The Impact of Adopting Business Intelligence Systems on Credit Risk Management: An Exploratory Study in the Omani Banking Industry

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at

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by

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Abstract

Background: Business Intelligence (BI) systems have become vital for many organisations, and continue to grow in popularity as important systems of analysis used to inform decision-making. The volatile banking industry, in an environment of increasing financial risk, requires banks to implement the most effective, intelligent solutions available in order to manage risks such as credit risk, market risk and operational risk. The banking sector of Oman has funded many investments and projects to boost its economy, while loan requests have increased significantly in recent times. Additionally, banks are making financial facilities available to local SMEs and investors in order to diversify the economy. The credit risks associated with these developments must be addressed with effective tools. BI tools could play an important role here, but there are few studies to date, which have investigated the effectiveness of such tools.

Aims: This thesis aimed to investigate the impact of adopting BI systems in the Omani banking industry, emphasising the credit risk management area, and more specifically, the effectiveness of BI in mitigating credit risks in Oman’s banks.

Methods: This research adopted the inductive approach and was conducted with a qualitative method using semi-structured interviews to collect data. The sample consisted of nine participants recruited from the Omani banking industry, including the Central Bank of Oman, Bank Muscat, HSBC Oman, Oman Arab Bank, National Bank of Oman, and Al IZZ Islamic bank.
**Results:** The results of this study provided confirmatory evidence that BI tools have contributed positively in mitigating potential credit risks across many banks in Oman. Furthermore, the study revealed that there are some critical areas which play vital roles in ensuring the success of BI implementation projects, such as top management support, business-IT alignment, strong collaboration between project stakeholders, and BI software selection. Top management support in particular was found to have a significant influence on BI implementation success. Some participants were concerned that raw data from unreliable sources would render BI systems ineffective.

**Conclusions:** BI systems have made a positive contribution in mitigating potential credit risks in banks of Oman. The support of top-level management has a strong bearing on BI implementation success. Results also suggest that BI tools are viewed as critical in managing banking risks.
Acknowledgements

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I humbly extend my thanks to all persons concerned who co-operated with me to finish this project.
شكر وتقدير

"وقال رجُلٌ أُذُينٌ: إنّي أُشكِّرُ نعْمَتُكَ الَّتِي أَنْعَمْتَ عَلَيْي وَعَلى وَلَدِي وَأَنّي أَعْمَلُ صَالِحًا تَرْضَاهُ
وَأَذْهَلْنِي بِرَحْمَتِكَ فِي عَبْدِكَ الصَّالِحِينَ" (سورة النمل: آية 19)

اشكر الله حمدًا وتعظيمًا أن اعاني ويسر لي أمرى ومنحني العزم والصبر على اتمام هذا البحث على وجه الذي يرضى ويرتقي مستواي العلمي إلى مراتب أعلى. 
و إنني ارى أنه لزاماً علي أن اختر شكري وامتناني وأن أنسب الفضل لأصحابه إهتداً بهدي النبي صلى الله عليه وسلم في قوله : ( من لا يشكر الناس لا يشكر الله).
فمن هنا اتقدم بخالص الشكر والامتنان إلى كل من افاض علي بدمعه ومساندته المعنوية فساهم في تشجيعي للعمل بإخلاص وتفاني لإتمام هذا البحث، وخصوصاً بالشكر والذى ووالدتي وزوجتي الغالية أم عبدالعزيز وقرة عيني ولدي عبدالعزيز الذين افاضوا علي بحبهم ودعمهم منذ بداية المشوار. كنتم نعم المعين والصاحب.

كما لا يسعني إلا أن اتقدم بجزيل الشكر والامتنان للدكتور جوناثان فوستر المشرف على هذا البحث، والذي منحني من وقته وفكره وتوجيهاته للخروج بأفضل النتائج وانجاز العمل بكل اتقان بلا ملل ولا كل.

كما أتوجه بخالص الشكر والتقدير لكل من البنك المركزي العماني، بنك مسقط، بنك العز الإسلامي، بنك HSBC، بنك عمان العربي والبنك الوطني العماني على مشاركتهم الفعالية وإثرائهم بالمعرفة والخبرة العلمية والمفيدة بما يتوافق مع متطلبات البحث.
الإهداء

أهدي هذا العمل إلى أمي وأبي أمد الله في عمرهما... إلى رفيقة دربي زوجتي أم عبد العزيز التي كانت سراجاً ينير عتمتي غربتي بدعمها وتشجيعها لي المستمر طيلة فترة إبعائي... إلى أملي المتجلد في الحياة ولدي عبد العزيز... إلى أخوتي وأخواتي سندي وقومتي في الشدة والرخاء... وإلى كل من شجعني وساعدني على إتمام هذا العمل بنجاح.

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Chapter 1 Introduction

This chapter provides an overview of the research area, significance of this study, aims and scope of the dissertation, and the alignment of chapters.

1.1 Research Background and Context

Business intelligence (BI) systems, have become incredibly important for many organisations and have remained a topic of interest in academic and practitioner research over the past two decades (Jourdan, Kelly Rainer, & Marshall, 2008; Lawton, 2006). These systems are typically used for decision-making problems that involve a real-time analysis of complex datasets embedded in different corporate information systems (Ranjan, 2009). Surveys, such as that conducted by the IBM Tech Trends Report, show that BI analytics have been recognised as one of the top four dominant technologies in the 2010s (as cited in Chen et al., 2012a). Furthermore, it has consistently been ranked as one of the key two agenda items of senior executives (Luftman & Ben-Zvi, 2010). Moreover, BI is the most common search term on gartner.com (Schlegel, 2011). These factors have therefore led to an increase in the popularity of the BI systems amongst different business organisations, that have recognised it as a critical fundamental underpinning of competition (Vercellis, 2009).

In recent years, the banking industry has been widely influenced by BI technology due to the rapid increase of financial risks, such as credit risk, market risk, and operational risk (Preko & Kester, 2015). These risks could emerge from the internal or external environments by which the financial sectors operate (Bessis & O’Kelly, 2015). Obviously, the environment in which banks conduct their business is highly dynamic, volatile and fiercely competitive (Chen & Lin, 2015).
Thus, controlling all these dimensions using traditional legacy systems is becoming impractical (Mishra, 2016). Moreover, the consistent changes in regulations, such as Basel II, have forced many banks to harmonise their business operations to comply with relevant regulations and policies.

In turn, the financial crisis (Beltratti & Stulz, 2012) that swept the globe positioned the credit risk problems at the forefront of financial entities’ priorities. This problem, however, has long been a challenge for many financial institutions worldwide (Gizaw, Kebede, & Selvaraj, 2015). Indeed, credit risk has a significant impact on the profitability and development of banks, since it is considered as the main source of income (Prakash & Poudel, 2012). Furthermore, credit risk plays a critical role in accelerating the pace of economic growth in a country as a whole (Funso, Kolade, & Ojo, 2012).

Caouette, Altman, and Narayanan (1998) define the term ‘credit risk’ as the likelihood that a borrower will default on a loan or credit, which, subsequently, causes the bank to incur losses. Given that definition, banks must adopt effective and more intelligent solutions to safeguard both the lender and the borrower (Chen & Lin, 2015). Thus, many banks today have adopted business intelligence software for effective management and control of credit risks (Gadda, 2014).

The banking sector in Oman is playing a critical role in helping the economy to thrive by providing funding for many investments and projects (Al-Lamki, 2005). More recently, the number of loan requests has increased significantly across Omani banks, due to a sharp decline in oil prices (Fayyad & Daly, 2011). Subsequently, the Oman government has directed all licensed banks to grant financial facilities for local SMEs and investors towards a more diversified economy (Zerban, Omar, & Al Sibani, 2015).
These factors, however, indicated an urgent need for effective tools to mitigate the credit risks, which triggered many banks in Oman to adopt various BI techniques.

Throughout this dissertation, the term business intelligence (BI) will refer to “a broad category of technologies, applications, and process for gathering, storing, accessing, and analysing data to help its users to make better decisions” (Wixom & Watson, 2012, p. 104).

1.2 Overview of the Banking Sector in Oman

The Omani banking industry combines seven local banks, nine foreign commercial banks, two local Islamic banks, and two specialised banks governed by the Central Bank of Oman (CBO) (see Table 1). These licensed banks are operating across different regions in Oman with a network of 468 branches (CBO, 2015). CBO\(^1\) is a regulatory body that plays a critical role in maintaining financial stability through effective supervision and monitoring of Oman's financial services industry.

A recent report shows that the top three leading banks, namely Bank Muscat, National Bank of Oman, and Bank Dhofar are being contributed to by approximately 62% of total sector assets (The Business Year, 2015).

\(^1\) http://www.cbo-oman.org
Table 1: Banks in Oman

Source: Developed for this research

<table>
<thead>
<tr>
<th>Bank Name</th>
<th>Bank Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. HSBC Bank Oman</td>
<td><a href="http://www.hsbc.co.om">http://www.hsbc.co.om</a></td>
</tr>
<tr>
<td>5. Oman Arab Bank</td>
<td><a href="http://oman-arabbank.com">http://oman-arabbank.com</a></td>
</tr>
<tr>
<td>7. Ahli Bank</td>
<td><a href="http://www.ahlibank-oman.com">http://www.ahlibank-oman.com</a></td>
</tr>
<tr>
<td>17. Al Izz Islamic Bank</td>
<td><a href="http://www.alizzislamic.om">http://www.alizzislamic.om</a></td>
</tr>
<tr>
<td>20. Oman Housing Bank</td>
<td><a href="http://www.ohb.co.om">http://www.ohb.co.om</a></td>
</tr>
</tbody>
</table>

The loan growth of overall credit facilities extended by all licensed banks in the Sultanate of Oman during the last six years is presented in Figure 1. As the data show, loan rates have increased significantly from 27.9% in 2010 to 46.3% up to June 2015, with an annual growth rate of 11.9%, as compared to 13.3% of deposits.
This incremental loan growth has been driven by the growing demands for credit from both the corporate and retail sectors to fund projects (Times of Oman, 2015). Speaking on this issue, H.E Hamood Al Zadjali, the executive president of CBO, reported that “the credit growth for the whole year would be in double digits and would probably hover around 10 percent” (Times of Oman, 2015). Oman’s banks are clearly facing a serious problem due to the rapid growth of credits, which requires effective control and monitoring.

Figure 1: Loans and deposits growth in Omani banking industry

Source: Bank Muscat (2015)
1.3 Significance of the Research

As seen above, Oman’s banking industry is going through a phase of major transformation, with the entry of Islamic banking and a sharp decline in oil prices (Fayyad & Daly, 2011). Given the current situation, the Oman government is struggling to keep its economy at pace with the oil price crises. This struggle, in turn, has led to an increase in the credit requests from Oman’s banks to ensure sustainable development in the country. However, such increases in credits have resulted in high default rates and exposed banks to greater risks (Mohammed Al Balushi, 2014). Under these circumstances, decision makers in Oman’s banks have realised the definite need for implementing effective intelligent tools, specifically BI for improving the predictive accuracy of credit risk decisions.

To date, there are few studies (Bekhet & Eletter, 2012; Chen & Lin, 2015) that have investigated the actual impact of adopting BI for credit risk management. Furthermore, no single study investigates this issue in the Omani banking context. Therefore, this research is expected to make a contribution to both practitioners and academic researchers. Theoretically, it contributes to the literature by providing insights into the effectiveness of BI and analytics in mitigating potential credit risks in Omani banking. Practically, this research will help the executives and leaders in making informed decisions towards implementing BI for credit risk purposes, since it highlights the pros and cons of, as well as the critical factors for successful BI initiatives.
1.4 Research Aim and Objectives

1.4.1 Research Aim

The overall aim of this thesis is to investigate the impact of adopting business intelligence systems in Omani banking industry, with an emphasis on the credit risk management area. More specifically, this study attempts to address the research question, “How effective is the BI system in mitigating the risks of credit in Omani banking industry?”

1.4.2 Research Objectives

To accomplish the research aim, the following objectives have been developed:

- To identify the motivations that triggered the banks of Oman to implement enterprise BI technologies.
- To explore the critical factors necessary for successful BI projects in Oman banking.
- To determine the benefits obtained from adopting BI tools for credit risk problem.
- To highlight the potential risks that could emerge after the implementation of BI for credit risk management.

1.4.3 Research Questions

- What are the motivations that triggered the banks in Oman to implement enterprise BI systems?
- What are the critical success factors for implementing BI systems in the Omani banks?
- What are the costs and benefits of adopting BI for credit risk management in Omani banks?
1.5 Structure of the Research

This thesis is composed of six themed chapters as follows:

**Chapter 1:** gives a brief introduction to the research background and context, the significance of the study, the research aim and objectives, research questions, and definitions of the main terms used in this study.

**Chapter 2** begins by laying out the theoretical dimensions of the research. The chapter then provides a review of related studies about BI in banking, BI for credit-risk management and critical success factors for BI implementation.

**Chapter 3** is concerned with the methodology used for this study. Specifically, this chapter includes sections related to the research approach, data collection methods, data analysis and ethical aspects.

**Chapter 4** presents the findings of the research, focusing on the three key themes: reasons for BI implementation in Omani banks, the critical success factors for BI deployment, and pros and cons of BI adoption.

**Chapter 5** discusses the results obtained from the previous chapter and compares them with relevant literature to draw a conclusion.

**Chapter 6** concludes by providing a summary of the whole research. This chapter also highlights the most significant findings derived that can answer the overall research question, limitations of the study and recommendations for future work.
Chapter 2 Literature Review

2.1 Introduction

Firstly, this chapter provides a brief history of the development of BI over time, followed by definitions of the concept BI. Secondly, this chapter reviews key studies relating to BI in banking, BI for credit risk management, critical success factors for BI implementation, and the benefits and costs of BI. Finally, the chapter ends by giving a summary of the literature review.

2.2 History of BI

The term BI is believed to have been initially proposed in 1989 by a Gartner researcher called Howard Dresner (Gibson, Arnott, Jagielska, & Melbourne, 2004). Dresner has been widely recognised as the father of BI and coining the term business intelligence as “a broad category of software and solutions for gathering, consolidating, analysing and providing access to data in a way that lets enterprise users make better business decisions” (Chee et al., 2009, p. 96).

Elena (2011) challenges the widely held view, arguing that the term BI was first originated by IBM analyst Hans Luhn in early 1958. In his article “A Business Intelligence System”, Luhn (1958) defines BI as “the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal” (p. 314).

In fact, both Luhn’s and Howard’s definitions are similar to the modern notion of BI. Despite these similarities, Howard was the one who familiarised the world with concepts and methods for improving business decision making through the use of fact-based support systems (Chee et al., 2009). Figure 3 shows the development of management information systems over time, starting from basic management information systems (MIS) and reaching into the BI tools.
2.3 Intelligence

The origin of the word *intelligence* can be traced back to the 14th century, and it has roots in the military (Vercellis, 2009). In the current literature, intelligence has become associated with many fields of knowledge, including business and information technology (IT) (Negash, 2004). According to Bouthillier and Shearer (2003), intelligence is defined as “the ability to understand and apply knowledge” (p. 3). For example, a person may be said to possess intelligence if he or she has the ability to make new sense beyond the original data.

Intelligence has an analytic component that differentiates it from simply knowing information. This term can be used to solve problems, but only when information and knowledge are integrated and assessed (Bouthillier & Shearer, 2003).
Information can be classed as intelligence when it is deemed to be unique to certain people or can be used to solve a previously unsolved question (Freeman, 1999). According to Choo (2002), intelligence is both the possession and creation of knowledge and is characteristic of adaptive behaviour. In addition, intelligence builds on the analysis of information, involving levels of interpretation that allow decision makers to confirm and validate their decisions. As Freeman (1999) succinctly points out, “intelligence, if used properly, can be the basis of strategic decision-making” (p. 72).

2.4 Definition of Business Intelligence

There is a lack of generally accepted definitions in the literature for the term BI, due to the differences in perspectives, such as academia, vendor, or a developer (Gangadharan & Swami, 2004; Golfarelli, Rizzi, & Castenaso, 2004; Zeng, Xu, Shi, Wang, & Wu, 2007). Also, there are numerous interpretations and concepts attached to BI, including competitive, market, consumer, technological, environmental and strategic intelligence (Pirttimäki, 2009). However, most of these concepts are mainly focused on the analysis of the external environments of the organisation, whereas BI serves the internal analysis function (Negash, 2004). This shows the need for explicitness about exactly what BI means. Before defining BI, it is worth mentioning that BI is not a new technology, but rather a series of mathematical models and analysis methodologies evolving from previous decision support systems (DSS) (Gray, 2003).

While reviewing the literature, existing BI definitions were noted to have come from three main perspectives: technological, management (aka process) and product aspects (Jagielska, Darke, & Zagari, 2003). Chee et al. (2009) draw on an extensive range of sources to capture the essence of BI from the view of those three categories (see Table 2).
Table 2: Three approaches to BI Definition

Source: Adapted from Chee et al., (2009)

<table>
<thead>
<tr>
<th>Approach</th>
<th>Managerial/Process</th>
<th>Technological</th>
<th>Product</th>
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<td>Definition</td>
<td>Focus on the process of gathering data from internal and external sources and of analysing them in order to generate relevant information for improved decision making</td>
<td>Focus on the tools and technologies that allow the recording, recovery, manipulation and analysis of information</td>
<td>Describe BI as the emerging result/product of in-depth analysis of detailed business data as well as analysis practices using BI tools.</td>
</tr>
</tbody>
</table>

* Note: The definition of Turban et al. (2007) spans across all three approaches.

From the managerial perspective, BI is recognised as a process in which data from both internal and external sources is incorporated through the deployment of integrated transaction processing systems to create actionable information for improved decision support (Whitehorn & Whitehorn, 1999).
In this case, priority is given to the coordination and management of integrating and analysing various information sources (from both inside and outside the organisation) to support the decision-making process (Petrini & Pozzebon, 2008).

From the technological perspective, Turban define BI as “an umbrella term that encompasses tools, architectures, databases, data warehouses, performance management, methodologies, and so forth, all of which are integrated into a unified software suite” (as cited in Chee et al., 2009, p. 194). This definition broadened the scope of BI to include not only the process, but also the technologies that support the gathering, loading, storing, analysing and mining of corporate data.

From the perspective of the vendor or product approach, BI is considered to be a tool that delivers “the right information to the right people at the right time to support better decision making and to gain competitive advantage” (Chee et al., 2009, p. 97). In this instance, BI is deemed a product that supports the decision-making process by providing executive managers and business leaders with high-quality data at the right time. Examples of top BI vendors in the market are IBM, Oracle, SAS, Business Objects, Cognos and SAP (Papadopoulos & Kanellis, 2010). Overall, there is no precise or common definition for BI, but the literature tends to treat it as the reporting and analysis functions of DSS.
2.5 Business Intelligence Architecture

In the literature, different BI architectures are proposed by many authors (e.g. Baars & Kemper, 2008; Bălăceanu, 2007; Efraim Turban, Sharda, Aronson, & King, 2008; Shariat & Hightower, 2007; Watson, 2009). These architectures vary in terms of structures, layouts, components, layers and processes (Shariat & Hightower, 2007). According to Coronel and Morris (2016), BI architecture is a framework for organising and coordinating different components of BI. These components include data, information management, people, technology, and processes for building BI systems. The underlying BI architecture is playing a critical role in BI-related projects, as it affects development and implementation success, as well as the operations of the BI environment (Ong, Siew, & Wong, 2011). Thus, having a solid BI architecture could arguably help organisations maximise value from their BI investments (Anand, 2014).

This maximisation is possible because of the many front-end applications, middle-tier services (e.g. online analytical processing [OLAP]) and visualisation products that help in communicating the results of the analysis (Elena, 2011). Consequently, the quality of the source data is inextricably linked to the technical infrastructure of the data warehouse (Vodapalli, 2009). Conversely, a poor BI design may lead to a situation where the wrong information is provided to the wrong people (Ong et al., 2011). This misinformation, in turn, can cause many problems, such as problems with data quality, inconsistencies among the different components and an inability to meet business requirements (Vercellis, 2009). In the worst case, misinformation may also lead incorrect decisions, thereby hindering business performance.
2.5.1 Components of BI Architecture

The basic structure of any BI software should consist of three main components: DW, OLAP and data mining (Turban & Volonino, 2010). The study by Vercellis (2009) offers the most comprehensive analysis of the primary components of a BI system. According to this study, the key elements of BI architecture comprise source systems, DW, and BI methodologies. In this dissertation, the proposed architecture by Mishra (2016) is adopted and discussed (see Figure 3).

Figure 3: A typical architecture of BI system

Source: Adapted from Mishra (2016)
2.5.1.1 Data Sources

A data source, in its simplest definition, is the origin of data and the first and most critical stage of BI system building blocks that has direct implications for the quality of analysis (Vercellis, 2009). Data sources can be generated from various primary and secondary sources, such as operational databases, historical data or an external provider (e.g. market research companies; Ranjan, 2009). In most cases, the origin and type of data are heterogeneous (Vercellis, 2009). In other words, the data source might contain structured information (e.g. spreadsheets and tables), as well as unstructured information (e.g. images, emails and multimedia data; Ranjan, 2009). Such variation in the data types, however, might raise challenges when attempting to unify and integrate different data sources (Vercellis, 2009). To tackle this problem, Rahm and Do (2000) emphasise the need for data cleaning, which is recognised as one of the prime concerns in data warehousing. According to Rahm and Do’s (2000) study, data cleaning involves removing duplications, errors, and inconsistencies from data to improve the quality of the data.

As shown in Figure 5, before loading the data into the warehouse servers, data cleaning is performed in a staging area as an integral part of the extraction, transformation, and loading (ETL) process.

2.5.1.2 Data Warehouse

Data warehouse is the core component for developing BI architectures and DSS (Power, Sharda, & Burstein, 2015), holding an enormous amount of enterprise data gathered from a variety of sources (Vercellis, 2009). DW is a subject-oriented (e.g. products, customers, orders and sales), integrated and non-volatile collection of data (Inmon, 1992).
According to Chaudhuri and Dayal (1997), the DW is described as “a collection of decision support technologies, aimed at enabling the knowledge worker (executive, manager, analyst) to make better and faster decisions” (p. 1). Because the DW technology is used primarily for decision support, the quality and correctness of the data sources must be ensured to avoid wrong decisions (Rahm & Do, 2000).

Mishra (2016) found that ensuring the quality of existing customers’ data has been a big barrier for adopting of the BI technology in Indian banks. Considering this problem, several BI current architectures tend to separate the DWs from the operational databases (Chaudhuri & Dayal, 1997). The reason for this isolation might be due to the difference between the functional and performance requirements of these databases (Chaudhuri & Dayal, 1997). Whereas the DWs support the process of OLAP applications, the operational databases are supporting online transaction processing (OLTP). Further evidence of this argument can be found in the study conducted by Vercellis (2009).

2.5.1.3 On-line Analytical Processing (OLAP)

OLAP application is another important category of the BI systems, potentially encompassing relational databases, reporting servers, data-mining techniques, and text analytics engines (Ranjan, 2009). For Reinschmidt and Francoise (2000), an OLAP server refers to a “data manipulation engine that is designed to support multi-dimensional data structures” (p. 13).

OLAP provides users with multi-dimensional information that allows them to analyse and generate aggregated views from multiple perspectives quickly (Ong et al., 2011). Thus, the data in an OLAP server are stored in the form of data cubes (i.e. a multi-dimensional dataset), rather than tables (i.e. rows and columns), to reduce query time (Mathur, 2016).
Fundamentally, a typical OLAP application handles four basic operations: drill-up, drill-down, slice and dice and pivot (i.e. rotate or swapping) (Chaudhuri & Dayal, 1997; Han, Pei, & Kamber, 2011).

2.5.1.4 Data Mining

Data mining (a.k.a knowledge discovery) is the fourth level of the BI architecture, with a primary purpose of extracting hidden patterns and relevant knowledge from a large quantity of datasets (Witten & Frank, 2005). To achieve this process, data mining integrates DWs and OLAP servers by applying various statistical techniques (e.g. regression analysis, classification or clustering) using sophisticated machines learning, such as WEKA2 (Vercellis, 2009).

Fayyad (1997) defines data mining as a method of extracting useful information that was previously unknown or invisible from the data stored in a warehouse or database. Furthermore, data mining provides managers and executives with data visualisation tools (Heer, Bostock, & Ogievetsky, 2010), which are useful for identifying unsuspected relationships or trends (Ong et al., 2011). Indeed, a significant intervention from the analyst is required at multiple phases to confirm the accuracy of the data, thereby avoiding misleading conclusions. Generally, data mining technology serves two main tasks:- interpretation and prediction (Witten & Frank, 2005).

2.5.1.5 Front-end Applications

The front-end application (or user-interface) is the higher level and most visible BI component to business users (Ong et al., 2011). This component consists of query and reporting tools, allowing users to access and generate ad hoc reports for decision-making purposes (Hamilton, 2009). This component also consists of dashboards and scorecards (Eckerson, 2006).

2 http://www.cs.waikato.ac.nz/ml/weka
From the perspective of managers, the ability to create queries and reports in an easy manner is considered a key indicator of successful BI implementation (Yeoh & Koronios, 2010). Given this relationship, the usability of the user-interface must be taken into account when selecting and implementing the BI product.

Summarising the above information, BI architecture is one critical factor that may affect the success of BI deployment (Vodapalli, 2009). A review of the existing BI architectures reveals a wide range, but a typical BI should include source data, DWs, and data-mining techniques.

2.6 Business Intelligence in Banking

Over the past decade, banks and financial services have made a significant investment in BI systems (Gadda, 2014; Lorenzetti, 2010). This trend towards BI adoption in the financial market resulted in the high capability of BI technology to help banks mitigate risks, increase their customer base, detect fraud, reduce transaction costs and provide insights into their profitability (Preko & Kester, 2015).

2.6.1 Motivations for BI Adoption in Banks

Before the emergence of analytical software packages in the 1970s and 1980s, manual reporting systems were increasingly used by banks with relatively small operations (Rasmussen, Goldy, & Solli, 2002). These systems were limited to branches requiring manual recording of branch transactions and ledgers (Sahu, 2012). Hence, the capability of manual systems was restricted to rudimentary reporting of banking transactions (Najmi, Sepehri, & Hashemi, 2010).
Indeed, as banks grew and expanded geographically, their transactions became vast and complex. Thus, managing such huge volumes of transactions through traditional legacy systems became time-consuming and error-prone (Sahu, 2012).

Additionally, the rapid increase of consumer and corporate loans has prioritised the banks’ concerns to issues relating to the repayment of credits in accordance with the agreed terms and conditions (Chen & Lin, 2015). Loans make up a core part of bank business; thus, effective management of credit risks is a major activity involved in achieving sustainable profits (Weber, 2012).

However, predicting credit defaults involves deep analysis of borrowers’ historical data and characteristics (such as earnings, liquidity and capital stock), which cannot be done via traditional systems (Weber, 2012). Moreover, the complexity of decision-making processes in banking requires rigorous analytical methodologies and mathematical algorithms (Vercellis, 2009).

Consequently, modern banks have increasingly began to adopt advanced analytical tools, such as BI, for managing their banking operations, thereby increasing operational efficiency (Mishra, 2016). This view is supported by Preko and Kester (2015), who showed that banks that applied BI techniques gained a competitive advantage and power in the financial market.

In general, the technical limitations of legacy systems, growth of credit risks and complexity of decision-making processes were the major influences that caused many banks to invest in BI technologies.
2.6.2 BI Uses in Banking

Mishra (2016) offers useful insight into the uses of BI and analytics in banking through a case study investigation covering various banks in India. His findings reveal that BI tools were used for historical data analysis, regulatory compliance, risk management, performance management, business performance analysis, customer profitability and credit risk management (see Figure 4).

![Figure 4: BI uses in banking](Source: Mishra (2016))
Similarly, Olszak and Ziemba (2006) highlight the most critical functional areas in banking that have obtained a significant business value from BI adoption. Particularly, these areas include customer profitability analysis, credit management and customer service improvement, as described in Table 3 (Olszak & Ziemba, 2006). Taken together, both studies agree that BI tools are largely used in banks for customer-relationship management and credit-risk analysis.

**Table 3: BI application areas in banking**

*Source: Adapted from Olszak and Ziemba (2006)*

| Banking, finance and securities |  
|--------------------------------|---|
| **Customer profitability analysis.** | Determinate the overall profitability of individual customer, current and long term, provide the basis for high-profit sales and relationship banking, maximize sales to high-value customers, reduce costs to low-value customers, provide the means to maximize profitability of new products and services  
| **Credit management.** | Establish patterns of credit problem progression by customers class and type, warn customers to avoid credit problems, to manage credit limits, evaluate of the bank’s credit portfolio, reduce credit losses  
| **Branch sales.** | Improve customer service and account selling, facilitate cross selling, improve customer support, strengthen customer loyalty |
2.7 Business Intelligence for Credit Risk Management

As discussed in Section 2.6, risk is at the heart of the banking industry, and failure to mitigate its occurrences can lead to significant losses in profitability (Wu & Olson, 2010). Thus, effective risk-management strategies become crucial to ensure the long-term survival of banks (Bessis & O’Kelly, 2015). In their study “Business Intelligence in Risk Management”, Wu, Chen, and Olson (2014) define risk management as “the process of identification, analysis and either the acceptance or mitigation of uncertainty in investment decision-making” (p. 2).

In practice, each business should efficiently cope with specific risks to exist (Wu & Olson, 2010). The financial sector, for example, should respond to numerous risks, including, but not restricted to, credit, market and liquidity risks. According to Chen and Lin (2015), credit risk is far more critical for the banking industry; therefore, this risk has prompted many banks to re-think their business strategies to reduce its negative impacts to an acceptable level.

In the era of big data, BI systems have provided new opportunities for credit officers to gain deep insights into borrowers’ credit information (Mishra, 2016). Through the integration of BI with credit-risk management approaches, predicting borrowers’ future behaviour becomes more practical by mining customers’ personal information (Yap, Ong, & Husain, 2011). This view is supported by Lee, Chiu, Chou, and Lu (2006), who confirm the effectiveness of clustering and regression BI techniques in providing a high-accuracy estimation of credit defaults. Furthermore, Thomas, Edelman, and Crook (2002) show that the survival analysis model can be utilised for performing credit behavioural scoring, as well as predicting the time in which borrowers are likely to default on debts.
Another major study has further extended the capabilities of survival analysis by integrating it with neural network methods (Baesens, Gestel, Stepanova, Van den Poel, & Vanthienen, 2005). In this regard, Bellotti and Crook (2009) found that further improvement in predicting the probability of default (PD) can be perceived by including macroeconomic variables (e.g., inflation rate and unemployment rate) into the Cox model.

Overall, the business effects of adopting BI technology for credit-risk analysis are numerous. This action can help banks perform better assessment and predictions of credit risk based on historical analysis of customer behaviour (Baesens et al., 2005; Bekhet & Eletter, 2012).

2.8 Critical Success Factors for BI Implementation

Modern BI projects rely heavily on IT; therefore, determining the most effective factors for BI implementations is important (Vodapalli, 2009; Yeoh & Koronios, 2010). Critical success factors (CSFs) provide insight into those factors that can influence the success of BI projects in a specific business context (Yeoh, Koronios, & Gao, 2008a). Adamala and Cidrin (2011) highlight a number of critical factors more likely to attain successful BI initiatives, as shown in Table 4.
Table 4: List of CSFs derived from literature review

Source: Developed for this research

<table>
<thead>
<tr>
<th>Source: (Adamala &amp; Cidrin, 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ensured user involvement</td>
</tr>
<tr>
<td>• Good project sponsorship</td>
</tr>
<tr>
<td>• Effective team skill set</td>
</tr>
<tr>
<td>• Realistic schedule</td>
</tr>
<tr>
<td>• Proper project control procedures (change control)</td>
</tr>
<tr>
<td>• Correct choice of tools</td>
</tr>
<tr>
<td>• Common data definition</td>
</tr>
<tr>
<td>• Well-defined transformation rules</td>
</tr>
<tr>
<td>• Properly trained users</td>
</tr>
<tr>
<td>• Expectation communication to users</td>
</tr>
</tbody>
</table>

Of those factors mentioned above, top management support has been widely recognised by researchers and practitioners as the most effective factor towards achieving successful BI implementation (Yeoh et al., 2008b).

In contrast, Cervone (2006) maintains that the failure of BI projects could be attributed to the following factors:

- Insufficient top management and end-user involvement
- Misunderstanding of the requirements due to lack of skills
- Failure to manage the expectations of end-users
Cervone (2006) emphasises the importance of involving management and the end-user in early stages of design, analysis and implementation of BI. Furthermore, he argues that developers may not have the required business knowledge or skills to achieve the desired result, and subsequent misunderstandings or inaccuracies may occur.

2.8.1 Categorisation of CSFs

Yeoh et al. (2008a) have categorised CSFs into three broader groups: organisational, technical and procedural perspectives (see Table 5).

Table 5: Categorisation of CSFs

Source: Adapted from Yeoh et al., (2008b)

<table>
<thead>
<tr>
<th>Organization Perspective</th>
<th>Process Perspective</th>
<th>Technology Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partnership between Business Community and IT</td>
<td>Business driven methodology and Project management</td>
<td>Robust and extensible Framework</td>
</tr>
<tr>
<td>Committed management support and sponsorship</td>
<td>Usage of iterative prototyping to define requirements and scope</td>
<td>Data quality and management issues</td>
</tr>
<tr>
<td>Information governance via BI competency center</td>
<td>Map the solutions to the users</td>
<td>Appropriate technology and tools</td>
</tr>
<tr>
<td>Clear business vision and planning</td>
<td>Balanced team Composition</td>
<td>Integrated BI Applications</td>
</tr>
<tr>
<td></td>
<td>User training and support</td>
<td>Performance Considerations</td>
</tr>
<tr>
<td></td>
<td>Change management</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5 provides a typical framework of the top five implementation factors (managerial and technical) for successful BI in any organisation.
Overall, many believe that the lack of CSF identification is more likely to result in potential failure of the BI system (Yeoh & Koronios, 2010).

2.9 Effectiveness of BI in Banking

The use of BI systems can likely bring vast benefits to an organisation if deployed properly (e.g. Ranjan, 2009; Tunowski, 2015). In their study, Gibson et al. (2004) classified the benefits of BI into tangible (e.g. cost savings and return on investments [ROI]) and intangibles (e.g. better quality, better strategies, better tactics and decisions and better information).
The researchers assert that the intangible benefits outweigh the tangibles due to the difficulty in measuring the tangibles’ delayed impacts on the business success (Gibson et al., 2004).

Watson and Wixom (2007) propose a model that illustrates the spectrum of BI benefits against its impact scope (see Figure 6).

According to Watson and Wixom’s (2007) model, the most tangible benefits (e.g. cost savings) have a major influence at the local level of an organisation, typically a departmental level. However, the most intangible benefits, such as business improvements and strategic support, can have a major impact on the entire organisation (Watson & Wixom, 2007).

Figure 6: Spectrum of BI benefits

2.9.1 Benefits of BI in Banking

In his study, Bhasin (2006) draws our attention to a number of business opportunities that could be obtained by adopting BI in banking. According to Bhasin (2006), BI can help banks and other financial institutions gain valuable insights into customers’ behaviours, predicting payment default by mining historical data, detecting fraudulent transactions, optimising business decisions and improving risk management. Through the use of BI, the bank would be able to increase its efficiency and effectiveness by making better and accurate decisions based on real-time data (Moro, Cortez, & Rita, 2015).

This view has been evidenced by Olszak and Ziemba (2003), who argue that BI can support all levels of management regardless of their structuralisation by providing effective decision making, strategic thinking and acting in organisations. As shown in Figure 9, BI software plays a critical role in transforming raw data into information and knowledge crucial for making smart decisions (Ranjan, 2009).

Through this automated process, banking enterprises can keep track of all relevant information and assess which information is valuable for increasing the revenue while reducing costs (Gibson et al., 2004; Microsoft, 2007). However, reducing costs cannot be achieved without proper mitigation and control of risks, as well as enhancing operational efficiency (Bekhet & Eletter, 2012; Dass, 2009). Furthermore, the use of BI systems clearly has allowed bankers to perform in-depth and accurate risk analysis based on an evaluation of borrowers’ trends (MicroStrategy, 2008; Wu et al., 2014).
From a strategic level, BI has allowed decision makers in banks to set up their strategic objectives and monitor key business performances through an interactive user interface (i.e. BI dashboards; Dass, 2009). By measuring business performance on a risk-adjusted basis, banks can strengthen their performance goals while adhering to new compliance requirements, such as Basel II (Bekhet & Eletter, 2012).

Also, by using BI models, such as predictive modelling, bank executives and officers can predict which customers will be likely default on a credit loan (Bessis & O’Kelly, 2015). This feature can help to mitigate potential credit risks (Chen & Lin, 2015).
Rao and Kumar (2011) report that banks worldwide are adopting intelligent business solutions, typically BI for managing risks, ensuring compliance requirements, profitability analysis, historical analysis, regulatory reporting, performance management and customer relationship management. Similarly, Chee et al. (2009) highlight critical areas of BI application in banking as evidence of its usefulness (see Table 6).

Table 6: Benefits of BI in banking

Source: adapted from Chee et al. (2009)

<table>
<thead>
<tr>
<th>BI Application</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banking industry relies on the BI platform to make more effective decisions in a few areas such as Customer Analysis, Operations &amp; Financial Analysis, Sales &amp; Marketing Analysis, Promotion Analysis, and Risk &amp; Fraud Analysis.</td>
<td>• BI applications help management to improve operational and strategic decisions based on better and timely information. • Potential customers are identified through the analysis of purchasing data. Cross-selling opportunities will be recognized via analysis of customer behavior.</td>
</tr>
</tbody>
</table>

Together, the most significant benefits gained from BI implementation, as reported by Hannula and Pirittimäki (2003), are as follows:

• Better quality of information,

• Better prediction of possible threats and opportunities,

• Increase knowledge base,

• Increase of information sharing,
• Improve efficiency,
• Easier acquisition of information and analysis, and
• Faster decision making.

In summary, the benefits of BI systems can be divided into five main categories. These categories, as shown in Figure 10, are revenue increase, profit increase, customer satisfaction improvement, saving increase and market share gain (Moss & Atre, 2003). In the context of banks and finance, BI provides the executives and officers with the ability to solve problems in various fields, including risk, performance, and compliance management, credit analysis and fraud detection (Sahu, 2012).

Figure 8: BI benefit categories

2.9.2 Costs of BI

Many current publications and books focus on the benefits of BI, but few sources consider its related costs or risks. Nevertheless, the most significant costs of BI are associated with the implementation requirements, including hardware, software, human resources, data quality issues and development costs (Scholz, Schieder, Kurze, Gluchowski, & Böhringer, 2010). Table 7 summarises the most common costs of BI implementation projects.

Table 7: Costs of business intelligence system
Source: Ponomarjovs (2013)

<table>
<thead>
<tr>
<th>Cost</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business intelligence requires investment into hardware, such as servers.</td>
<td>Gartner, 2013, Madsen, 2010</td>
</tr>
<tr>
<td>Business intelligence requires investment into software, such as tools, applications, and licences.</td>
<td>Gartner, 2013, Madsen, 2010</td>
</tr>
<tr>
<td>Business intelligence biggest expenses are related to solution initial implementation, on-going development, and maintenance.</td>
<td>Gartner, 2013, Madsen, 2010</td>
</tr>
<tr>
<td>Business intelligence solution implementation requires investment into business process redesign. Moreover, business intelligence solution implementation has cost of disruption.</td>
<td>Gartner, 2013, Madsen, 2010</td>
</tr>
<tr>
<td>Business intelligence requires investment into human resources, such as salaries, wages, travel expenses, trainings.</td>
<td>Gartner, 2013, Madsen, 2010</td>
</tr>
</tbody>
</table>
2.10 Summary of Literature Review

To conclude, BI architecture is a vital aspect in the implementation process because a poor design can create false information (Yap et al., 2011). Ultimately, this false information can lead to inconsistent and incorrect decisions. BI allows banks to increase its efficiency with more accurate decisions based on real-time data analysis. BI also provides bankers with the capability to build accurate predictive models, which can anticipate the likelihood of defaults by analyzing borrowers’ behaviours. The support of top management is the most important factor for BI implementation success, and a problem with data quality seems to be the most obvious risk.

Chapter 3 Methodology

3.1 Introduction

This chapter is concerned with the research methods used in this dissertation. Section one starts by highlighting the major methodological approaches in social sciences. In section two, data collection methods related to qualitative research is highlighted. The third section presents the research process used for conducting this research, data gathering and data analysis, which followed by ethical aspects.

3.1.1 Research Purpose

The aim of this research was to investigate the impact of adopting BI systems for credit-risk management in the banking industry of Oman.
3.2 Research Approach

Many scholars (e.g. Bryman & Bell, 2015; Walter, 2013) in the social sciences have emphasised the importance of selecting an appropriate approach and strategy to achieve the objectives of the research. Typically, there are two common approaches available for the researcher when dealing with social science studies (Neuman, 2002). These approaches can involve either deductive or inductive reasoning (Heit & Rotello, 2010).

3.2.1 Inductive Approach

An inductive study, or “bottom-up approach”, starts with observations from the real world and moves towards generalisations and ideas (Neuman, 2002). According to the same study, inductive reasoning aims to generate general conclusions or develop a theory from the data set collected.

In contrast, in deductive studies the researcher moves from broader to the more specific observations, known as a top-down approach (Singleton, Straits, & Straits, 1993). In this sense, the researcher establishes ideas or hypotheses from known theories and, then uses empirical data to accept or reject these hypotheses (Kumar & Phrommathed, 2005).

Considering these factors, adopting inductive reasoning is arguably the most appropriate approach for this research. This conclusion is determined because this study is exploratory, aiming to develop theoretical explanations based on empirical data collected through interviews. Also, this study begins with observations and analysis of the empirical findings, rather than hypotheses or existing theories. The model presented in the following figure provides an overview of the steps taken in this inductive study.
3.3 Research Methods

According to Matthews and Ross (2010), the choice of a research method should be determined by the research topic, research questions or hypotheses, relevant literature and personal experience of the researcher. Generally, research methods can be categorised into quantitative, qualitative (Neuman, 2002; Patton, 1990) or sometimes a combination of both approaches (aka mixed methods). In his study, Bryman (2008) provides common contrasts among qualitative and quantitative research, as shown in Table 8.

Quantitative research is deductive, focusing on numerical data (e.g. numbers, percentages) (Creswell, 2013). Such numerical data is used often to test a hypothesis or measure relationships using statistical and mathematical models (Creswell, 2013).
In contrast, qualitative research is inductive and interpretive, focusing on the qualities of subjects, words, feelings, opinions and beliefs (Bryman & Bell, 2015). Because the current study is based on the inductive approach, the qualitative method was adopted.

**Table 8: Comparison between qualitative and quantitative research**

*Source: (Bryman, 2008, p. 393)*

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>words,</td>
<td>Number</td>
</tr>
<tr>
<td>points of view of participants,</td>
<td>point of view of the researcher</td>
</tr>
<tr>
<td>researcher close,</td>
<td>researcher distinct</td>
</tr>
<tr>
<td>theory emergent,</td>
<td>theory testing</td>
</tr>
<tr>
<td>process,</td>
<td>static</td>
</tr>
<tr>
<td>unstructured,</td>
<td>structured</td>
</tr>
<tr>
<td>context understanding,</td>
<td>generalizing</td>
</tr>
<tr>
<td>rich in depth,</td>
<td>hard reliable data</td>
</tr>
<tr>
<td>micro,</td>
<td>macro</td>
</tr>
<tr>
<td>meaning,</td>
<td>behaviour</td>
</tr>
<tr>
<td>natural setting</td>
<td>artificial settings</td>
</tr>
</tbody>
</table>

**3.3.1 Qualitative Research**

According to Marshall and Rossman (2014), qualitative research is an inquiry that attempts to improve a human’s understanding of a phenomenon or situation by investigating why and how something happens in reality. Thus, his types of research appears to be an appropriate method for conducting exploratory study, which typically aims to answer ‘why’ and ‘how’ questions (Denzin & Lincoln, 1994).
Benoliel (1984) describes qualitative research as “modes of systematic inquiry concerned with understanding human beings and the nature of their transactions with themselves and with their surroundings” (p. 3).

Because there is some agreement on human involvement within qualitative research, the quality of data collection is arguably influenced by human credibility and knowledge (Myers, 2000). Also, qualitative research is subjective, involving the researcher as a social being (Matthews & Ross, 2010).

The lack of generalisability, however, is seen as a serious limitation of qualitative methodology (Hamel, Dufour, & Fortin, 1993; Yin, 2013). The term generalisability is defined by Polit and Beck (2004) as the ability to generalise the findings to an entire population based on the study sample.

The motivation for adopting qualitative research comes from several places. First, qualitative research can provide the researcher with an opportunity to investigate additional questions surrounding the topic and provides in-depth analysis within its natural settings (Mason, 2002). The latter point, however, cannot be achieved through purely quantitative methods (Patton, 2005). Second, qualitative research methods generally are designed for exploratory research that involves collecting and analysing data from various sources (e.g. interview transcripts, observations and existing documents). Third, the use of qualitative research is increasing in assessing the effectiveness of BI on a particular phenomenon or context (e.g. Kaplan & Maxwell, 2005).
3.4 Data Collection Methods

In order for the fundamental research goals to be met, it is vital that the right method, or a combination of methods, is chosen for the analysis stage (Olsen, 2011). For this reason, the researcher must have a clear understanding of each research method so as to decide on the most appropriate method for the project. Matthews, B., and Ross (2010) have defined data collection methods as “the means by which the data is collected, for example, a questionnaire, a format or, in the case of semi or unstructured interviews, the researcher herself…” (p. 181). In his study, Gummesson (2000) suggests the following five research methods for data collection purpose:

1. Using existing materials
2. Questionnaire surveys
3. Qualitative interview
4. Observations
5. Action science

This qualitative research seeks to gain an understanding of the impact of BI systems from the perspectives of Omani bankers; therefore, the interview method was applied.

3.4.1 Interviews

Interviewing is a well-established data collection method in qualitative research (Bryman & Bell, 2015; Miles, Huberman, & Saldana, 2013). The qualitative interview can be informal or formal, but it must be a conversation with a particular purpose, which is usually to gather opinions, perceptions and feelings from the interviewees (Neuman, 2002).
Kvale and Brinkmann (2009) define the interview as a dialogue that aims to discover the world from the subject’s point of view before entering into scientific explanations.

By using qualitative interviews, the researcher can obtain different types of data, including explanatory, descriptive and exploratory data (King & Horrocks, 2010). These data, however, may or may not lead to the development of new theories (Hamel et al., 1993; Patton, 1990). Although it seems simple to conduct an interview, the researcher should be careful to design questions that obtain useable and the most relevant data (Kvale & Brinkmann, 2009; Richards, 2014).

### 3.4.1.1 Types of Interview Method

There are three types of interviews methods available to researchers conducting qualitative research (Louise Barriball & While, 1994). These are structured, semi-structured and unstructured interviews (King, 1994).

In a structured interview, the questions are typically short, precise, and often in closed-ended form (Strauss & Corbin, 1990). Also, questions are asked in a certain sequence that is consistent for all the participants, and there is no opportunity to deviate from this predetermined set of questions (Kvale & Brinkmann, 2015). Even though the structured interviews provide consistency, it is the less efficient method of data collection in grounded theory research (Strauss & Corbin, 1990).

In an unstructured interview, the questions are usually complex and open-ended and can be asked in any sequence (Strauss & Corbin, 1990). In this instance, the sequence of questions follows the interests and ideas of the participant (Richards, 2014).
Thus, there is the potential risk that the researcher could lose control of the interview and, in the worst cases, end up with unsatisfactory data (King & Horrocks, 2010).

A semi-structured interview is a combination of both structured and unstructured formats (Louise Barriball & While, 1994). This method is the most common in qualitative research because it provides the researcher with some flexibility and consistency over the topics and structure of the interview (Strauss & Corbin, 1990).

However, there are disadvantages to this approach. For example, because the questions asked will differ across participants, the results are hard to generalise (Denzin & Lincoln, 2011). Thus, the researcher must try to avoid asking too complex or leading questions (Kvale & Brinkmann, 2009). Furthermore, the quality of results in the semi-structured interview is highly dependent on the skill and expertise of the interviewer (Louise Barriball & While, 1994).

The current study involves a direct interaction between the researcher and participants to gain a detailed understanding of a phenomenon. Therefore, adopting a semi-structured interview approach is more sensible and provides the researcher more flexibility in preparing the core format and topics of the interview (Louise Barriball & While, 1994). This preparation, in turn, can ensure that the interview questions have the correct focus. Additionally, through the semi-structured interview, the researcher can add supplementary questions based on the participants’ responses (Louise Barriball & While, 1994). Consequently, a more in-depth exploration of the phenomena under a selected context is possible.
3.4.2 Sampling

In qualitative research, designing a robust sampling strategy is important because it has a significant impact on the validity and quality of the research results (Marshall & Rossman, 2014). Walter (2013) defines sampling as a “set of cases or elements that are selected from a population” (p. 101), whereas he describes a population as “the total collection of all cases or elements that we want to study…” (p. 101).

3.4.2.1 Sample Populations of the Study

Participants of this study were recruited from the Omani banking industry, including CBO, Bank Muscat, HSBC Oman, Oman Arab Bank, National Bank of Oman and Al IZZ Islamic bank. The actual sample size consists of nine participants. The participants were divided into two groups based on their functional departments at the banks: technical and non-technical. These departments included, but were not limited to, risk management, credit bureau, IT, financial stability and project management.

3.4.2.2 Sampling Method

Generally, there are two major types of sampling strategy: probability and non-probability sampling (Punch, 2013). The former is based on the theory of probability (Curtis, Gesler, Smith, & Washburn, 2000), where samples are randomly selected from a larger population. This technique, however, is more suitable for quantitative research, which often involves a large representative sample for hypothesis testing (Vogt, 2000). In sharp contrast, non-probability sampling involves a non-random selection of the samples, typically with purpose (aka purposive sampling).
Based on this information, the choice of purposive sampling is arguably more acceptable in this research because this study focuses on a particular context of subjects (i.e. professionals from Omani banks). Also, the sample is selected purposively for obtaining in-depth understanding of Omani banks’ experiences with BI for credit-risk management.

3.5.2.3 Purposive Sampling

An example of purposive sampling is when participants are recruited because of their knowledge of or experience with a certain research area. This specific knowledge can help the researcher build a theory or investigate a particular research question (Tongco, 2007). By drawing on the concept of purposive sampling, Tongco (2007) provides some important steps to consider before deciding which sampling technique to use (see Figure 10). Furthermore, maintaining a list of unique conditions can save the researcher time and effort in obtaining a valid sample of a larger population (Devers & Frankel, 2000).

3.4.2.5 Criteria for selecting the sample

In the present study, the criteria for selecting the subjects were as follows:

- The participant should be a member of an Omani bank supervised by CBO.
- Non-technical participants should have at least three years of experience in BI-related concepts and technologies, as well as credit risk.
- The technical participants should be a member of a BI implementation project.
1. Decide on the research problem.

2. Determine the type of information needed.
   - Information from every individual in the community is potentially valuable > use random sampling
     - Time and resources are too limited for random sampling > use purposive sampling with caution
   - Information is held by only certain members of the community > use purposive sampling
     - Information needs a high degree of interpretation regarding cultural significance > use key informants

3. Define the qualities the informant(s) should or should not have.

4. Find your informants based on defined qualities.
   - Research about the area and community.
   - Ask for help before going to the site and upon arrival at the site.
   - Realize finding informants may be a trial and error process. Be patient and persistent!

5. Keep in mind the importance of reliability and competency in assessing potential informants.

6. Use appropriate data gathering techniques.

7. In analyzing data and interpreting results, remember that purposive sampling is an inherently biased method.
   - Document the bias.
   - Do not apply interpretations beyond the sampled population.

**Figure 10: Steps in purposive sampling**

**Source:** Tongco (2007)

### 3.5 Research Process

The researcher has followed a systematic approach to design this qualitative study, derived partially from Pickard's study (2012).

The steps undertaken can be summarised as follows:

1. **Framing the research question:** In this phase, the researcher formulated the research question to identify the scope and type of information to be collected from the research participants (King & Horrocks, 2010). To narrow the scope of the research question, the researcher focused on one particular context (i.e. Omani banks).
2. **Thematising:** In this stage, the researcher divided the established research question into sub-topics and themes. Thematising the research question into themes helped the researcher to stay focused on the aims and objectives of the research.

3. **Reviewing the literature:** This stage is very critical because it provided the researcher with insight into the research topics and issues. During this phase, relevant studies were reviewed, and key questions were derived accordingly.

4. **Preparing the interview guide:** The interview guide was developed based on the structure proposed by Kvale and Brinkmann (2009). The researcher first outlined the key topics the study intends to cover as sections. To phrase the interview questions (see Appendix A), two main sources were used: personal experience of the research topic and previous studies concerning BI and credit-risk management in banks (Naveen K. Vodapalli, 2009; Prevé, 2008; Wang, 2013).

5. **Piloting:** Before conducting the interview, the research conducted pilot testing with two participants matching the sampling criteria specified by the researcher.

6. **Interviewing:** The research conducted the interviews using the guide and checklist suggested by Kvale and Brinkmann (2009).

7. **Transcribing the interviews:** In this stage, the researcher transcribed the recorded interviews from audio to text for data-analysis purposes.

8. **Analysing the interviews:** Once the interview materials were transcribed, the researcher began coding the data before proceeding with the textual analysis. In this case, thematic analysis was adopted as it provided more focus on research objectives.
9. **Verifying interview findings:** To ensure the validity and reliability of this qualitative research interview, the researcher used numerous sources of information. These sources included interviews with various people within the same organisation and examination of that company’s website and annual reports. The former, however, could not be fully achieved due to the time constraints and difficulty in recruiting more respondents by telephone or email. This study is considered reliable because the selected participants have been in a professional capacity for a number of years and, therefore, have a good understanding of the business.

10. **Reporting the interview findings:** To comply with the scientific criteria of social science (Turner, 2010), this study took into account the possible ethical aspects arising from communicating the research results. Therefore, the researcher clearly explained what would happen to the findings of the research in the consent form (see Appendix B).

### 3.6 Data Collection and Analysis

In this research, the data were gathered through telephone interviews (Carr & Worth, 2001). This method is not employed as often as face-to-face interviews are when gathering qualitative data (King, 1994). However, the situation was unavoidable because the interviewees were based in Oman, and the interviewer was in the UK.

The participants were recruited through an email invitation that included an overview of the research objectives and data collection methods and an ethical approval letter from the university. Upon their confirmations, the researcher contacted the interviewees to agree on a timeframe for conducting the interview.
Before starting the telephone interview, participants were asked to read the informed consent and provide his or her signature accordingly. For data quality assurance, most of the interviews were recorded using digital assistance. The time period for each interview ranged from 30 minutes to one hour 30 minutes.

After completing the interview, the researcher transcribed the audio recordings into text using Microsoft Word. Previous data transcriptions, both written notes and recorded conversations, were compared to validate the accuracy of data entry before starting the analysis.

3.9 Ethical Aspects

Ethical concerns have challenged practitioners and academic researchers to conduct social research that complies with a set of principles and standards (Walter, 2013). Research ethics, as cited by Matthews and Ross (2010), refers to “the moral principles guiding research, from its inception through to completion and publication of results and beyond…” (p. 71). Examples of ethical issues that could arise include confidentiality of data, anonymity, informed consent and data protection.

This research was approved by the University of Sheffield’s Research Ethics Committee and classified as low risk (see Appendix C). Because this research involved interactions with human beings, a set of ethical guidelines was applied to safeguard the rights of the participants.

First, this study strictly conformed to the University of Sheffield's Research Ethics Policy\(^3\). Second, the participants were provided with informed consent (see Appendix B) before the interview, which explained the purpose, methods and possible use of the research findings, as well as the ethical aspects.

\(^3\) For more information please visit the website: http://www.shef.ac.uk/ris/other/gov-ethics/ethicspolicy
Third, the researcher anonymised personal identifiable information by assigning each participant an arbitrary number. More importantly, all collected data, including digital files and transcripts, were stored on the Information School's research data drive. This drive can only be accessed by the researcher, supervisor, and school's examinations officer.

Moreover, the researcher will destroy and delete all collected data after three months of completing the dissertation. Overall, the potential risks of taking part in this research are no greater than what might be experienced in daily life.

Chapter 4 Results and Data Analysis

4.1 Introduction

As has been seen in the previous chapter, this dissertation is based on a qualitative approach, utilising a semi-structured interview to answer the research questions mentioned in the introduction. This chapter presents the most significant findings of this research; they are then discussed in more detail in the next chapter.

4.2 Demographic characteristics of the study sample

Table 9 below shows some of the main characteristics of the sample study. From this data, it can be seen that nine interviews were conducted with technical and non-technical professionals working at different banks in Oman. These participants were interested in joining the study because they believe that credit risk management is one of the critical issues faced by most banks in the world, including Omani banks.
One of the key participants stated “credit risk is the essential and core risk in commercial bank activities, this why we need more studies, guidelines and principles, to be prepared for financial crises or technological changes which might arise risk credit occurrence” [Respondent 8].

**Table 9: Respondents’ Profile**

<table>
<thead>
<tr>
<th>Respondent ID</th>
<th>Gender</th>
<th>Bank Code</th>
<th>Bank Category</th>
<th>Department Name</th>
<th>Job Title</th>
<th>Total Years of Experience in Credit Risk</th>
<th>Total Years of Experience in BI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female</td>
<td>CBO</td>
<td>Regulatory</td>
<td>Banking Surveillance</td>
<td>Manager</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Male</td>
<td>CBO</td>
<td>Regulatory</td>
<td>Banking Surveillance</td>
<td>Senior Bank Examiner</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Male</td>
<td>CBO</td>
<td>Regulatory</td>
<td>Banking Surveillance</td>
<td>Expert</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>CBO</td>
<td>Regulatory</td>
<td>Financial Stability</td>
<td>Sr. Financial Analyst</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>BM</td>
<td>Commercial</td>
<td>Credit Administration</td>
<td>Consultant</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Male</td>
<td>ALIZ</td>
<td>Islamic commercial</td>
<td>Credit risk</td>
<td>Assistant Manager</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>Male</td>
<td>HSBC</td>
<td>Commercial</td>
<td>Customer Experience</td>
<td>Manager</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Female</td>
<td>OAB</td>
<td>Commercial</td>
<td>Risk Management</td>
<td>Senior Manager</td>
<td>35</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Male</td>
<td>NBO</td>
<td>Commercial</td>
<td>Project Management</td>
<td>Project Manager</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
4.3 Themes Identification

According to Saldaña (2015), the identification of themes is a fundamental step before analysing and interpreting qualitative interview data. Thematic analysis is one of the most used techniques in qualitative research for identifying and exploring common patterns (or themes) across empirical data (Braun, Clarke, & Terry, 2014). Given that a pattern is a consistent occurrence of code or word within data sets (Saldaña, 2015), the higher repetition does not always imply a significant theme. Thus, the choice of thematic categories must be in line with the established research questions the researcher intends to investigate (Aronson, 1994). Themes discovery, in general, involves six stages: familiarisation with data, generating initial codes, searching for themes among codes, reviewing themes, defining and naming themes, and producing the final report (Braun & Clarke, 2006).

To identify the most appropriate themes for this study, the researcher applied his personal experience regarding the subject, and the steps highlighted by Braun and Clarke (2006). Additionally, NVivo qualitative analytical tool was used to gain an insight into the most repeated theme across the interview data. The identified thematic categories for this research are presented in Table 10 below.
**Table 10: Themes identified for this research**

| Research Question 1: What are the motivations that triggered the banks in Oman to implement enterprise BI systems? | • Credit risks  
• Lack of traditional reporting systems  
• Data quality issues and inconsistencies  
• Decision-making support |
| --- | --- |
| Research Question 2: What are the critical success factors for implementing BI systems in Omani banks? | • Robust architecture and platform.  
• Well-defined business problem and requirements  
• Commitment and support from top management  
• Vendor evaluation and selection |
| Research Question 3: What are the benefits and costs of adopting BI systems for credit risk management in the banks of Oman? | **Benefits.**  
• Effective supervision of the credit risk management process  
• Making better predictions  
• Ensuring compliance with all regulatory and supervisory norms  
• Real-time unified access to data.  
**Costs.**  
• Improper data integration  
• Data quality problems  
• Over-reliance on data fed into the system without application of logic. |
For example, the themes data quality and credit risks were appeared most frequently in interviews data when the respondents asked about the reasons that motivated them to implement the BI system, as shown in Figure 14.

![Figure 11: Word cloud for the motivations of BI implementation in Omani banks](image)

4.4 Interview Findings

4.4.1 Reasons for BI Implementation in Omani Banks

In the interview, respondents were asked to answer the following question: “What were the primary motivations for implementing BI technology in your organisation /department?”

Most of those who responded to this question revealed that credit risks and data quality issues were among the major factors that prompted them to adopt a BI solution.
This view was supported by participants’ responses from both technical and non-technical departments.

For example, an expert from a banking surveillance department stated that:

“As a central bank the credit facility information further aids in the effective supervision and monitoring of the credit environment in the country. However, to derive insights from the micro data to make macro decisions there is a definite need for an effective BI framework” [Respondent 3].

Similarly, another interviewee from the credit administration department reported that the motivation for implementing BI was “to reduce risk on missing any aspects of credit and other forms of risk” [Respondent 5]. Clearly, both views agree on the necessity of having a robust credit information system as an integral part of risk management.

Other participants provided quite different responses to the same item. For instance, a manager from customer experience argued that their implementation of a BI system was motivated by the need “for better decision making in various departments” [Respondent 7]. He added that “without BI analysis, decisions cannot be made on assumptions or estimates”. In contrast, a participant from a financial stability department explained that the reason for installing BI as an effort to “increase efficiency and effectiveness of our analysis” [Respondent 4].

Together, it seems that there are three common reasons for BI adoption across the represented banks in this research: credit risk management, decision-making support, and data quality problems.
### 4.4.2 Critical Success Factors for BI Implementation in Omani Banks

Table 11 presents the results gathered from the participants in response to the following question: ‘What factors do you think have contributed to ensuring successful implementation of BI technology in your organisation/department?’.

**Table 11: List of Critical Success Factors**

Source: Developed for this research

<table>
<thead>
<tr>
<th>Respondent 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exhaustive scope definition document</td>
</tr>
<tr>
<td></td>
<td>Support of the top management</td>
</tr>
<tr>
<td></td>
<td>Thorough feasibility study</td>
</tr>
<tr>
<td></td>
<td>Periodic discussion (initial and continuous) with all relevant</td>
</tr>
<tr>
<td></td>
<td>internal departments, external agencies, banks and financial</td>
</tr>
<tr>
<td></td>
<td>institutions for requirements gathering</td>
</tr>
<tr>
<td></td>
<td>Phased project implementation roadmap with well-defined milestones</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respondent 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Robust architecture and platform</td>
</tr>
<tr>
<td></td>
<td>Strong partnership between business and technology teams</td>
</tr>
<tr>
<td></td>
<td>Well-defined business problem</td>
</tr>
<tr>
<td></td>
<td>Flexibility to adapt and change</td>
</tr>
<tr>
<td></td>
<td>Support of top executives</td>
</tr>
<tr>
<td></td>
<td>Data standardisation across business/process/sources</td>
</tr>
<tr>
<td></td>
<td>Training of end users</td>
</tr>
<tr>
<td></td>
<td>Continuous improvement</td>
</tr>
<tr>
<td></td>
<td>Selecting the appropriate vendor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respondent 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Having highly skilled staff with relevant experience</td>
</tr>
<tr>
<td></td>
<td>Choosing the right technology platform and partner/vendor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respondent 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Professionalism of the implementation team and management</td>
</tr>
<tr>
<td></td>
<td>decisiveness</td>
</tr>
</tbody>
</table>
The results, as shown in Table 11, indicate that top management support and professionalism of the project team were acknowledged as the most critical factors for successful BI deployment in selected Omani banks. Most participants agreed that the involvement of senior executives helped to secure the necessary operating requirements (e.g. human resources, funding, and technical infrastructure). One interviewee stated the following firmly:

“The source of our BI success was due to the unlimited support and sponsorship of senior managers throughout the implementation project…” [Respondent 5].
In this case, top-level sponsorship seems to be imperative, specifically in resolving conflicts among teams and breaking down challenges that may emerge during the project journey.

Unsurprisingly, some participants expressed the belief that the expertise and competencies of the project stakeholders had a significant impact in ensuring smooth BI implementation. One participant stated:

“The employees were good at solving problems and had the information and data they need to make the best decisions at all levels of the company” [Respondent 8].

Additionally, a small number of those interviewed argued that the business case of a BI initiative should be aligned to the overall strategy and vision of the organisation. According to their arguments, BI is business-driven, hence, implementation needs to comply with the strategic business vision and the goals of the company. As stated by one manager:

“The success of any BI strategy must be aligned to the overall vision and objectives of the organisation. Accordingly, it will have to consider multiple factors covering human resource, technology, process, policy…” [Respondent 1].

Regarding technological concerns, a key factor highlighted by most of the respondents was the need to select the correct BI framework. A framework must be capable of satisfying the current and future needs of the dynamic business requirements. Commenting on this issue, one interviewee said the following:

“...Scalability and flexibility are always given a greater attention when evaluating the proposed solutions.
We learn from previous experiences that the lack of scalable system results in an inability to meet the business requirements, which means a failure of the whole project ...” [Respondent 7].

In summary, the study participants provided details and justifications for critical success factors that could enable or hinder a BI project.

4.4.3 The Effectiveness of BI on Credit Risk Management

4.4.3.1 Perspectives from Participants

Respondents were asked to provide their opinions about whether BI tools were effective in managing credit risks. According to most participants, the use of BI tools contributed in decreasing the likelihood of defaulting through the provision of high-performance predictive techniques. A senior manager from a risk management department provided insight into his experience with BI:

“BI implementation from credit risk perspective, it supported us to deliver proper analytical review to the BOD, with clear understating of the bank portfolio... to make proper decision...”[Respondent 8].

This view was supported by another senior specialist from the regulatory bank who said the following:

“Yes BI systems are very much effective in managing credit risk

• BI system allows predicting and forecasting and also measuring the potential risk factor in any transaction.
The bank's management can also make use of certain credit models embedded into the BI system which can act as a valuable tool which can be used to determine the level of lending measuring the risk” [Respondent 2].

Therefore, the adoption of BI systems can be inferred to be effective, as this system helps create proactive decisions because of their abilities for predictive accuracy.

4.4.3.2 The Benefits of BI Systems

When the participants were asked about the advantages they gained from their experience with BI systems, a range of responses was elicited, as summarised in Table 7. Interestingly, the participants, on the whole, deemed the effective supervision of credit-risk management as a key benefit of BI adoption.

They reported that the use of BI software enabled them to gain a thorough understanding of the bank’s overall credit risk through the interactive dashboard and online reporting service. As one interviewee stated:

“As a credit bureau, we collect, collate and process data from various sources with differing velocity and frequency. The BI system has helped us in automating this process from end-to-end through data standardisation, effective ETL and reporting”. [Respondent 2]

Furthermore, most participants expressed similar feelings about the usefulness of BI systems in transforming raw data into meaningful information, which, in turn, allowed them to make informed business decisions. For example, one interviewee stated the following:
“Past, present and future data is very important to take a better decision to mitigate any possible risk associated with the same. BI technology is one of the important platforms to provide better information to make such decision in all its stages”. [Respondent 6]

Additionally, some interviewees argued that data-mining techniques embedded within the BI solution add greater value in discovering hidden patterns and establishing relationships from large data sets. Still, others stressed that visualisation tools enabled them to understand complex and multidimensional relationships by plotting the information into interactive graphical displays. As one interviewee said:

“The BI system should provide data visualisation capabilities that get important information into the hands of those who need it, when they need it ...”. [Respondent 3]

Comparing the two arguments, it can be seen that both techniques are more likely to amplify human understanding by making sense of data.

However, only a small number of those interviewed indicated that BI tools improved compliance with various regulatory and legal policies. According to those participants, having quick access to enterprise data can help to build up comprehensive reports that meet certain regulatory requirements:

“Reports and analysis are available on one click; various analytical reviews are carried which serves numerous regulatory requirements”. [Respondent 8]
Table 12: Benefits of business intelligence systems

**Source:** Developed for this research

| Respondent 1 | • Real-time scoring and limits monitoring  
|             | • Robust stress-testing capabilities  
|             | • Data visualisation techniques  
|             | • Effective supervision and monitoring of credit risk |
| Respondent 2 | • Extensive credit risk functionality integrated with economic and regulatory credit risk applications  
|             | • Ensure compliance with all regulatory and supervisory norms  
|             | • Real-time unified access to data  
|             | • Predictive analysis and data mining techniques |
| Respondent 3 | • Independent evaluation of the banks’ loan portfolio  
|             | • Effective supervision of credit risks management process  
|             | • Conduct a review of the quality of a sample of individual credits  
|             | • Early detection of risks  
|             | • Decision-making support |
| Respondent 4 | • Enhance monitoring of credit portfolios  
|             | • Quick access to data  
|             | • Increase efficiency and effectiveness of analysis |
| Respondent 5 | • Improve the decision-making process  
|             | • Better credit administration  
|             | • Discovery of Hidden patterns |
| Respondent 6 | • Better quality of information  
|             | • Enhance business decisions  
|             | • Effective monitoring of risks |
| Respondent 7 | • Better understanding of customer segments  
|             | • Trends analysis over time-series |
Increasing the accuracy of making loans decisions
Timely and reliable data

**Respondent 8**
- Enhance customer relationships
- Making accurate forecasts based on past trends
- Managing enterprise risks
- Increase the operational efficiency
- Reporting and analysis

**Respondent 9**
- Knowledge of vulnerable areas of the bank’s lending
- Time series analysis
- Improve the banking supervision
- Forecasting capabilities

### 4.4.3.3 The Costs of BI Systems

Respondents raised some concerns when they asked to indicate the risks of implementing BI tools in the banking industry. Of nine participants, only four provided a response to this question (see Table 13). Poor quality of source systems was amongst the key issues identified by the majority of interviewees. One individual stated:

“Reports are built on raw data inserted by various sources and departments, which are unreliable and missing”. [Respondent 8]

Another interviewee commented:

“If data is not mapped correctly, it could lead to[the] wrong presentation and wrong analysis...”. [Respondent 7]
The understanding from these results is that poor quality of data can hinder business decisions, thereby causing negative consequences to the bank and customers.

Another serious drawback highlighted by respondents was the over-reliance on BI machines to make decisions without considering human interpretations. Talking about this issue, an interviewee stressed the need for human involvement in every stage of the decision-making process, since the role of BI technologies is typically communicating data to the end-user.

Table 13: Costs of business intelligence systems

Source: Developed for this research

<table>
<thead>
<tr>
<th>Interview question</th>
<th>Responses</th>
</tr>
</thead>
</table>
| What are the potential risks or costs associated with using BI technology for credit risk management in your organisation? | • Over-reliance on data fed into the system without application of logic  
• Improper data integration may lead to making wrong decision  
• Data quality issues from the source systems  
• Over-looking qualitative factors of credit risk management.  
• Excessive information overload |
4.4.3.4 Suggestions for Further Improvements

By the end of the interview, respondents were asked to provide suggestions for better management of credit risk in the Omani banking sector. A variety of perspectives emphasised the necessity of adopting modern state-of-the-art data visualisations tools (e.g. Tableau Public and Spotfire) that can provide 360-degree visibility of the most vulnerable areas in the banks. The participants also suggested that the establishment of a country-wide data warehouse could enable the banks to extract useful features about the borrowers for making accurate predictions. This view was echoed by another respondent, who stated:

“CBO should look into establishing an enterprise-wide data warehouse, which will help overcome some of the above challenges...”[Respondent 3]

Interestingly, there was a sense of ignorance amongst interviewees of the ethical issues that could emerge from sharing such personal information without informed consent from customers.

In addition, other participants proposed a global performance report that could help in performing cross-validation check with peer banks within the country.

Moreover, when the respondents were asked to provide some suggestions to improve the capabilities of BI tools, the below points were indicated:

- Hiring of expertise technical staff
- Performing a periodic health check on data quality
- Exploring the existing functionalities of BI to make the best use of it
- Utilisation of a data warehouses
4.5 Summary of the Findings

The majority of interviewees revealed that credit risks and data quality issues were major factors in adopting BI solutions. BI systems were regarded as being very effective in managing credit risk and decreased the likelihood of defaulting. Furthermore, the predictive accuracy of BI systems allowed for proactive decision-making. For successful implementation of BI in Omani banks, top-level management support and the professionalism of project teams were viewed as the most critical factors. The quality of source systems was a potential concern for participants since unreliable data could lead to incorrect analysis and decisions. Most participants felt that the capabilities of BI tools would be improved with periodic checks on data quality. Another concern raised was the potential for decisions to be made based purely on BI systems, with no human involvement. One respondent stressed the importance of human participation and at every stage of the BI project.

Chapter 5 Discussion

1.1 Introduction

This chapter synthesises and elaborates the most significant findings obtained from this study and compares and contrasts the results of the research with relevant literature. These aspects are followed by a critical evaluation.
5.2 Key findings

This section provides a general overview of the main results derived from this study. Figure 11 shows the key factors that could influence the effectiveness of BI systems as highlighted by most interviewees.

Figure 12: Factors influence the BI effectiveness

Furthermore, the respondents were drawn our attentions to key challenges encountered throughout different phases of BI implementation project, as shown in Table 14.
Table 14: Key issues before, during and after BI implementation

<table>
<thead>
<tr>
<th>Initiation</th>
<th>Implementation</th>
<th>Impacts</th>
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<tbody>
<tr>
<td>• Ad-hoc change requests</td>
<td>• Data quality issues</td>
<td>• Poor data quality could lead to wrong decision-making</td>
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<tr>
<td>• Communication issues</td>
<td>• Lack of skilled staff</td>
<td>• Improper selection of BI product could lead inability</td>
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<tr>
<td>• User training and awareness</td>
<td>• Migration of old data to new BI system</td>
<td>to meet business requirements</td>
</tr>
<tr>
<td>• Software and hardware preparation</td>
<td>• Rapid growth of big data</td>
<td>• Insufficient support from top management may hinder</td>
</tr>
<tr>
<td>• Vendor selection</td>
<td></td>
<td>the progress of BI project</td>
</tr>
<tr>
<td>• Top management support</td>
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</table>

Given the limited research in the area of BI for credit risk, this dissertation attempted to address the questions below:

5.3. Research Questions

5.3.1 Research Question 1: What are the motivations that triggered the Omani banks to implement the BI systems?

From the findings in Chapter 4, the participants agreed that risk management and credit risk in particular was the key problem that motivated decision makers in Omani banks to adopt business intelligence and analytics. These results are in line with those of previous studies (e.g. Bessis & O’Kelly, 2015; Bodla & Verma, 2009).
In their article entitled “Business Intelligence in Risk Management”, Wu, Chen, and Olson (2014) showed that risk management is at the heart of the banking sector; this factor is often viewed as a motivator for applying high-performance predictive systems that seek to ensure sustainable profitability in banks while reducing possible risks.

This view is further supported by Bekhet and Eletter (2012) who conducted cycles of interviews with credit managers in commercial banks in Jordan. According to their findings, the majority of Jordanian banks have implemented intelligence solutions to improve their predictive accuracy for making informed credit decisions, which were previously based on subjective reviews.

Arguably, Oman’s banks have become more vulnerable to credit risks because of the increasing pressures from external environments. For example, in 2013, the government directed all of Oman’s banks to grant financial support and credits for local SMEs to reduce over-dependence on oil revenues, the main source of income (Omar, Zahir, & Al, 2015). This action, in turn, has increased the responsibilities of Omani’s banking industry in reinforcing economic growth, which shows a definite need for an effective risk-control system.

Another reason for the banks in this study to use BI software was the need to improve data quality to make informed decisions. This result is similar to those of Verbitskiy and Yeoh (2011), who show that poor quality of data could cause significant costs, since various functional units within the organisation use the data to make strategic and tactical decisions. The main difference is that in this study, the participants viewed BI as a technology that can provide a ready-made solution for addressing data quality issues.
Contrarily, Verbitskiy and Yeoh (2011) assert that fixing data quality issues involves a comprehensive review and understanding of source systems using appropriate tools, business processes and human resources.

A possible explanation for this difference might be a lack of adequate development guidelines and frameworks, which can lead to misunderstanding the core capabilities of BI. Another possible explanation is that the Omani banking industry is yet to reach the full maturity level in BI technology, as it only began adopting such tools very recently.

According to these data, data quality management is inferred to be one of the most serious issues facing Oman’s banks, which requires effective collaborative effort from multiple sources before initiating a BI project.

5.3.2 Research Question 2: What are the critical success factors for implementing business intelligence systems in the Omani Banking Industry?

The respondents highlighted several factors that could affect the success of BI implementation, as seen in Table 11. The findings reveal that top management support, alignment to corporate strategy, team skills, and selecting the right BI framework were the most important factors highlighted by participating bankers. These results match those observed in earlier studies (e.g. Dawson & Van Belle, 2013; Yeoh & Koronios, 2010). According to Dawson and Van Belle (2013), the critical success factors for BI projects can differ according to industry type by which the company operates. Because BI implementation has increased rapidly across many banks in Oman, learning from successful BI projects could reduce the likelihood of failure by identifying key CSFs. Of interest was how most of the respondents showed a reasonable awareness of most CSFs in BI, which indicates their solid skills in project management.
An empirical case study conducted by Crossland and Smith (2010) found that the actual business value of BI tools is achieved through an alignment of BI initiative with organisational strategy. On this point, Grandhi and Chugh (2013) argue that the classical bottom-up approach which focuses on the technology implementation without taking into consideration the strategic objectives of an organisation can lead to project failure. Further support for this claim can be found in a study conducted by Ranjan (2008).

In the context of the Omani banking industry, there seems to be some evidence to suggest that most IT-related projects, including BI, are adopting the top-down approach. Firstly, an expert from the regulatory bank was quoted as saying: “the success of any BI strategy must be aligned with the overall vision and objectives of the organisation...”. Secondly, the participants, on the whole, reported that their BI initiatives were driven by business goals, rather than technology.

This result is likely because BI technology was originated and developed from DSS, which was typically designed for business purposes (Power et al., 2015). Moreover, the practical experience of the researcher shows that the adherence to both IT and core objectives is key for evaluating the merit of BI systems in most Omani banks.

The second critical success factor highlighted by participants was senior management commitment and sponsorship. Over half of those interviewed agreed that consistent support from senior executives helped them to overcome complex organisational issues during and after BI implementation efforts. However, these results differ from some published studies (Kamel, 2006) showing that a lack of managerial support is an inhibiting factor, causing the slow adoption of technology in the Omani banking sector.
However, the results are broadly consistent with a large-scale survey by Yeoh et al. (2008b), who found that BI implementation success is determined by effective support from top executives. This success might be because senior executive involvement helps resolve change management issues, provision of domain expertise and championship and selection of funding model. These results, therefore, need to be interpreted with caution. Most of the respondents are from senior management, and they may prefer to not show their lack of support and attempt to approve their abilities in managing IT projects.

Additionally, it was expected that strong technical expertise, along with the ability to understand business requirements, was central to any successful BI systems implementation projects (Yeoh & Koronios, 2010). In contrast to earlier research, however, the results of this study have been unable to detect strong evidence from participants to confirm the impact of IT expertise on BI implementation success. A possible explanation for this might be that most licensed banks in Oman try to complement the lack of in-house technical capabilities and competencies by outsourcing their IT activities to external vendors.

The selection of an appropriate technical BI framework was another prime factor mentioned by most respondents. This result is in agreement with Dawson and Van Belle's (2013) findings that scalability and extensibility are two core requirements for building a long-term successful BI solution that can meet ad-hoc business needs. Therefore, the Omani banking industry is arguably facing a greater challenge in technology due to the rapid growth of big data in recent years, which calls for high-performance systems.
This view is evidenced by Mr. Asad Batla, Chairman of GCC New Age Banking Summit, who stated the following:

"With the exponential growth of smartphones and new technologies, the way we do things has changed and banks have to embrace digital landscape to deliver better banking experience through better customer engagement, mobile apps, digital payments, big data analysis and partnering with external service providers" (Times of Oman, 2016).

Considering this statement, Omani banks are seemingly entering into a new age of big data that involves a robust and flexible technical infrastructure to meet both the regulatory and business requirements.

5.3.3 Research Question 3: What are the benefits and costs of adopting the BI systems for credit risk management in the Omani banking industry?

5.2.3.1 Benefits of Business Intelligence

Whereas not generalisable, the preliminary analysis of the results suggest that the BI system is an effective tool for risk management, predictive analysis, historical analysis, knowledge discovery, managing compliance requirements and decision-making support (refer to Table 12). According to the majority of respondents, credit risk management is the most obvious advantage obtained from the deployment of business intelligence tools. These results further support previous research into the opportunities of BI technology in banks worldwide (Gadda, 2014).

Omani banks have increasingly become exposed to credit risks due to the rapid increase of loan requests from multiple sources (e.g. consumers and corporates) as a result of a consistent decrease in oil prices (Al-Hajri & Tatnall, 2008).
Likely, such increases in credits have encouraged these banks to acknowledge the value of BI in mitigating potential credit risks, since BI provides bankers with a capability to classify customers into good or bad debts. According to some respondents, classifying customers allows banking supervisors to monitor the quality of loan portfolios by taking remedial action before credit delinquency occurs.

In this respect, Preko and Kester (2015) make a valid point. They argue that the analysis of customers’ historical data can strengthen banks’ credit portfolios by predicting the future behaviour of borrowers. Similarly, Bekhet and Eletter (2012) stress that the profitability and stability of a bank are strongly influenced by the effective analysis of credit behaviours. In alignment with the previous arguments, Omani banks have seemingly benefited from implementing BI techniques in refining and improving their risk-management processes. This view can further justify early risk detection, real-time scoring and monitoring of credit limits and forecasting capabilities (Preko & Kester, 2015).

Furthermore, most respondents agreed that by adopting data-mining techniques embedded within a BI solution, they have improved the decision-making process. This belief is not surprising because data-mining techniques can extract hidden patterns quickly and easily from complex data sets, by which managers can make appropriate decisions based on evidence. Further support for this claim can be found in a study by Yap, Ong, and Husain (2011). There is some evidence to suggest that Omani banks are facing a significant increase in the number of defaulters. Thus, the need for accurate credit decisions becomes a crucial requirement for maintaining financial stability in the country.
Also, the global financial crisis and Basel II have deemed credit risk a core problem in the banking sector, which encouraged many banks in Oman to apply recent innovative technologies to protect their capital assets by making informed decisions (Moro et al., 2015).

5.2.3.2 Costs of BI.

On the contrary, the results of this research show that data quality issues, over-reliance on BI technology and data integration are the major drawbacks concerning most respondents. These results are quite different from those of Tunowski (2015), who considered the lack of professional experience as a major risk of BI adoption. This discrepancy could be attributed to the recent trends of most Omani banks towards outsourcing their IT activities to external vendors who can provide 24/7 technical support and consultations.

While such activities may cause a violation of customer confidentiality, CBO has advised all licensed banks to avoid outsourcing their core functions, including IT services, to retain direct ownership and responsibility of customer data (CBO, 2011).

Regarding the issue of data quality and integration, this problem arguably lies primarily in the lack of a data governance policy framework and duplication of customer information across multiple legacy systems in most Omani banks. Also, the available evidence appears to indicate that there is neither appreciation nor understanding of the necessity for standardised metadata, which may have a significant impact on the quality of data retrieval (Gangadharan & Swami, 2004).
5.4 Effectiveness of BI Systems on Credit Risk Management

As was discussed in the literature review chapter, the effects of BI systems are hard to evaluate through traditional financial measures, such as ROI. According to Grandhi and Chugh (2013), a successful BI solution should help the organisation meet its objectives and goals, solve existing problems, increase user satisfaction and provide new business opportunities.

Returning to the overall question posed at the beginning of this study, it is now possible to suggest that the implementation of BI technologies in Omani banks has significant positive impacts in mitigating the problem of credit risks. The overall level of satisfaction was relatively high, and most respondents considered BI a useful tool for risk management. Accordingly, the banks were able to generate business value and benefits by reducing the likelihood of defaulters. Taken together, it can be inferred that BI is a mission-critical tool and effective in managing credit risks in the Omani banking industry. Thus, the overall aim of this research has been met and addressed. The next chapter provides a summary of the research, following by recommendation for future work and limitations of this study.
Chapter 6 Conclusion

This research investigated the effects of adopting BI systems in the Omani banking industry, with an emphasis on credit risk management. A qualitative semi-structured interview approach was applied to answer the overall research question, which was:

“How effective is the BI system in mitigating the problem of credit risks in Omani banking industry?”.

A telephone interview method was used to collect primary data from the participants. The interview questions were designed on the basis of an extensive review of relevant literature, research questions, and personal experience of the researcher. The interviews were recorded using a digital assistance and transcribed into text format prior to the analysis phase. The NVivo tool was used to gain an insight into the most repeated themes via word cloud representation.

An email invitation was sent to 40 technical, and non-technical professionals who matched the sampling criteria (refer to Section 3.5.2.5), yet only nine respondents agreed to take part in this study. Over half of the participants (n= 5) were recruited from commercial banks, while the remaining four participants were from the regulatory bank (i.e. Central Bank of Oman).

The results of this investigation provided confirmatory evidence that BI tools contributed positively in mitigating potential credit risks across Omani banks. These findings complement those of earlier studies (e.g. Bekhet & Eletter, 2012; Wu et al., 2014). Furthermore, the study revealed that there are some critical areas that play vital roles in ensuring the success of BI implementation projects, such as top management support, business-IT alignment, strong collaboration between project stakeholders, and BI software selection.
From this study, it was apparent that the majority of respondents (77.7%) deemed the BI to be a mission-critical tool for achieving both departmental and organisational objectives. The respondents, on the whole, agreed that BI assisted them in managing banking risks effectively, understanding credit risk profiles, improving the decision-making processes, building accurate predictive models, conducting a robust stress testing, as well as increasing operational efficiency.

### 6.1 Practical Contribution

The results of this research have several practical applications. First, the research provides insight for bankers into the core capabilities and uses of BI systems in the area of credit-risk analysis. Second, the findings can help non-BI adopters understand the most critical areas that should be improved to generate actual business value from a BI implementation project. Third, this study can serve as a framework for practitioners and decision makers when evaluating BI tools, since it highlights both the pros and cons of adopting such systems in banks. More importantly, this research acts as a bridge between IT and business by aligning BI initiatives to the overall business goals of the organisation.

### 6.2 Theoretical Contribution

To the best of the researcher’s knowledge, this is the first study to investigate the effect of BI systems on credit-risk management in the context of Omani banking industry. Most of the existing literature has examined the impact of BI in risk management (e.g. Wu et al., 2014), but little research has focused on credit risk (e.g. Bekhet & Eletter, 2012).
Therefore, this research will fill a gap in the literature by providing a new understanding into the role of IT-enabled organisational tools, such as BI initiatives, in the banking industry, in general, and credit risk, in particular. This study can also serve as a first step for future researchers, since it points to some directions.

6.3 The Limitations of the Research

As with any study, this thesis has experienced certain limitations regarding time, resources and applied methods. The most significant limitation lies in the case selection and sample size. Due to the time constraints and physical distance, the researcher was unable to recruit more participants from multiple banks and branches, which, in turn, affected the level of generalisation.

The second limitation was the use of telephone interviewing as a method for data collection. In this particular study, the telephone interview was not as effective as a face-to-face interview for recruiting a large number of participants. This lack of effectiveness is because some cases refused to take part in this research because of an assumption that a telephone interview was an informal chat and insecure.

The third limitation of this thesis was the lack of local studies and publications that discuss the impact of implementing a BI for credit-risk management in Omani banks. Consequently, the quality of the research findings largely depended on the credibility of the interviewees, which may have led to an incorrect interpretation of the phenomenon in question because of possible bias.
6.4 Recommendations for Future Research

Further studies regarding the effect of BI systems on credit-risk management would be worthwhile. The following are some areas to consider:

- A case study research could be performed to gain an in-depth understanding into the actual business value obtained from implementing the BI tool within its real-life context.
- A mixed-methods approach is recommended so the researcher can statistically measure the usefulness of BI technology across multiple Omani banks by adopting a Technology Acceptance Model-based quantitative survey. The obtained results may then be validated by conducting qualitative interviews to improve generalisability.
- Further research should be undertaken to investigate the impact of broader external factors (e.g. vendor selection and partnership) on the success of BI projects.
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Appendices

Appendix A: Interview Questions

The Impact of Adopting Business Intelligence systems on Credit Risk Management: An Exploratory Study in Omani banking industry

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<thead>
<tr>
<th>Interviewee’s name:</th>
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<td>Organisation:</td>
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<td>Email:</td>
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<td>Interview’s start time:</td>
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<td>Interview’s finish time:</td>
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Section 1: General Information
Please tell me about yourself:

1. Your professional background and experience
   a. In what industry do you work? (e.g. IT services, Healthcare, Public Sector or Banking)
   b. Size of the organisation (Number of employees, approximately)
   c. A total number of years in the industry?
   d. What is your working experience in a BI field?

Section 2: Credit Risk Management

2. How would you define the concept ‘credit risk’?

3. What is meant by credit risk management?

4. Why do you think credit risk management is important?

5. What are the current problems of managing credit risks in your organisation/department?

6. How can a BI technology help with mitigating potential credit risks?

Section 3: Business Intelligence

7. Do your organisation/department use any BI tools? If yes, in which function/area it has been utilised?

8. How would you define the term “Business Intelligence”?

9. What were the primary motivations for implementing a BI technology in your organisation/department?
10. Do you think a BI technology is a mission-critical tool for your organisation /department? If yes, why?

Section 4: BI Implementation Project

11. For how long has the BI system been deployed in your organisation /department?

12. Could you please describe the process your organisation /department followed to deploy the BI system?
   a. Implementation duration and stages
   b. Pre-requisites for deploying a BI system (e.g. Technical and business requirements)
   c. The current status of the BI system (e.g., in-use, partially in-use or planning stage?)
   d. Primary BI applications or tools used (e.g., Dashboards, Scorecards, Reporting, Online Analytical Processing ). How are they used?
   e. BI architecture *(optional)*

13. What were the key challenges you encountered throughout the BI implementation project or after the implementation phase?

14. How did your organisation/ department deal with these challenges?

15. Can you give an example of how BI implementation contributes to achieving your organisational or departmental objectives?
Section 5: Critical Success Factors for BI implementation

16. What criteria do you use in defining the success or failure of BI implementation?

17. What factors do you think have contributed to ensuring successful implementation of BI technology in your organisation /department?

18. In terms of the organisation or technology perspectives, what factors do you think have a direct impact on the success of BI implementation in your organisation /department?

19. In your opinion, do you think the BI system is effective in managing credit risks? If yes, why do you think it is effective?

Section 6: Impact of BI adoption on credit risk management

20. What are the benefits perceived after implementing the BI system on credit risk domain?

21. What are the potential risks associated with using BI technology for credit risk management in your organisation?

22. Can you please provide some examples of how BI has improved the management of credit risks in your organisation /department?

23. Overall, are you satisfied with the results of the BI system on credit risk management? Why/or why not are you satisfied?

Section 7: Conclusion and Recommendation
24. What future improvements do you suggest to take place towards better management of credit risks in the banking industry of Oman, and CBO in particular?

25. What do you think could further enhance the capability of BI tool in your organisation /department?

26. Do you have further comments to add?

Thank you very much for your participation

Appendix B: Informed Consent Form

| The University of Sheffield Information School | The Impact of Adopting Business Intelligence Systems on Credit Risk Management: An Exploratory Study in Omani Banking Industry |

Researchers

1. Jihad Rashid Al Wahshi (Researcher)
2. Dr Jonathan Foster (Supervisor)

Purpose of the research

The overall aim of this thesis is to investigate the impact of adopting Business Intelligence systems in Omani banking industry, with an emphasis on credit risk management area. More specifically, this study attempts to address the research question: “How effective is the BI system in mitigating the risks of credits in Omani banking industry?”.

Who will be participating?

This research involves the collection of inputs in the form of an interview from participants who are currently working in the Omani banking industry or CBO. In particular, those officers or stakeholders who are working in various functional areas of Omani banks, including risk
management, credit department, IT, operations, and project management office. As specific criteria for sample selection, the participant should have an experience of BI related concepts and technologies, as well as credit risk aspect.

**What will you be asked to do?**

At the initial stage, the researcher will send you a copy of the informed consent sheet via email that includes a brief summary of the research. Once you read and understand all information on the form, you can then decide whether to participate in this study or not.

If you agree to participate, please sign on the form or else provide verbal consent in case you do not wish your name to be shown on the form.

After that, we will conduct a 1-hour telephone interview via Skype service or any suitable media to discuss why and how the BI system is being used for managing credit risk in the Omani banking industry. It should be noted that your participation is voluntary, and you may decide to leave the study at any point in time. Also, you may refuse to answer any specific questions if you are uncomfortable with.

**What are the potential risks of participating?**

The possibility of harm or distress is no greater than what might be experienced in everyday life. The researcher will ensure to anonymise/ encrypt all personally identifiable information (PII) by assigning an arbitrary number for each participant.

**What data will we collect?**

Please note that the interview will be audio recorded for the purpose of transcribing the material. This recording will not be accessible to anyone other than the researcher and if necessary the supervisor. The participant has a right to withdraw permission for his/ her data to be used. In this case, all collected information/ or transcriptions will be destroyed and deleted. The interview questions will focus on the overall aim and objectives of the research. In other words, you will not be asked to provide any sensitive or confidential information. The interview questions will
be emphasised on the interviewee’s experience and opinion on the impact of using a BI system on credit risk domain within the context of his or her organisation/ department.

For example, the participants will be asked to answer specific questions as mentioned below:

- What were the primary motivations for implementing a BI technology in your organisation/ department?
- What were the key challenges you encountered throughout the BI implementation project or after the implementation phase?
- What factors do you think have contributed to ensuring successful implementation of BI technology in your organisation /department?
- Why do you think credit risk management is important?

To ensure the validity of the interviews’ questions, the researcher has conducted a thorough review of the literature pertaining BI from the banking perspective. Furthermore, pilot testing has been performed to verify that the questions are clear and valid.

**What will we do with the data?**

All digital data and transcripts will be stored on the Information School's research data drive. This drive will be accessed by the researcher, supervisor, and School's Examinations Officer. The data files will be deleted/ destroyed after three months of completing the dissertation.

**Will my participation be confidential?**

This study has conformed to the University of Sheffield’s Research Ethics Policy (see http://www.shef.ac.uk/ris/other/gov-ethics/ethicspolicy). Additionally, the researcher has applied rigorous measures to ensure the confidentiality of the collected data. A random number has been assigned to each entity to prevent disclosure of information or any potential identification of participants. The data has anonymised, and the audio records will only be used for transcription purposes. Furthermore, no personally identifiable information will be retained. Please note that this research has been already approved by the University’s ethics team and classified as low risk.

**What will happen to the results of the research project?**
The results of this research will be included in my master’s dissertation which will be publicly available at the database of Information School (University of Sheffield). Also, the researcher intended to post the summary of the results to the website of Central Bank of Oman (http://www.cbo-oman.org/) or possibly on an academic journal.

- I confirm that I have read and understand the description of the research project and that I have had an opportunity to ask questions about the project.
- I understand that my participation is voluntary and that I am free to withdraw at any time without any negative consequences.
- I understand that if I withdraw I can request for the data I have already provided to be deleted, however this might not be possible if the data has already been anonymised or findings published.
- I understand that I may decline to answer any particular question or questions, or to do any of the activities.
- I understand that my responses will be kept strictly confidential, that my name or identity will not be linked to any research materials, and that I will not be identified or identifiable in any report or reports that result from the research, unless I have agreed otherwise.
- I give permission for all the research team members to have access to my responses.
- I give permission for the research team to re-use my data for future research as specified above.
- I agree to take part in the research project as described above.
Participant Name (Please print)  
Participant Signature

Researcher Name (Please print)  
Researcher Signature

Date

Note: If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, please contact Dr Jo Bates, Research Ethics Coordinator, Information School, The University of Sheffield (ischool_ethics@sheffield.ac.uk), or the University Registrar and Secretary.
Appendix C: Ethical Approval Letter

Jahad Al Wahshi
Registration number: 150216292
Information School
Programme: Data Science

Dear Jahad

PROJECT TITLE: The Impact of Adopting Business Intelligence and Analytics on Credit Risk Management: An Exploratory Study in Central Bank of Oman
APPLICATION: Reference Number 008084

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 17/03/2016 the above-named project was approved on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 008084 (dated 15/03/2016).
- Participant consent form 1016468 version 1 (15/03/2016).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Matt Jones
Ethics Administrator
Information School
PRINCIPLES OF ANONYMITY, CONFIDENTIALITY AND DATA PROTECTION

For a detailed discussion of the law on which University policy in this respect rests, see the Specialist Research Ethics Guidance Paper, ‘Principles of anonymity, confidentiality and data protection’, of which the following is no more than a brief summary.

A researcher who collects, stores, uses, discloses or destroys identifiable personal information - as defined as in the next paragraph - about living individuals, must comply with the requirements of the Data Protection Act 1998 (DPA) and the Common Law duty of confidence. A researcher who collects, stores, uses, discloses or destroys identifiable personal information about deceased individuals, must comply with the requirements of the Common Law duty of confidence. The collection, storage, use, disclosure or destruction of anonymised personal information, whether relating to the living or the deceased, falls outside the scope of these legal requirements.

The DPA applies to ‘personal data’, which are data that relate to a living individual who can be identified either from those data alone or from those data taken in conjunction with other information that is available to the person who controls the data. This is the meaning of ‘identifiable personal information’ here. The use of identifiable personal information in research should be reduced so far as possible. Thus researchers should always think carefully about (a) whether it is necessary to use identifiable personal information, and (b) what is the earliest stage at which de-identification might be possible without compromising the integrity of the research. All uses of personal information should be defensible as both accurate and relevant.
If it is necessary to use identifiable personal information, this should generally only be done with consent. It may be possible to use such data without consent - when the material is already in the public domain, for example - but consent is to be preferred, unless it can be shown to be inappropriate for some reason.

When gathering identifiable personal information researchers should aim at all times to ensure that its processing is defensible as both ‘fair and lawful’. This requires as much transparency as possible about the uses to which data will be put and any risks that might be involved.

Personal information must be kept secure at all times. The level of security should be proportionate to the risks inherent in the nature of the data, but all personal information should be kept securely. Although personal information should not be retained for longer than necessary, it is recognised that, as long as relevant conditions are satisfied, research may require the retention of data for long periods and that this may be justified.

Personal data that are processed for research purposes may be exempt from a DPA subject-access request. In general, the disclosure of identifiable information, including information that may be identifiable to others, should be avoided wherever possible. If it is necessary to disclose personally identifiable information, or information that may be potentially identifiable, then this should usually only be done with the consent of the individuals involved.

Finally, the common law duty of confidence applies to research, as to all other activities. Individuals have a reasonable expectation of privacy with respect to confidential information that refers to them. Any use of such confidential information that exceeds that which an ordinary person could reasonably be said to expect constitutes a breach of confidence.
Appendix E: Interview question design

Hennink, Hutter, and Bailey (2010) argues that the design of interview questions should be developed based on the research type, aims and objectives of the study, as well as the fieldwork approach (e.g. quantitative or qualitative). For example, the questions style in a semi-structured interview tends to be less structured as compared to the quantitative survey (Hove, S.E., Anda B., 2005). Kvale and Brinkmann (2009) provide a set of guidance into a typical interview structure. According to them, a basic structure of qualitative interview should include the following parts: introduction, opening questions, core questions, and closing questions.

Through the introduction section, the researcher typically introduces himself or herself, providing a brief description of the research objectives, ethical aspects (e.g. confidentiality and anonymity), and data management procedures (Hove, S.E., Anda B., 2005). Following the introduction, background and demographics questions (e.g. age, gender) are usually asked to gain some context about the interviewee. After that, the researcher is continue building a rapport with the participants by asking them some broader and general questions that are related to the research topic. Commenting on this point, Turner (2010) stress the importance of maintaining a good relationship with the interviewees as it encourages them to share their views and experiences in a more a comfortable environment.

Next part, is central of the interview guide where the interviewer begins asking key questions that aim to collect core information necessary to address the established research questions (Kvale, S., & Brinkmann, 2015). Having collected the core information for the study, it is ethically vital to conclude the interview by asking closing questions. Such questions can help to reduce rapport, and eliminating any sensitive issues or concerns occurred during the interview (King, 1994). Further description of the interview guide can be found in a book entitled
“qualitative research methods” that has been published by Hennink et al., (2010). The subsequent section provides the structure of our interview guide.

E. 1. The structure of interview questions

This research has been developed using the interview structure described above. The interview questions have been mainly derived from the research questions, the conceptual framework of the study, and review of relevant literature. The interview guide consists of twenty-six open-ended questions divided into seven sections (See Appendix A). King and Horrocks (2010) have stated that the use of open-ended questions in the semi-structured interview could enable the researcher to answer complex issues by given the respondents a freedom to express their opinions without limiting their responses. Regarding the sequence of questions, Hennink et al., (2010) highlights the need for following a logical order to avoid possible confusion and thereby reducing the quality of data collected from the interviewee. While this study is based on a semi-structured interview, hence the order of the questions has been determined by the topics emerging from the conversation between the interviewer and interviewee (Hennink et al., 2010).

In his book, Patton (2005) argued that there are six common types of topic questions can be asked in qualitative research interview, as described below:

Background /demographics: General and standard background questions about the interviewee, such as gender, age, and education level.

Knowledge: A question that seeks to obtain factual information, and therefore is vital for building up an understanding of a specific topic.

Opinions /values: what a respondent thinks about the topic or issue.
Feelings: A question to get a participant's feelings about a situation or event rather than what he or she thinks.

Behaviours: A question to discover what a subject has done or is doing in a real world context.

Sensory: What respondents have seen, touched, heard, tasted or smelled.

**E. 2 Description of interview sections**

The first part of interview guide focuses on obtaining general and demographics information about the respondents, such as profession and occupation. Having a clear understanding of the interviewees’ professional knowledge and attitudes help the researcher to decide which section to start first. For instance, if the participant shows more interest in the business intelligence technologies than credit risk aspects, thus it is more acceptable to begins the interview with section three regarding credit risk questions.

The second section is containing a set of opening questions by which the researcher seeks to explore two general questions surrounding the research topic as follows:

What are the current problems facing by Omani banking industry regarding credit risk management?

*How does business intelligence technology help Omani banks to mitigate the potential credit risk?*

To answer the above questions, the participants were asked first to define some basic concepts, such as “*How would you define the concept credit risk?*”. Such questions are used by the researcher to ensure that the respondent has some awareness of the related research topics.
The third section of the interview guide is typically aimed to answer one of the research questions: “What are the key drivers for implementing business intelligence systems in Omani banks?”. The first question has been designed to investigate the different uses of BI technology across different banks in Oman. The second question seeks to understand the term BI terminology from the perspective of the various participants who are working in different departments in Omani banks (e.g. IT or business). The fourth question is the core issue by which the researcher intends to find out the primary motivations that lead to implementing a BI technology in Omani banks. The last question has been asked to get the participants’ opinions of whether or not they see a BI as mission critical tool within their respective bank or department. Although this question was subjective depending on personal evaluation, there are some cases where the participant refused to provide an answer.

The fourth part intended to collect some information related to the BI implementation project that may have a positive or negative impact on the outcome. During the piloting test, it has observed that a majority of respondents tends to avoid disclosing any information about their BI architecture. Hence, question 12.e under the same section has been changed to ‘optional’ for those who are willing to share such information. Despite these, the main purpose of this section was to get an insight into the main obstacles and challenges that the participants have encountered during their BI implementation journeys.

In section five, the researcher aimed to address a core research question: “What are the critical success factors for BI implementation in the context of Omani banks?”. To address this issue, the interviewee has been asked to identify either enablers or constraints factors that they think may
lead to success or failure of a BI project. Following that, they have been asked to provide their opinions on the effectiveness of BI tool in mitigating potential credit risk.

The sixth part and perhaps the most important one seek to address the overall research aim: “What is the impact of successful implementation of the BI system on credit risk management in Omani banking industry”. To measure the impact of BI system on credit risk management, three measures has been used: benefits, costs, and level of satisfaction. The final section concludes by asking some closing questions which allow the participants to add further comments and suggestions.

Appendix F: Access to dissertation

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