.	Under-perceived Inconsistent
Data Completeness	Manageability	Critical (?). The ability to involve complete data is important to create detailed insights. Though, the activities should not be too complex as manageability is of same importance.	Very difficult (1). The objective is audit-related, thus complete information is of high importance. On the other side, there are limited FTEs wherein the objective must be done.	Difficult (2). Even though the ability to achieve completeness should be high, the activities should be manageable.	Recognised Inconsistent
Data Completeness	Security and Integrity	Critical (?). The firm possesses HR related and sensitive data whereby Security and Integrity are prominent capabilities. For this objective, however, it is important that the internal audit have all the data what they need to achieve the objective.	Easy (2). Security and Integrity need to be pursued, as anonymization also allows the achieving of the objective.	Easy (2). The analytics should comply with the Security and Integrity regulations. This is a pre-condition for Data Completeness of the objective.	Recognised Consistent
Data Availability	Security and Integrity	Easy (2). The availability of timesheet data should be bounded by the regulations of Security and Integrity.	Easy (2). The availability of the timesheet data should be within the possibilities that are allowed by the Security and Integrity regulations.	Difficult (2). Although Security and Integrity is an important capability, availability of data is essential with respect to the objective.	Under-perceived Consistent
Autonomy and Flexibility	Predictability	Easy (2). Consistency in analyses and insights that allow predictions is more important as the timesheet process optimisation is partially based on predictions (see objective).	Difficult (2). Analyses need to be consistent to achieve predictive insights. They are modules stacked on each other whereby Autonomy and Flexibility should be limited.	Difficult (1). Autonomy and Flexibility is more important to have in order to conduct constructive and useful analytics.	Under-perceived Inconsistent
Predictability	Data Understandability	Easy (1). Predictions become complex when insights are difficult to recognise (with gut feeling), though they are essential for realising optimisation of the timesheet process.	Very difficult (1). Even though predictions are more difficult to recognise and trust, regarding this objective they are necessary. The internal audit team is capable of dealing with them.	Difficult (2). The ability to understand the insights is required for trusting the predictions. When these are not understood, they likely not engaged in decisions.	Under-perceived Inconsistent

Table 53: Perceived trade-offs of each business unit of case study 1 (employment agency)

C. RESOURCES CASE STUDY 2

The resources that are necessary for embedding BDA in case study 2 are displayed in the table.

Resource type	Specific resources	Purpose
Physical	Transaction data of all the production lines	Data about the temperature, locations, products specifications
	Data sets of involved farmers	Locations, product specifications and quantities, costs per farmer
	Data sets of the transporters	Product quantities, distance, costs per transporter
	Data interface	Mapping interface between the different data sets
	Standardised analyses	Predefined analyses that can be ran continuously
	BDA tool for staging, executing and visualising	Engine of the BDA activities
Human	Knowledge about production lines	Knowledge and expertise on the production lines (supply chain management)
	Knowledge about local ERP systems	Knowledge and expertise on the system landscape
	BDA staging, executing and visualising skills	Skills to use the data and adapt to insights
Organisational	Access to all ERP systems	Authorisation must be granted to required data
	Support from rayon and production line managers	Collaboration from operational management to realise the change
	Farmers privacy	Privacy to protect farmers
	Data governance	Data warehouse/lake
	Quality standards	Standards of the quality of the dairy products
	Change management plan	Engage insights to perform actions
	Production line (re)design	Improved design of the loss-making lines

Table 54: Resources to establish for the dairy producer

D. TRADE-OFFS CASE STUDY 2

The perceived trade-offs of the second case study are displayed in the table below.

Capability 1	Capability 2	Executive Management	Operational Management	BDA Expert Team	Conclusion
Data Completeness	Data Understandability	Easy (2). It is more important that the insights to a basic level are understood instead of detailed insights that are not understood.	Easy (2). When the insights are not understood it is not possible to use them for improving the production lines.	Easy (1). There are many production lines. When it is investigated which ones are underperforming, a complete as possible data input is required.	Recognised Inconsistent
Data Completeness	Data Quality	Easy (2). When decisions are made based on data insights, it is important that its quality can be trusted.	Difficult (1). To achieve insights that cover all the production lines, it is important to be able to involve much and complete data.	Difficult (2). It is more important to have limited data with high quality than plenty of data where you cannot rely upon.	Under-perceived Inconsistent
Data Understandability	Security and Integrity	Very easy (1). Although the ingredients are secret, the production lines regard no privacy sensitive data. Therefore, it is more useful to ensure that it is understood.	Very difficult (2). The composition and exact origin of dairy products should be kept secret. Filtering out these data fields allows that.	Difficult (1). As these types of products are not privacy sensitive, no anonymization should be required for BDA analyses.	Under-perceived Inconsistent
Data Completeness	Manageability	Easy (2). Important is that the BDA activities remain manageable, even though it hampers the ability to include large amounts and complete data.	Easy (1). With the current technology ability to pursue completeness should not have to be a problem for the ability to manage.	Very difficult (1). Manageability is always an important aspect, although in this case the ability to pursue completeness is crucial to create insights of the performance of the production line.	Under-perceived Inconsistent
Data Completeness	Security and Integrity	Very easy (1). The security and privacy capability does not regard to the production lines, as the secret elements do not need to be included in performance numbers.	Very difficult (2). The ability to ensure Security and Integrity of the (farmer and product) data can be maintained by leaving out data fields.	Very difficult (1). It is more important to be able to involve high amount of data, and then anonymise it, instead of leaving out fields.	Under-perceived Inconsistent
Data Availability	Security and Integrity	Very easy (1). The ability to avail data for BDA should not be hampered by the Security and Integrity capability.	Very difficult (2). Of high importance is that the production line transaction data is secured, though in the meantime is collected and made available for analyses.	Difficult (2). It is not possible to both comply with the bounding Security and Integrity rules and also collect and avail data for BDA.	Under-perceived Inconsistent
Autonomy and Flexibility	Predictability	Difficult (2). Autonomy and Flexibility in BDA activities should be limited in order to create consistency and make predictions.	Difficult (2). When Autonomy and Flexibility are controlled, predictions can be made.	Difficult (1). Solutions are difficult to create when there is no Autonomy and Flexibility to tailor them to solve a problem.	Recognised Inconsistent
Predictability	Data Understandability	Difficult (2). When predictions are made and are not recognised they cannot be used in to assess performance of the production lines.	Difficult (2). To assess the performance of the production lines it is more important to be able to understand the underlying reasons so that actions are related to the insights.	Difficult (2). The ability to understand the insights and engage them is more important than making predictions.	Recognised Consistent

Table 55: Perceived trade-offs of each business unit of case study 2 (dairy producer)

Scientific article

Scientific article of master's thesis of Systems Engineering Policy Analysis and Management
University of Technology Delft in collaboration with KPMG Netherlands IT Advisory Risk Consulting.

PERCEIVING TRADE-OFFS TO SUCCESSFULLY EMBED BIG DATA ANALYTICS IN BUSINESS OPERATIONS

A CONTRIBUTION OF THE MULTI-ACTOR, MULTI-CAPABILITY AND MULTI-TRADE-OFF PERSPECTIVE TO CURRENT LITERATURE

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ABSTRACT

Due to the popularity and complexity of Big Data Analytics (BDA), numerous articles have been published about embedding BDA in business operations. What they have in common is that they use the Resource Based View to assess where a firm needs to be capable of to achieve this. However, in practice, capabilities for BDA can conflict with each other. This means that when one capability is developed, it hampers another capability. When both capabilities are developed, unforeseen problems can emerge in later stadiums of the project. Solving these problems is expensive and intensive. Questions emerge on how to perceive these trade-offs and how to consider them. The Resource Based View is incomplete on this part. Therefore, through exploratory research ten generic capabilities are defined that are important for embedding BDA. Conflicting interrelations between them are assessed whereby eight trade-offs are encountered. This perception of these trade-offs is assessed for different business units from the organisation for two case studies. In both case studies the Executive Management tends to underestimate and inconsistently perceive the majority of the trade-offs with respect to the other business units. Therefore, this study emphasises the importance of involving three perspectives when defining strategy for embedding BDA whereby unforeseen problems are aimed to be avoided.

Key-words: *Big Data Analytics, Resources, Innovation Adoption, Business Intelligence, Capabilities, Trade-offs, Resource Based View*

I. INTRODUCTION

Big Data Analytics (BDA), the umbrella term of Big Data and Data Analytics, has increased extreme popularity of the last years and is expecting to become more important in firms (Kowalczyk *et al.*, 2014). Through creation of insights it drives organisational innovation, competition and productivity they aim to increase a firm's performance (Loebbecke *et al.*, 2015). According to a survey among firms of the Fortune 1000, more than 90% of the firms have decided to invest in BDA in the upcoming years (Kiron *et al.*, 2014).

Nonetheless, many BDA projects have not reached their objectives, due to the technological, human and organisational complexities (Gupta *et al.*, 2016). A reason for this is that firms are unable to embed BDA in their business operations (LaValle *et al.*, 2011). The Resource Based View is a common-used theory in literature that aims on defining where a firm should be capable by using BDA resources. When capabilities are known, it is clear to a firm how resources need to be used in order to reach a certain objective.

However, literature regarding the development of capabilities with BDA resources has its shortcomings, as it does not take into account that capabilities can have a negative impact on each other. Thereby, it implicitly assumes that capabilities can always be combined. In other domains, including product development and supply-chain management, literature asserts that

capabilities can hamper other capabilities in achieving an objective (Leonard-Barton, 1992; Pettit, 2008). This implicates that a firm needs to consider a trade-off between these conflicting interrelated capabilities whereby their desired and undesired effects are taken into account. When these trade-offs are considered erroneously, unforeseen problems can emerge in later stadiums of the project. Solving these 'late problems' is expensive and intensive with as a consequence that objectives become unfeasible (Nicholas *et al.*, 2008).

The following question emerges: *what trade-offs need to be considered when embedding BDA and how they are currently perceived by firms?*

Through exploratory research, it is investigated what trade-offs and how they are perceived. When they are perceived adequately, they can be considered in an early stage. This prevents unforeseen problems in later stages of the process of embedding BDA. This is done for two case studies including an employment agency and a dairy producer that want to embed BDA in their business operations in order to achieve their objective. In this way, three additional perspectives are contributed to the current Resource Based View-related literature: multi-capability, multi-trade-off and multi-actor perspective.

This paper is structured as follows. Firstly, the concept of the Resource Based View is discussed in the context of BDA. This is

followed by an explanation of trade-offs between capabilities and the different perspectives that business units have on them. Secondly, two case studies regarding the employment agency and dairy producer are introduced. Thirdly, eight perceived trade-offs and the implications of inadequately perceiving them are discussed for the two case studies. This paper concludes with a discussion of the contributions, limitations and an agenda for future research.

II. THEORETICAL BACKGROUND

EMBEDDING BDA FROM THE RESOURCE BASED VIEW

The Resource Based View is a commonly used theoretical lens that defines where a firm should be capable of in order to improve performance of their business operations (Barney, 1991). These, so called, capabilities are created when physical, human and organisational resources are managed adequately.

The difference between resources and capabilities can be explained by the way of describing them. Whereas resources are occasionally passively described and regard to sources or objects that can be utilised (e.g. ERP system, authorisation, data lake, analytical skills, knowledge and data staging software), capabilities are actively described and regard to abilities of firms to perform actions (e.g. the ability to capture, store and access relevant transaction data in systems). Hence, when resources are combined and managed adequately, capabilities are created that allow firms to achieve a specific objective (e.g. resources such as ERP system, authorisation, data lake, analytical skills, knowledge and data staging software create the capability that of a firm 'to be able to capture, store and access relevant transaction data in systems').

According to the Resource Based View, a firm should develop a set of capabilities in order to embed BDA in their business operations. Embedded BDA means that BDA resources are managed adequately and frequently deployed (e.g. where employees know what to do and what resources to use) whereby business units are capable of performing actions (capabilities) to achieve specific objectives. This enables firms to get the most out of their investments in BDA resources.

MULTI-CAPABILITY PERSPECTIVE

Whereas the Resource Based View assumes that capabilities solely contribute towards achieving the objective, they can also entail negative side-effects that hamper other capabilities. Although this is not discussed in the context of embedding BDA, in other domains these are discussed in literature. In product development, Leonard-Barton (1992) speaks about the 'dysfunctional flipside' of capabilities, that has a negative effect on other parts of the project. When these are not considered an objective can be come unfeasible. In supply-chain management, Pettit et al. (2008) mention that each capability can entail several vulnerabilities that hamper the firm to achieve its objective. Neither Leonard-Barton nor Pettit et al. discuss what these

conflicting interrelations between capabilities entail in the domain of BDA.

On a high level, capabilities are more abstract and do not necessarily conflict. However, this is different on a low level because decisions are then more concrete. When capabilities are conflicting with each other, this means that they hamper each other whereby they cause problems during later stages of the project of embedding BDA. These 'late problems' are more expensive and intensive to solve due to the investments that are already made (Nicholas et al., 2008). Therefore, a trade-off needs to be considered between capabilities whereby their desired and undesired effects are taken into account (Pettit, 2008).

MULTI-TRADE-OFF PERSPECTIVE

Trade-offs are inevitable and therefore need to be considered (Steenhuisen, 2009). Notice that capabilities in a trade-off are conflicting, so only one capability can be chosen. Investing in the resources of both capabilities would not make sense when the trade-off is perceived. Therefore, it is important to perceive the trade-offs beforehand so that they can be considered timely. In this way there are no investments made in resources for capabilities that turn out to be redundant or unfeasible in a later stage.

However, it cannot be claimed that trade-offs should be considered identical for every BDA embedding project. On the contrary, this depends on the context of the case (Lunenburg, 2012). Based on the organisation, the objective, the environment and business unit, trade-offs can be perceived differently. For this reason, the phenomenon of a trade-off is complex, as there is no generic solution applicable on every case. In order to consider a trade-off, sacrifices have to be made in order to achieve the desired effects which can have impact on different parts of the organisation (O'Brien, 2015).

MULTI-ACTOR PERSPECTIVE

An organisation can be divided in several business units that each have different expertise, responsibility and interests (Mintzberg, 1979). Three business units can be distinguished when implementing a technological artefact in an organisation (Steenhuisen, 2009). In the context of embedding BDA, these business units are as follows.

1. Executive Management, is the highest in hierarchy, which makes strategic decisions, imposes policies and regulations. It aims to pursue the firm's strategy (e.g. performance, competitive advantage) by adopting innovative technologies, which in this case is BDA.
2. Operational Management, represents the middle-line management, which is responsible for business processes and that use BDA insights to improve their performance.
3. BDA Expert Team, is part of the technical staff, which collects and stages data, performs analyses, creates insights and provides them to business units that need them.

As these business units have different expertise, responsibility and interests the objectives that they have can differ (Porter, 1989). This also means that they can perceive the trade-offs differently. For example, a trade-off encountered can be differently perceived by BDA Expert Team than by the Executive Managers. In order to get a more complete perception of these trade-offs, multiple business units are involved.

III. RESEARCH APPROACH

After the three different perspectives are discussed, the question emerges whether or not this also applies to the process of embedding BDA in business operations. The research objective of this study is to assess: 1. What trade-offs need to be considered? 2. How are trade-offs perceived? This is achieved by conducting exploratory research and two case studies.

Regarding the multi-capability perspective, the first part aims on defining ten generic capabilities, that are important for embedding BDA. Also it is assessed whether conflicting interrelations occur between them. For each conflict between capabilities, a trade-offs needs to be considered. Information for this part is acquired through literature review and exploratory interviews. The interviewees are asked what capabilities are important for a firm to possess in order to successfully embed BDA and which capabilities hamper other capabilities. A list of ten generic capabilities is aimed for together with a list of the most prominent conflicts between capabilities.

Regarding the multi-trade-off perspective, the second part aims on assessing how trade-off are perceived in a specific case context. Two case studies are performed by conducting evaluation interviews. Here, the interviewees are asked to prioritise the two capabilities within a trade-off (that are conflicting with each other). Also it is asked what the difficulty is of each trade-off. In order to assess the difficulty of the trade-offs, they are classified in five levels: very easy, easy, difficult, very difficult and critical. This is determined by the perceived relative importance of the two capabilities. When a business unit perceives both capabilities as same important it is a 'critical' trade-off (extremely difficult to choose what capability is more important). When one capability is prioritised much more important than the other, the trade-off is perceived as 'easy'. A list of the perception on the trade-offs is aimed for, in terms of difficulty and relative priority of the capabilities. This is done for each business unit and for two cases, these are introduced below.

Regarding the multi-actor perspective, the second research part is conducted by interviewing people from different business units. The reason for this is to acquire a multilateral perspective which provides insights in how the decision makers (in this study: Executive Management) perceive the difficulty and the direction (capability A or capability B) of a trade-off. Based on the difference in perceptions that business units have on a trade-off, several case examples are discussed.

CASE STUDY 1: AN EMPLOYMENT AGENCY

The employment agency is situated in the Netherlands and operates in countries all over the world. Its aim is to start using BDA to optimise processes. Hereby, costs need to be reduced, quality of information processes has to be kept high and it has to be made more time-efficient. A small part of the strategy concerning BDA is used in this case study to derive the objective for one country and one process; completing timesheets in Australia. The objective is: *"To optimise average lead times of the different types of timesheets used in the Australian part of the firm"*.

Currently, there are four types of completing timesheets that are used in the Australian part of the firm. After employees hired by the employment agency have finished their (periodical) jobs, they have to complete their timesheet to get their salary. This is one of the main administrative processes of the employment agency. However, it can become complex due to the irregularities of the employees. For example, they have different wages, locations, types of job, expertise, function roles and working times. Based on the timesheets the client firms are billed, which forms the main revenue of the employment agency. In order to ensure correct billing, it is important to make this activity as efficient as possible. It has to be performed correctly, in time, and it should not take too much effort. Therefore, the employment agency wants to use BDA to acquire insights about these timesheets in order to optimise them.

The business units are defined as follows: the supervising board represents the Executive Management, the Australian management represents the Operational Management, and the internal audit team and KPMG team represent the BDA Expert Team.

CASE STUDY 2: A DAIRY PRODUCER

The dairy producer is situated in the Netherlands and operates in several countries in Europe. There are many production lines from farmers to the factory in the Netherlands. However, Its aim is to start using BDA to detect which production lines are beneficial and which ones are not. Also an explanation is searched by examining the root causes. Therefore, the objective of embedding BDA *"to determine which supply chains are underperforming and why"*.

Currently, there are various combinations how a production line can look like. As farmers have different locations, the distance and temperature play important roles. Most important is that the dairy products stay in good state hence that the quality is high. Besides that, the production times and costs need to be optimised. However, due to the large amount of different production-line combinations data becomes complex. It is difficult to monitor what lines are performing positively and negatively. Therefore, the dairy producer wants to use BDA to achieve insights that can be monitored and controlled when necessary. These insights need to lead to actions, as the firm wants to optimise its commercial position.

The business units are defined as follows: the management team represents the Executive Management, the production line management and rayon management represent the Operational Management and the KPMG team represents the BDA Expert Team.

IV. FINDINGS

This chapter is divided in two parts: part I which presents the generic findings and part II which presents the case-specific results.

PART I: GENERIC FINDINGS

In this part, firstly, the ten most important capabilities are enumerated based on both literature research and exploratory interviews. Secondly, the eight most prominent trade-offs are depicted based on exploratory interviews.

IMPORTANT CAPABILITIES AND THEIR CONFLICTS

After literature review of 54 articles and exploratory interviews, a list of 48 specific capabilities is produced. However, to prevent the list of becoming too long and reduce overlap of the capabilities, related capabilities mentioned by different authors are merged. This resulted in a smaller list of 10 generic capabilities as depicted in Table 2 in de Appendix.

Examples of these capabilities that firms need to develop are: Data Completeness which is described as 'the ability to involve complete data in analyses and create detailed insights' and Manageability which is described as 'the ability to create, process and manage BDA activities'. As can be seen in the table, it is remarkable that not all capabilities are mentioned by the interviewees from the different business units. An explanation for this can be that the business units have need different capabilities based on their interest and objective. On the

contrary this can also signify that these business units are not aware of the fact that these capabilities are important.

Notice that all ten generic capabilities are important for firms to develop in order to embed BDA. However, in current literature the multi-capability perspective is not taken into account as the assumption is made that capabilities can always be combined. Next section this is elaborated.

WHICH TRADE-OFFS ARE PROMINENT

From the exploratory interviews, eight trade-offs are mentioned by the interviewees from the different business units. These trade-offs are subsequently used for the execution of the case studies. Figure 1 displays an schematic overview wherein each red line represent a conflicting interrelation between capabilities. Both of the conflicting capabilities entail desired and undesired effects. To prevent unforeseen problems in later stages of embedding BDA, one of the two capabilities should be prioritised. Hence, for each red line, a trade-off has to be considered.

An example of a trade-off is: Data Completeness vs. Manageability (see Figure 1). Here, the ability to involve complete data in analyses and create detailed insights hampers the ability to create, process and manage BDA activities, and vice versa. As these capabilities have a conflicting interrelation, a trade-off needs to be considered by weighing up the advantages of capability A against the advantages of capability B.

However, the perception of these trade-offs, in terms of difficulty and relative priority of the capabilities, is dependent on the case context. To clarify this, the perception of these trade-offs is discussed for two case examples from the multiple business unit perspectives.

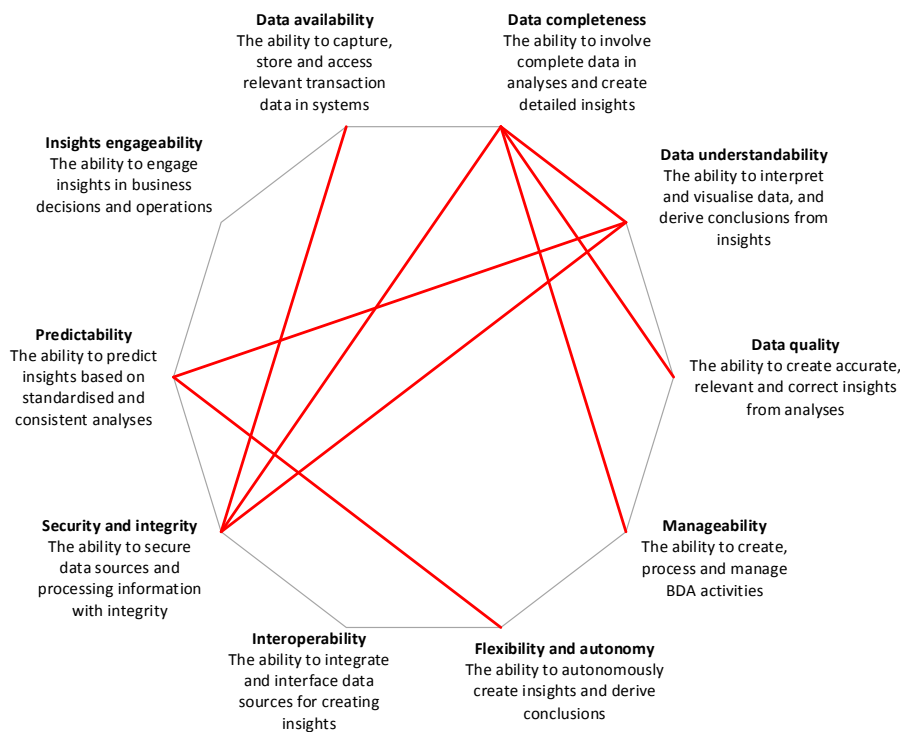


Figure 1: The trade-offs between conflicting interrelated capabilities. The perception of these trade-offs is assessed for both case studies.

PART II: CASE-SPECIFIC FINDINGS

In this part, firstly, the difference in business units' perception is discussed. Supplemented with an example trade-off per case study, it is explained what the reasoning is behind this difference. Secondly, it is discussed what the implications are when trade-offs are inadequately perceived, which is underpinned with an example trade-off per case.

HOW TRADE-OFFS ARE PERCEIVED ACROSS THE FIRM

Six case interviews are conducted with three actors per case study. In order to determine the perception of trade-offs, one actor per business unit is interviewed. There is a large difference in perception on the trade-offs of the business units for both case studies. The Executive Management of both firms perceives most trade-offs easier (under-perceived¹) and distinctively (inconsistently²) than the Operational Management and the BDA Expert Team. Figure 2 and Figure 3 demonstrate under-perception by the level of difficulty axis and inconsistency by the difference in direction of the axis. As is depicted in Table 1, this difference in perception entail a risk of inadequately perceiving trade-offs (explained in next section). However, it should be noticed that there is a reason behind a perception on a trade-off, which can be seen in Table 4 for case 1 and Table 5 for case 2 in the Appendix. For both cases an example is discussed below, of

the difference in perception on a trade-off and its underlying reasoning.

	Employment agency (case 1)	Dairy producer (case 2)
Under-perceived trade-offs	6 of the 8	5 of the 8
Inconsistently perceived trade-offs	6 of the 8	7 of the 8
Risk for inadequately perceived trade-offs	7 of the 8	7 of the 8

Table 1: Perceptions of trade-offs for both cases

CASE EXAMPLE: DATA COMPLETENESS VS. DATA QUALITY

EMPLOYMENT AGENCY (CASE 1)

The Operational Management perceives Data Completeness vs. Data Quality as a critical trade-off (Figure 2). It cannot prioritise one capability before another because *“for optimisation of timesheet processes based on insights, the quality needs to be high, though the completeness also needs to be high”*. This can be explained by the fact that its interest is to ensure that the billing of the worked hours is done correctly and in time. To achieve this, both Data Completeness and Data Quality is of high importance because both lead to an increase of money billed. The Executive Management prioritises Data Completeness because *“acquiring detailed data is more important than its quality, which can be compensated when a data set is complete”* and perceives the trade-off as very easy. Its interest is to optimise the processes regarding the timesheets processes while

¹ Under-perceived trade-off: the Executive Management (decision-maker) perceives a trade-off **easier** than the other business units.

² Inconsistently perceived trade-off: the Executive Management (decision-maker) perceives a trade-off **distinctively** than the other business units.

complying with the regulations. With that perception, Data Completeness is more important and the Data Quality less because involvement of complete data and creation of detailed insights are essential for increasing accuracy and effectiveness of the timesheets. However, the BDA Expert Team prioritises the capability over Data Quality and perceives this trade-off as difficult because *“this objective is very specific, therefore, it is more important to create high quality insights instead of complete and very detailed insights”*. Its interest is to conduct

reliable analytics, control transaction data and check for weaknesses and opportunities. To realise this, it is more important to be able to involve complete data in analyses and create detailed insights as in that case the change of missing out is reduced. As this regards billable hours that result in money, it has a high priority.

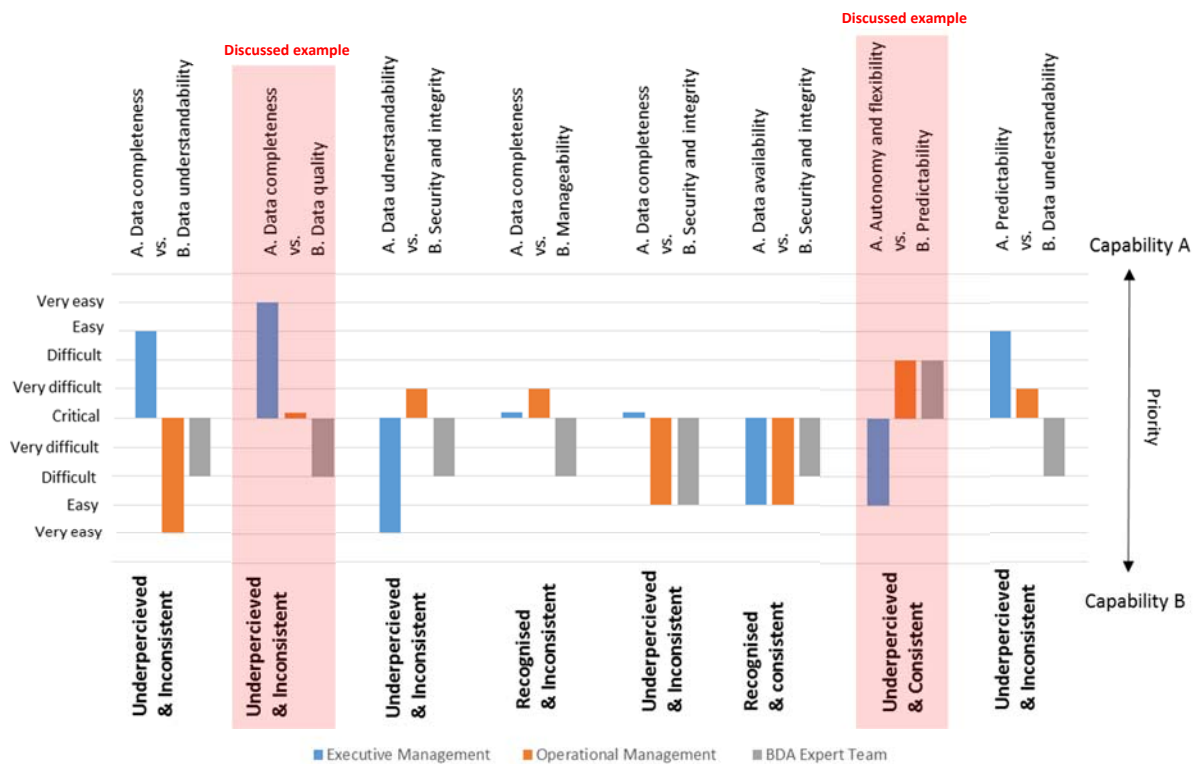


Figure 2: Overview of the perceived trade-off by the different business units for the employment agency (case 1)

CASE EXAMPLE: DATA COMPLETENESS VS. SECURITY AND INTEGRITY

DAIRY PRODUCER (CASE 2)

The trade-off of Data Completeness vs. Security and Integrity is perceived by the Executive Management as a very easy trade-off (Figure 3). It prioritises Data Completeness before Security and Integrity because *“the security and privacy capability does not regard to the production lines, as secret elements do not need to be included in performance numbers”*. Its interest is to optimise the production lines while complying with the quality standards. In order to achieve this, all relevant transaction data about the dairy production lines need to be involved in the analyses. The BDA Expert Team agrees upon the fact that Data Completeness is more important, however, it perceives this trade-off very difficult because *“it is more important to be able to involve high amount of data and then anonymise it, instead of leaving out*

data fields”. Its interest is to control the transaction data about the production lines and provide a solution for creating efficiency. This necessitates extensive analyses with complete data about the production lines of the dairy products. This provides opportunities for encountering underperforming lines and its underlying reasons and exploring solutions for improving production line efficiency. The Operational Management does not agree on this, as it prioritises Security and Integrity before Data Completeness because *“the ability to ensure Security and Integrity of the (farmer and product) data can be maintained by anonymising data fields”*. Its interest is to comply with the production quality, cost and time standards. Besides, it aims on produce, transport and process the dairy products on the way from the farmer to the factory. Security and Integrity of this information is important, as the reputation of the farmers need to be disclosed and is resolved internally in the organisation.

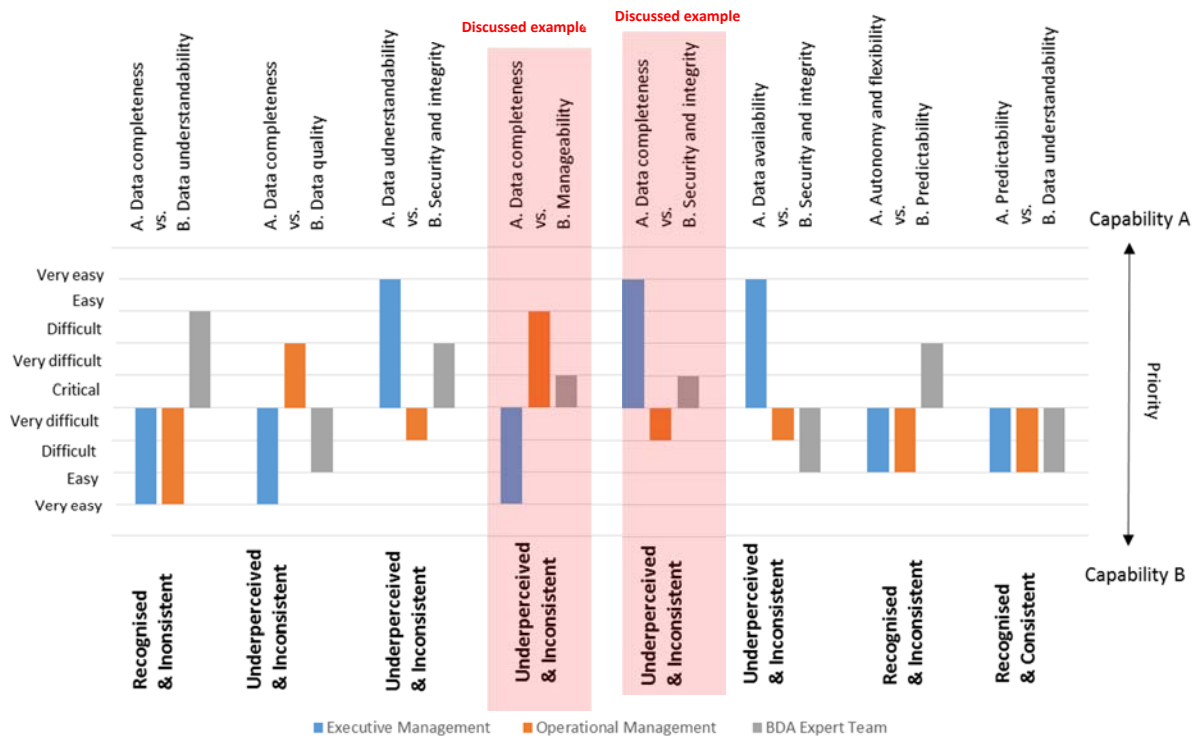


Figure 3: Overview of the perceived trade-offs by the different business units for the dairy producer (case 2)

IMPLICATIONS OF TRADE-OFFS

In both cases, the majority of the trade-offs is under- and/or inconsistently perceived by Executive Management with respect to the other business units. This can imply that it is better in considering trade-offs. However, this can also imply that it is not completely informed about the organisational and technological challenges of the project. A reason for this is that on a high hierarchical level the complexities that occur on the work floor are not entirely known. This is illustrated with (the same) two case examples from Figure 2 and Figure 3. The trade-off-specific implications of both directions (capability A or capability B) are discussed from the different perspectives of the involved business units.

CASE EXAMPLE: DATA COMPLETENESS AND DATA QUALITY

EMPLOYMENT AGENCY (CASE 1)

The encountered risk for erroneously considering trade-offs here is two-fold: the Executive Management 1. under-perceives this trade-off and 2. perceives it inconsistently with respect to the other business units (Figure 2). The Executive Management tends to choose for a high Data Quality, which entails the ensuring of accuracy and correctness and including of solely relevant insights. However, this also implicates that insights are basic, the overview is incomplete and there is a chance of missing information. The data analyses would become more complex hampering the ability to understand them. However, this weighs up against this complexity as it is very important that for optimising timesheets and being compliant at the same time.

The risk of missing out data should be minimised as missing billable hours directly lead to missing revenues. Besides, complete data is required to ensure compliancy.

The BDA Expert Team tends to choose for a high Data Completeness, which entails detailed insights, a complete overview and in-depth information. However, this also implicates that the Data Quality is low which entails the increasing chance of containing errors on detailed level, the making of wrong assumptions due to wide scope and the enclosing irrelevant data. The amount of transaction data of the timesheets - that can be extracted from the ERP systems - is enormous. Findings on efficiency on the timesheets become less concrete when too much data is involved. To be able to derive actionable steps to improve this efficiency, it is required to aim on the ability of Data Understandability.

The Operational Management perceives both capabilities as equally important which is a critical situation. This can be explained by the fact that it's interests is situated on the interface between these two capabilities. However, it should be noticed that it is no option to not consider a trade-off. Because, the capabilities of Data Completeness and Data Understandability are hampering each other. This will eventually lead to problems in realisation of the objective because with the current resources (BDA tools and skills for staging, executing and visualising, change management plan and data governance) only one of the two capabilities is possible. Hence, a choice should be made between Data Completeness or Data Quality.

CASE EXAMPLE: DATA COMPLETENESS VS. SECURITY AND INTEGRITY

DAIRY PRODUCER (CASE 2)

The encountered risk for erroneously considering trade-offs here is two-fold: the Executive Management 1. under-perceives this trade-off and 2. perceives it inconsistently with respect to the other business units (Figure 3). The Executive Management and BDA Expert Team tend to choose for a high Data Completeness, which entails detailed insights, a complete overview and in-depth information. However, this also implicates that the Security and Integrity is low, which entails that derivations can be made to personal entities (of farmers) and personal sensitive information of (farmers) becomes visible. The data analyses and insights would be more prone on being exposed as the aim is to aim for a complete analysis. But, this is outweighed by the fact that insights on the production line performance are acquired on a more detailed level. The chance becomes bigger to find out which lines are underperforming and its underlying reason.

The Operational management tends to choose for a high Security and Integrity, which entails that data is protected, access to data sources is restricted and regulations is complied with. However, this also implicates that the Data Completeness is low, which entails that insights are basic and not in-depth, the overview is incomplete and information can be missing. The preserving of the privacy of the farmers hampers the ability to involve complete data sets and achieve detailed insights. This is an important aspect of the managing of the farmer's products. By filtering out the Data Completeness, still, actionable insights can be produced. The only problem, however, is that each production line is farmer-specific. This means that when data is anonymised or filtered out, it is not possible to determine on which specific production line needs to be intervened.

UNFORESEEN PROBLEMS HAMPERING THE EMBEDDING PROCESS

In last section, for both cases examples of trade-off-specific implications are discussed as the majority is inadequately perceived Executive Management. However, the question what this means in the bigger picture remains unanswered. Inadequately perceived trade-offs occur when they are either under- or inconsistently perceived. When trade-offs inadequately perceived, they may be erroneously considered or considered too late. Unforeseen problems may emerge in later stages of the process of embedding that can lead to the consequence that the objective becomes unfeasible or that the scope needs to be narrowed down. Therefore, three examples of general unforeseen problems are debated, which emerge when trade-offs (in general) are inadequately perceived.

First example, when the different perceptions on a trade-off are not taken into account, the expectations of a solution deliverable are not aligned. The business problem can become obscure because the business units are not involved, objectives are not commonly defined, resources are not delivered throughout the organisation or the BDA solution is not accepted or engaged in decision-making and business operations.

Second example, when the trade-offs are erroneously considered without consulting other compliance business units, sanctions can backfire the project. The firm can become non-complaint because laws are not obeyed, regulations are not followed, the firm's policy is unclear or not taken into account, and privacy and security can be breached.

Third example, when challenges and issues on the work floor (operational level) are not perceived when considering trade-offs, the process of embedding BDA can be plagued with technical complexities. Data may contain errors and inconsistencies, data may not be available real-time, data quality is lacking, or information overload may occur due to the large data volumes.

Hence, these examples emphasise the importance that different perspectives need to be involved in perceiving trade-offs. Thereby, it can be prevented that they are erroneously considered or that problems emerge without even knowing about the existence of a trade-off.

V. CONCLUSIONS

With the knowledge acquired from this study, we can make three concluding statements. In this thesis we emphasised the importance of perceiving trade-offs when embedding BDA in business operations.

- We claim that capabilities do not solely entail benefits towards achieving an objective. Instead, they can also have a conflicting impact on other capabilities whereby they hamper to achieve this objective (multi-capability perspective). When capabilities are conflicting, the Executive Management of firms needs to consider a trade-off by asking itself which capability contributes more to the objective.
- We emphasise that trade-offs differ per case and therefore should be considered in an early stage. As they cannot be avoided, they should be perceived adequately (multi-trade-off perspective). When the Executive Management does not perceive a trade-off, unforeseen problems can emerge in later stages of the project. Solving these problems is more expensive and more intensive due to former investments in resources and work done. As a consequence, objectives become unfeasible.
- We assert that it is important to involve multiple actors from different business units from the organisation when embedding BDA (multi-actor perspective). Then, a more complete perception can be achieved which prevents the Executive Management to under-perceive (easier than other business units) or inconsistently perceive (distinctive than other business units) trade-offs.

Thus, embedding BDA in business operations is more than only defining capabilities and resources. This is where current Resource Based View-related literature is incomplete. We contributed to this literature by explicating that firms should take the three perspectives into account: multi-capability, multi-

actor, multi-trade-off. This has to be done before initialising the BDA embedding process. Thereby, this study is valuable in trimming down the percentage of failing BDA projects³ as it contributes to support firms to get the full potential out of their BDA projects.

VI. LIMITATIONS AND FUTURE RESEARCH

Like every other research, this study has its limitations. Three most important limitations are discussed below. First, the case studies concern large scale projects with high stakes and many objectives. Therefore, a general objective was chosen during the case studies in this thesis. However, these cases are big enough to divide them into more smaller in-depth case studies. This choice was made because the in-depth case studies would have led to more complex trade-offs. Besides, there was limited time available for interviews.

Second, similar to last point, the phenomenon of capabilities was difficult to grasp by the interviewees. Often, they were confused with resources, which can be seen in the transcriptions of the interviews. It was important that during the interviews the right information was gathered, however, the chance remains that interviewees did not interpret the capabilities correctly. Besides, there were too many specific capabilities to discuss them all, especially as there was a serious time constraint during the interviews of 60 minutes. This limitation was taken into account by adding a sentence of context with an example to the interview protocol and reducing the amount of capabilities.

Third, this study only discussed the trade-offs that are recognised by the interviewees of both cases. As in theory one capability has an interrelation with each other capability, there are many possible trade-offs that needed to be discussed during the explorative and evaluation interviews. The plan was to structure the interviews with a self-interaction matrix. However, as there was a time constraint of 60 minutes per interview, it was not possible to discuss each interrelation. In the given time, only the trade-offs that were recognised by the interviewees could be discussed. Therefore, the list of trade-offs is not completely covering each situation. This limitation was taken into account by letting the interviewees choose the most relevant conflicting interrelations for discussion.

Two agenda points for future research are discussed below. Firstly, one of the questions that emerged (to me and my supervisors) is how these trade-offs can be coped with. During the interviews already much information was given by the interviewees how they coped with the trade-offs. This could have been used to investigate what strategies can be applied to cope with them. However, as the objective of this research was to perceive the trade-offs, this was not within scope. Future

research would be investigating how firms can cope with these trade-offs.

Secondly, eight trade-offs are encountered as a result of the exploratory interviews. The perception on these trade-offs is subsequently assessed by evaluation interviews with interviewees from different business units. However, limited information was available to go into depth on each trade-off for each case study. Besides, not enough time was available to talk about more trade-offs between conflicting capabilities during the interviews. Future research would be to shed light on each of these trade-offs in depth. Also more research is necessary to investigate which additional trade-offs are important to perceive. This is in line with the third limitation discussed in this section.

³ Although one should always be careful with percentages, according to several articles the percentage of firms that do not achieve success of their BDA projects is between 50-70%. (Buhl et al., 2013; Clavier et al.,

2012; Grant, 2016; Gupta et al., 2016; Hannula et al., 2003; Olszak, 2016)

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APPENDIX

Capability name	Capability description	Purpose	Executive Management	Operational Management	BDA Expert Team	Reference
Data availability	The ability to capture, store and access relevant transaction data in systems	Access to data sources and readily available insights.	✗	✓	✓	(Chawda <i>et al.</i> , 2016; Chen <i>et al.</i> , 2012; Clavier <i>et al.</i> , 2012; Davenport <i>et al.</i> , 2013; Dutta <i>et al.</i> , 2015; Gupta <i>et al.</i> , 2016; Ross <i>et al.</i> , 2013; Tan <i>et al.</i> , 2016)
Data completeness	The ability to involve complete data in analyses and create detailed insights	Acquisition and provision of a complete overview and specific insights.	✗	✓	✓	(Buhl <i>et al.</i> , 2013; Isik <i>et al.</i> , 2011; Kowalczyk <i>et al.</i> , 2014; Kwon <i>et al.</i> , 2014; Zack, 2007)
Data understandability	The ability to interpret and visualise data, and derive conclusions from insights	Acquisition and provision of understandable and practical insights.	✓	✗	✓	(Akter <i>et al.</i> , 2016; Clavier <i>et al.</i> , 2012; Davenport <i>et al.</i> , 2013; Dutta <i>et al.</i> , 2015; Elbashir <i>et al.</i> , 2008; Gupta <i>et al.</i> , 2016; Olszak, 2016)
Data quality	The ability to create accurate, relevant and correct insights from analyses	Acquisition and provision of high quality insights that are correct, relevant and up to date.	✓	✓	✓	(Davenport <i>et al.</i> , 2013; Isik <i>et al.</i> , 2011; Janssen <i>et al.</i> , 2012; Kwon <i>et al.</i> , 2014; Loebbecke <i>et al.</i> , 2015; Pospiech <i>et al.</i> , 2012; Tan <i>et al.</i> , 2016)
Manageability	The ability to create, process and manage BDA activities	Good coordination and planning of BDA related activities.	✓	✗	✓	(Akter <i>et al.</i> , 2016; Buhl <i>et al.</i> , 2013; Davenport <i>et al.</i> , 2007; Dutta <i>et al.</i> , 2015; Gupta <i>et al.</i> , 2016; Keller <i>et al.</i> , 2012; Kwon <i>et al.</i> , 2014; McAfee <i>et al.</i> , 2012; Pospiech <i>et al.</i> , 2012; Watson <i>et al.</i> , 2007)
Flexibility and autonomy	The ability to autonomously create insights and derive specific conclusions	Agile and autonomous decision-making that increase the flexibility and resilience of BDA related activities.	✓	✓	✗	(Davenport <i>et al.</i> , 2007; Dutta <i>et al.</i> , 2015; Elbashir <i>et al.</i> , 2008; Gupta <i>et al.</i> , 2016; Kiron <i>et al.</i> , 2011; LaValle <i>et al.</i> , 2011; Olszak, 2016; Pettit, 2008; Tan <i>et al.</i> , 2016; Watson <i>et al.</i> , 2007)
Interoperability	The ability to integrate and interface data sources for creating insights	Easy to combine data sets in analyses from multiple sources.	✓	✓	✓	(Arnott <i>et al.</i> , 2008; A. Bharadwaj <i>et al.</i> , 2013; Chawda <i>et al.</i> , 2016; Davenport <i>et al.</i> , 2013; Gantz <i>et al.</i> , 2011; Gupta <i>et al.</i> , 2016; Isik <i>et al.</i> , 2013; Janssen <i>et al.</i> , 2012; Kowalczyk <i>et al.</i> , 2014; Pospiech <i>et al.</i> , 2012; Radaelli, 2000; Tan <i>et al.</i> , 2016; Wamba <i>et al.</i> , 2016)
Security and integrity	The ability to secure data sources and processing information with integrity	Compliance with the data protection acts and privacy regulations. Protection of sensitive firm information from being exposed.	✓	✓	✓	(Akter <i>et al.</i> , 2016; Davenport <i>et al.</i> , 2013; Gantz <i>et al.</i> , 2011; Janssen <i>et al.</i> , 2012; Kowalczyk <i>et al.</i> , 2014; Loebbecke <i>et al.</i> , 2015; Tan <i>et al.</i> , 2016; Wamba <i>et al.</i> , 2016)
Predictability	The ability to predict insights based on standardised and consistent analyses	Acquisition and provision of realistic predictions and insights.	✗	✗	✓	(Arnott <i>et al.</i> , 2008; A. S. Bharadwaj, 2000; Davenport <i>et al.</i> , 2013; Dutta <i>et al.</i> , 2015; Elbashir <i>et al.</i> , 2008; Goodhue <i>et al.</i> , 1992; Isik <i>et al.</i> , 2011; Isik <i>et al.</i> , 2013; Janssen <i>et al.</i> , 2012; Kowalczyk <i>et al.</i> , 2014; Kwon <i>et al.</i> , 2014; LaValle <i>et al.</i> , 2011; Zack, 2007)
Insights engage ability	The ability to engage insights in business decisions and operations	Intervention based on data insights to improve performance and realise objectives.	✓	✗	✓	Only found in exploratory interviews.

Table 2: Overview of the ten most important generic capabilities (based on both literature review and exploratory interviews)

	Output choice A	Output choice B
I. Data Completeness vs. Data Understandability	High Data Understandability, low Data Completeness	High Data Completeness, low Data Understandability
Advantages	• Understandable insights • Agile conclusion derivation • Easy visualise able information	• Detailed insights • Complete overview • In-depth information
Disadvantages	• Basic insights • Incomplete overview • Missing information	• Difficult to visualise • Complex insights • Poor understanding • Slow conclusion derivation
II. Data Completeness vs. Data Quality	High Data Completeness, low Data Quality	High Data Quality, low Data Completeness
Advantages	• Detailed insights • Complete overview • In-depth information	• Ensuring accuracy and correctness • Solely including relevant insights
Disadvantages	• Making wrong assumptions (due to wide scope) • Increasing chance for containing errors on detailed level • Enclosing irrelevant data	• Basic insights • Incomplete overview • Missing information
III. Data Understandability vs. Security and Integrity	High Data Understandability, low Security and Integrity	High Security and Integrity, low Data Understandability
Advantages	• Understandable insights • Agile conclusion derivation • Easy visualise able information	• Protected data (by anonymization) • Restricted access to sources • Compliance with regulations
Disadvantages	• Derivations can be made to personal entities • Personal sensitive information visible • Change of breaking regulations	• Difficult to visualise • Complex insights • Poor understanding • Slow conclusion derivation
IV. Data Completeness vs. Manageability	High Data Completeness, low manageability	High manageability, low Data Completeness
Advantages	• Detailed insights • Complete overview • In-depth information	• Adequate management of BDA activities • Agilely data staging and analysing • High control on outputs
Disadvantages	• Difficult to process and manage BDA activities • Data staging and analysing become more complex and intensive • Low control on outputs	• Basic insights • Incomplete overview • Missing information
V. Data Completeness vs. Security and Integrity	High Data Completeness, low Security and Integrity	High Security and Integrity, low Data Completeness
Advantages	• Detailed insights • Complete overview • In-depth information	• Protected data (by anonymization) • Restricted access to sources • Compliance with regulations
Disadvantages	• Derivations can be made to personal entities • Personal sensitive information visible	• Basic insights • Incomplete overview • Missing information
VI. Data Availability vs. Security and Integrity	High Data Availability, low Security and Integrity	High Security and Integrity, low Data Availability
Advantages	• Easy access to data insights • Insights available on places where needed to support operations • Increasing accuracy (due to multiple data sources)	• Protected data (by anonymization) • Restricted access to sources • Compliance with regulations
Disadvantages	• Derivations can be made to personal entities • Personal sensitive information visible • Chance for data leakages	• Difficult to access data insights • Insights not available on places where needed, thus not supporting all operations

		Missing data sources (due to restrictions) causing lower accuracy
VII. Autonomy and Flexibility vs. Predictability	High Autonomy and Flexibility, low predictability	High predictability, low Autonomy and Flexibility
Advantages	- BDA solutions tailored to problem - Specific analyses - Ad-hoc decision-making and conclusion derivation - High resilience	- Standardised analyses - Consistent data outputs - Corresponding insights - Allowance for predictions and prescriptions
Disadvantages	- Inconsistent data outputs - High variance in insights - Predictions and prescriptions not possible (due to variation)	- Less specific insights - Low variation and flexibility in BDA activities - Low resilience
VII. Predictability vs. Data Understandability	High predictability, low Data Understandability	High Data Understandability, low predictability
Advantages	- Standardised analyses - Consistent data outputs - Corresponding insights - Allowance for predictions and prescriptions	- Understandable insights - Agile conclusion derivation - Easy visualise able information
Disadvantages	- Difficult to visualise - Complex insights - Poor understanding - Slow conclusion derivation	- Inconsistent data outputs - High variance in insights - Predictions and prescriptions not possible (due to variation)

Table 3: The eight most important trade-offs and their consequences that are assessed for each case study

Capability 1	Capability 2	Executive Management	Operational Management	BDA Expert Team	Conclusion
Data Completeness	Data Understandability	Easy (1). Only the audit team has to understand the data. They are experts and can deal with Data Completeness and complexity better. Insights are not used by other business units (yet).	Very easy (2). Too large amounts of data become complex. When the amount of available FTEs is limited, the project should start small.	Difficult (2). Although both are important, in this case, it is more important to create a particular insight that is understandable instead of making it as complete as possible.	Under-perceived Inconsistent
Data Completeness	Data Quality	Very easy (1). Acquiring detailed data about the timesheets is more important than its quality. Quality can be compensated when the set is complete.	Critical (?). For optimisation of the timesheet process based on insights, the quality needs to be high. Though, the completeness is of same importance.	Difficult (2). This objective is very specific, therefore, the ability to create high quality insights is important. The ability to create complete and detailed insights is less important, because of the objective's level of specificity.	Under-perceived Inconsistent
Data Understandability	Security and Integrity	Very easy (2). As the firm possess HR data related to individuals important is to pursue Security and Integrity. By anonymization of data and insights the objective can also be achieved.	Very difficult (1). With a low ability to understand the data and derive conclusions the objective becomes at risk. Security and Integrity for an employment firm is also essential.	Difficult (2). Security and Integrity is a capability that should be possessed at all times, though it should hamper the ability to understand the insights minimally.	Under-perceived Inconsistent
Data Completeness	Manageability	Critical (?). The ability to involve complete data is important to create detailed insights. Though, the activities should not be too complex as manageability is of same importance.	Very difficult (1). The objective is audit-related, thus complete information is of high importance. On the other side, there are limited FTEs wherein the objective must be done.	Difficult (2). Even though the ability to achieve completeness should be high, the activities should be manageable.	Recognised Inconsistent
Data Completeness	Security and Integrity	Critical (?). The firm possesses HR related and sensitive data whereby Security and Integrity are prominent capabilities. For this objective, however, it is important that the internal audit have all the data what they need to achieve the objective.	Easy (2). Security and Integrity need to be pursued, as anonymization also allows the achieving of the objective.	Easy (2). The analytics should comply with the Security and Integrity regulations. This is a precondition for Data Completeness of the objective.	Recognised Consistent
Data Availability	Security and Integrity	Easy (2). The availability of timesheet data should be bounded by the regulations of Security and Integrity.	Easy (2). The availability of the timesheet data should be within the possibilities that are allowed by the Security and Integrity regulations.	Difficult (2). Although Security and Integrity is an important capability, availability of data is essential with respect to the objective.	Under-perceived Consistent
Autonomy and Flexibility	Predictability	Easy (2). Consistency in analyses and insights that allow predictions is more important as the timesheet process optimisation is partially based on predictions (see objective).	Difficult (2). Analyses need to be consistent to achieve predictive insights. They are modules stacked on each other whereby Autonomy and Flexibility should be limited.	Difficult (1). Autonomy and Flexibility is more important to have in order to conduct constructive and useful analytics.	Under-perceived Inconsistent
Predictability	Data Understandability	Easy (1). Predictions become complex when insights are difficult to recognise (with gut feeling), though they are essential for realising optimisation of the timesheet process.	Very difficult (1). Even though predictions are more difficult to recognise and trust, regarding this objective they are necessary. The internal audit team is capable of dealing with them.	Difficult (2). The ability to understand the insights is required for trusting the predictions. When these are not understood, they likely not engaged in decisions.	Under-perceived Inconsistent

Table 4: Perceived trade-offs of each business unit of case study 1 (employment agency)

Capability 1	Capability 2	Executive Management	Operational Management	BDA Expert Team	Conclusion
Data Completeness	Data Understandability	Easy (2). It is more important that the insights to a basic level are understood instead of detailed insights that are not understood.	Easy (2). When the insights are not understood it is not possible to use them for improving the production lines.	Easy (1). There are many production lines. When it is investigated which ones are underperforming, a complete as possible data input is required.	Recognised Inconsistent
Data Completeness	Data Quality	Easy (2). When decisions are made based on data insights, it is important that its quality can be trusted.	Difficult (1). To achieve insights that cover all the production lines, it is important to be able to involve much and complete data.	Difficult (2). It is more important to have limited data with high quality than plenty of data where you cannot rely upon.	Under-perceived Inconsistent
Data Understandability	Security and Integrity	Very easy (1). Although the ingredients are secret, the production lines regard no privacy sensitive data. Therefore, it is more useful to ensure that it is understood.	Very difficult (2). The composition and exact origin of dairy products should be kept secret. Filtering out these data fields allows that.	Difficult (1). As these types of products are not privacy sensitive, no anonymization should be required for BDA analyses.	Under-perceived Inconsistent
Data Completeness	Manageability	Easy (2). Important is that the BDA activities remain manageable, even though it hampers the ability to include large amounts and complete data.	Easy (1). With the current technology ability to pursue completeness should not have to be a problem for the ability to manage.	Very difficult (1). Manageability is always an important aspect, although in this case the ability to pursue completeness is crucial to create insights of the performance of the production line.	Under-perceived Inconsistent
Data Completeness	Security and Integrity	Very easy (1). The security and privacy capability does not regard to the production lines, as the secret elements do not need to be included in performance numbers.	Very difficult (2). The ability to ensure Security and Integrity of the (farmer and product) data can be maintained by leaving out data fields.	Very difficult (1). It is more important to be able to involve high amount of data, and then anonymise it, instead of leaving out fields.	Under-perceived Inconsistent
Data Availability	Security and Integrity	Very easy (1). The ability to avail data for BDA should not be hampered by the Security and Integrity capability.	Very difficult (2). Of high importance is that the production line transaction data is secured, though in the meantime is collected and made available for analyses.	Difficult (2). It is not possible to both comply with the bounding Security and Integrity rules and also collect and avail data for BDA.	Under-perceived Inconsistent
Autonomy and Flexibility	Predictability	Difficult (2). Autonomy and Flexibility in BDA activities should be limited in order to create consistency and make predictions.	Difficult (2). When Autonomy and Flexibility are controlled, predictions can be made.	Difficult (1). Solutions are difficult to create when there is no Autonomy and Flexibility to tailor them to solve a problem.	Recognised Inconsistent
Predictability	Data Understandability	Difficult (2). When predictions are made and are not recognised they cannot be used in to assess performance of the production lines.	Difficult (2). To assess the performance of the production lines it is more important to be able to understand the underlying reasons so that actions are related to the insights.	Difficult (2). The ability to understand the insights and engage them is more important than making predictions.	Recognised Consistent

Table 5: Perceived trade-offs of each business unit of case study 2 (dairy producer)