



Aalto University
School of Business

Mikkeli Campus

ADOPTION OF SUPPLY CHAIN ANALYTICS IN SMEs
An exploratory study

Do Tan Dat

International Business
Bachelor Thesis
Supervisor: Susan Grinsted
Date of approval: 09 April 2018

Declaration

By completing this cover sheet and declaration, I confirm that this assignment is my own work, is not copied from the work (published or unpublished) of any other person, and has not previously been submitted for assessment either at Aalto University or another educational establishment. Any direct or indirect uses of material (e.g.: text, visuals, ideas...) from other sources have been fully acknowledged and cited according to the conventions of the Harvard Referencing System.



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Author: Tan Dat Do

Title of thesis: The adoption of supply chain analytics in SMEs: an exploratory study

Date: 09 April 2018

Degree: Bachelor of Science in Economics and Business Administration

Supervisor: Susan Grinsted

Objective

Given the extant knowledge in the literature of the intersection among big data, analytics, and supply chain management, this thesis is aimed to explore the adoption of supply chain analytics in the SMEs. More specifically, the thesis' main objectives are to investigate under what situations the SMEs adopt supply chain analytics and provide the recommendations for SMEs in adopting supply chain analytics.

Summary

Based on the content analysis of interviews with solution providers from different countries, the thesis has explored the main motivations behind the adoptions from SMEs, and the necessary existing resources and the challenges for SMEs to adopt supply chain analytics. Given such findings, a framework for future research on the factors that affect the adoption of supply chain analytics in SMEs is proposed and detailed recommendations for such companies are also discussed.

Conclusions

In conclusion, the adoption of supply chain analytics in SMEs is still in modest rate due to certain barriers and complex required resources for SMEs in adopting such practices. The decisions to adopt supply chain analytics in SMEs depends on factors such as perceived benefits, dynamic environment, data-driven culture, necessary resources, and challenges of the adoptions. The thesis recommends that SMEs should firstly build basic awareness of analytics, and technical capability related to data management before adopting supply chain analytics. Then, SMEs also need to emphasize on change management and adopt alignment strategy to optimize the benefits gained from analytics adoptions.

Keywords: supply chain analytics, big data, supply chain management, SMEs

Language: English

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COVER PAGE

TITLE PAGE

ABSTRACT

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1. INTRODUCTION

1.1. Background

The term big data and analytics become buzzwords in recent years and are commonly mentioned by both scholars and businesses. Some scholars refer to current years as the “big data era” or the third generation of Business Intelligence evolution (Arunachalam et al. 2017) in which big data are changing the nature of businesses in most sectors from marketing, manufacturing, management, and finance.

In the supply chain context, the emergence of big data and analytics is visible with the increasing of the amount of data captured by different companies due to the growth of mobile phone, social media, other sensing technology in supply chain like RFID (Radio Frequency Identification). Indeed, companies, nowadays, treat data as an essential asset which brings insights, visibility about firms’ internal operation and external market, thus generate competitive advantages. With such changes, the term supply chain analytics was coined and is commonly used by both scholars and businesses. On the other hand, the supply chains nowadays are becoming more vulnerable due to the turbulence of the market and market disruptions. Therefore, firms need to employ technologies and techniques to turn their available data into actionable insights to assist them in decision-making in supply chain management. Indeed, according to the survey by Dresner Advisory Services (2017), about 53% of all companies have adopted big data analytics.

However, due to certain barriers to integrating analytics and big data in small to medium enterprises (SMEs), the adoption rate of big data and analytics in SMEs are still negligible (SAS, 2013) and there is a gap in the literature about the adoption of analytics and big data in SMEs companies (Arunachalam et al., 2017; Coleman et al., 2016). However, SMEs have vital roles in the global economy, and SME supply chains are claimed to be an important player to flow of goods and products in different industries. In addition to that, supply chain management in SMEs also faces the similar problems with those of larger companies (demand management, inventory management, logistics...), and those problems can be addressed by the analytics adoption.

Therefore, this thesis is aimed to study the early adoption of analytics in SMEs. By studying those pioneers, the thesis is also expected to provide recommendations for future SMEs in adopting data analytics.

1.2. Research Problem

There is a consensus in the literature that Big Data and Supply chain analytics have the potential to transform the supply chain design and improve the supply chain performance. Different empirical studies in the intersection between supply chain and analytics recently have extended our knowledge of the positive relationship between the adoption of Big Data Analytics and organizational performance. However, such studies mostly focus on large-size companies which have advantages over small to medium enterprises (SMEs) in adopting big data and Big Data Analytics due to the availability of necessary resources for BDA adoption in those large enterprises.

Such ignorance toward SMEs is unfortunate. Indeed, given the complex requirement in adopting supply chain analytics and SMEs' barriers in adopting such practices, the lack of knowledge on how SMEs can adopt supply chain analytics may present an additional barrier for SMEs and widen the digital divide between SMEs and larger organizations in term of supply chain management. Therefore, an exploratory study of the adoption of big data and data analytics in SMEs companies will shed a new light to the current gap in the literature and provide new insights of the current adoption of big data and analytics into supply chain management in SMEs.

1.3. Research Questions

Based on the extant literature, this thesis employs an exploratory research which explores characteristics of the current supply chain analytics adoptions in SMEs and how SMEs can ensure successful adoptions. More specifically, the thesis is aimed to understand:

- Under what situations, SMEs can adopt supply chain analytics to improve supply chain management?
- What should SMEs do to ensure the successful integration of supply chain analytics and big data?

1.4. Research Objectives

Specifically, the thesis will:

- Explore the motivation behind the adoption of data analytics and big data in SME supply chains or supply chain analytics in SMEs
- Uncover the necessary resources and challenges of such adoption for SMEs
- Provide recommendations for SMEs in adopting supply chain analytics
- Propose a framework for future research which can examine factors that influence adoptions of supply chain analytics in SMEs.

1.5. Key definitions

Small to Medium Enterprise (SME) are companies which have less than 250 employees. (OECD)

Big Data are “high-volume, velocity, and variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision-making.” (Beyer and Laney, 2012: 2)

Big Data Analytics (BDA) is the process in which big data is examined and analyzed by applying advanced tools; such tools include data management technologies, open-source programming, and visualization tools. (Chen et al., 2015)

Supply Chain Analytics (SCA) can be defined as the applications of advanced analytics or data analytics into the supply chain context to turn supply chain data into actionable insights for improving the management of flow material in the value chain (Arunachalam, 2017).

1.6. The structure of this thesis

To answer research questions above, this thesis will, firstly, examine the current literature review to provide a big picture of what has been known and explore the current gap in the literature. After reviewing the extant literature, the methodology chapter will explain the methodology used in this study and then present the analyses of finding generated from the data collected during the research in the finding chapter.

Next, in the discussion chapter, those findings are then examined to see whether the findings are consistent or contradicting to the current literature. Finally, the conclusion will summarize the main finding of the thesis, the thesis's implication to International Business, and the directions for future research.

2. LITERATURE REVIEW

2.1. Introduction

This chapter is aimed to provide the systematic review of what has been known in the literature about the intersection between data analytics, and supply chain management in SMEs and present the knowledge gaps related to the topic. Therefore, firstly, it will provide an overview of big data, big data analytics, and supply chain analytics. Then, the chapter examines different important aspects of SMEs and supply chain management in SMEs. This chapter then reviews important resources for successful integration of supply chain analytics and what has been addressed in the literature about such integration in SMEs such as barrier, suitable solutions for SMEs, etc. Finally, the chapter will summarize the relevant knowledge in the literature related to the topic and provide a conceptual framework which supports the later research processes in this thesis.

2.2. Overview of Big Data, Big Data Analytics, and Supply Chain Analytics

2.2.1. Big Data

In recent years, big data become a buzzword because of the emergence of technologies such as Internet-of-Things (IoT), and RFID (Radio Frequency Identification), smartphone, social media, etc. Indeed, 90% of data all over the world are created within last decades (Fawcett and Waller, 2014). According to Oxford English Dictionary, big data is defined as “an extremely large data sets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behaviors and interactions.” However, Arunachalam et al. (2017) argue that this definition does not successfully differentiate “big data” and “data” in general because the main distinctions between the two, which are scalability, a variety of data, and real-time analytics, are not discussed thoroughly.

In the literature review, definitions of big data are varied and evolve through time due to the changing nature of data. Cox and Ellsworth (1997) described Big Data as the challenges in storing datasets which were large in terms of size and require extra resources; this early definition seemed to only reveal the size characteristics of big data. However, though there is no clear agreement on the extant literature in terms of how big data should be defined, the big data definitions in current literature review have captured further characteristics of big data.

Big Data can be defined as the datasets whose size are beyond the storing capacity of the traditional database; to capture the new characteristics of big data, a 3Vs model was proposed by Manyika et al. (2011). This model characterizes big data into three dimensions: "Volume," "Velocity," and "Variety" (Manyika et al., 2011.) According to Manyika (2011), Volume represents the "magnitude of data generated," Variety is related to "structural heterogeneity in a data set," and Velocity refers to "the speed at which data are generated."

The 3Vs model gains great attention in the literature, and many later definitions of big data have been based on the model. Among those definitions, the one proposed by Beyer and Laney (2012: 2), which are "high-volume, velocity, and variety assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision-making", has been cited and widely accepted in the extant literature.

2.2.2. The development of Business Intelligence: from Business Analytics to Big Data analytics

There are different terminologies (BI, BA, BDA) closely related to BD and BDA. Among those terminologies, BI and BA are relatively not new terms and are commonly used interchangeably. Sahay & Ranjan (2008) define BI as the using technologies to gather and exploit information in order to enhance organizational performance, whereas Sangari & Razmi (2015) propose that BI are a group of technologies and tools including data mining, online analytical processing (OLAP), and data warehouse to facilitate information processing, recording, recovery, and analysis. On the other hand, BA is defined as applications of a broad range of analytical techniques to different business domains (Chae et al. 2014).

Though scholars agree that BA and BI are closely related, there is a debate about the nature of such relationship. Certain studies claimed that BA is a division of BI (Mortenson et al., 2015; Gudfinnsson et al., 2015). Nonetheless, others considered BI as a part of analytics and lead to the coin of the new term “BI&A”. Barbosa et al. (2017) argue that BI mainly refers to tools supporting decision-making with the focus on extracting information and reporting, whereas BA emphasized the application of mathematics and statistics in conjunction with IT to support decision-making.

Though there is no clear consensus among scholars in term of defining those terminologies, Arunachalam et al. (2017) claim that the pattern of development of capabilities used to support decision-making are clear, and such development can be categorized into 3 stages. In the first-generation of BI (in the 1990s), data mining and advanced statistical analytics had emerged (Chen et al., 2012). The second-generation evolved in the 2000s with the emergence of the term BA (Barbosa et al. 2017; Arunachalam et al., 2017). The sharp growth of information resulted from technologies such as RFID, smartphone, ... leads to the big data era and thus the 3.0 generation of BI. In such context, the term “BDA” is coined to refer to advanced techniques and methods to manage big data (Ularu et al., 2012). BDA represent the “practical meaning” of Big data because BDA’s main objective is to seek Business Intelligence (Wu et al., 2014). Wu et al. (2014) also argue that the combination of data science techniques (machine learning, data-mining), and data generating technologies such as IoT constitutes big data analytics. On the other hand, Chen et al. define big data analytics as the process in which big data is examined by applying advanced tools; such tools include data management technologies, open-source programming, and visualization tools.

2.2.3. Supply chain analytics (SCA) and areas of supply chain applications

Supply chain analytics (SCA) can be defined as the use of advanced analytics into the supply chain context to turn supply chain data into actionable insights for improving the management of flow material in the value chain (Arunachalam, 2017). Supply chain analytics is special terms used in supply chain management to refer to the applications of either business analytics or even big data analytics in the supply chain contexts.

Therefore, whether SCA is BDA or just data analytics depends on the data which the companies possess.

Based on the nature of the application and the level of analytics, supply chain analytics are categorized into either descriptive, predictive, and prescriptive analytics. Souza (2014) has elaborated in each type of analytics and describe the areas of applications for each type of supply chain analytics.

Descriptive analytics answers questions of what is happening, predictive answer and prescriptive both answer questions of what will happening (Arunachalam, 2017). The predictive analytics in supply chain derives demand forecast from past data, whereas the prescriptive analytics derives decision recommendations based on descriptive and predictive models (Souza, 2014). Besides, to explore the applications of advanced data analytics in detailed areas of supply chain management, the study utilizes the SCOR model from Supply Chain Council. With the center on the use of data generated from technologies such as GPS and RFID, the descriptive analytics can be applied in providing real-time information and analysis. On the other hand, the predictive analytics are mainly applied in demand forecasting which is essential for the operation planning in the supply chain. Finally, prescriptive analytics provide a “decision support tools” by utilizing mathematical optimization and simulation techniques.

In conclusion, in this thesis, we consider supply chain analytics as the applications of advanced analytics techniques which are rooted in data science and statistics and employ the supply chain data to generate insights for decision-making in supply chain management. Supply chain analytics can be just data analytics in general or big data analytics depends on the availability of the nature of data in different companies, how are supply chain analytics need to be employed different analytics rather than traditional statistical technique (time series analysis which solely based on historical data).

2.3. SME: Definition, Business Intelligence, and Supply chain

2.3.1. Definitions of SMEs

Small to Medium Enterprises can be defined by different metrics (staff headcount, turnover, or balance sheet total) (Ogboikiri et al., 2015). Staff headcount or the number

of employees is the most common metric used to define SMEs. Indeed, the definitions of SMEs based on staff headcount method vary by countries. According to EU commission and OECD, SMEs are companies which have below 250 employees, whereas the definitions of SMEs in Japan and the US are companies which respectively have fewer than 300 and 500 employees. Indeed, SMEs are claimed to be an important part of different economies in the world and the essential force for economy innovation (Polkowski & Nycz, 2016; Coleman et al., 2016). According to EU commission, SMEs hold 99% of all businesses in EU. SMEs present 90% of all businesses and 50% of employment all over the world (International Finance Corporation).

2.3.2. SME and Supply Chain Management

Supply chain management is defined as a combination of different practices which are employed to effectively integrate different parts of supply chains such as supplier, customers, distributor to generate a better performance for both each company in the supply chains. (Chopra & Meindl, 2001): effective supply chain management ensures the strong integration each entity in the value chains to another to ensure the smooth exchange of information, material and cash flows. (Kukalis, 1989). In term of strategy, SMEs usually aim to position themselves in the market niche, whereas larger organization usually tries to gain large market share. Larger companies have a bigger scope of information and product flow than those of SMEs. Such characteristics lead to differences in SME supply chain management compared to larger companies (Hong & Jeong, 2015).

SMEs can play different roles in the chain of value: they can be suppliers, distributors, producers, and customers. (Hong and Jeong, 2015). The advantages of SMEs are their flexibility and quick decision-making which allow them to gain competitive advantages and quickly learn and adopt practices from big players in the field (Nguyen, 2010).

They can compete within the supply chain to get competitive positions in terms of either low-cost operations or value-added operations (e.g. new product and service development) (Nguyen, 2010).

2.4. Adoption of Analytics of SMEs into supply chain management

2.4.1. Background

In general, SMEs is left behind in adopting big data and analytics. Big data analytics adoption in SMEs are still insignificant (SAS, 2013), or adoption rate of data analytics in different countries, for example, the UK was only 0.2% (Coleman et al., 2016). Certain reports have forecasted that the BI and analytics market for SMEs will increase sharply (Dresner Advisory Service, 2017); the growth rate of the global market for analytics adoption in SMEs has been expected to increase by 42% from 2013 to 2018 (Coleman et al, 2016). On the other hand, such number is still small when comparing to the total number of SMEs in the global market. In addition to that, with significant challenges in adopting data analytics, most of SMEs will fall into the group of low digitalization and low data-driven companies. Thus, analytics and big data can cause a digital divide between SMEs and larger organizations in the future (Arunachalam et al., 2017).

A recent report by Dresner Advisory Service (2017) state that growth in revenues and increased in competitive advantages are among the main motivations behind such adoptions. However, there is a shortage of academic paper which investigate the rate of analytics adoption in SMEs companies and the motivation behind those adoptions, especially in supply chain management sector.

Extant literature has investigated pre-factors affecting the adoption of BDA, but such studies mostly focus on companies with larger sizes (Chen et al., 2015; Verma & Bhattacharyya., 2017). Main findings from those studies are that the adoption of BDA has a positive relationship with perceived benefits of big data analytics. Other factors such as competitive pressure from competitors and industry type play moderating role in the adoption and successful usage of analytics in companies. However, the supply chain management in SMEs appear to be different from larger companies and the competitive pressure are also different due to the differences in their strategy which is elaborated above, it is essential to conduct research on the adoption of analytics by SMEs.

Because analytics and big data are considered an essential part of BI investment for supply chain management, it is essential to review the current state of BI in SMEs. Hatta et al. (2015) argue that SMEs are still left behind in developing BI & A even though it is

reported that there is growing demand from SMEs for BI&A. In term of knowledge on extant literature, the majority of papers are focused on concept constructing methods in which frameworks, models are proposed and barriers for SMEs in BI are also discussed (Llave, 2017). However, it is lack of studies which provide empirical tests for such conceptual studies: therefore, future research on this field should employ empirical study on adoption of BI & A or case studies to provide recommendations for future SMEs.

2.4.2. Opportunities for SME supply chains

Generally, big data adoption is claimed to improve decision-making in organizations and thus improve the organizational performance. Specifically, in supply chain context, Waller and Fawcett (2013) state that the combination of big data and advanced analytics techniques such as data mining, machine learning, etc. has the potential to transform the supply chain design. Empirically, various studies have shown the positive relationship between big data analytics adoption in supply chain management and firm performances (Chen et al. 2015; Gunasekaran et al., 2016). However, samples from such studies mostly focus on larger organizations.

Extant literature in the intersection between big data and analytics in SMEs has the consensus about the opportunities presented to the growth of SMEs; the opportunities in such research papers can be either the potential impacts of analytics on SMEs or ways in which SMEs can address barriers in adoption. In this part of the literature review, the former will be discussed first, and the latter (ways to address barriers) will be elaborated later in the “Recommendations for SMEs from extant literature” section.

Big data present increasing significance to the SMEs due to the need from SMEs to understand more about both internal performance of the companies and the external market (Polkowski & Nycz, 2016). On the other hand, Rising et al. (2014) propose the strategic importance of big data for SMEs: because, different from larger companies, SMEs usually make decisions based more on intuition, the use of analytics will transform those SMEs into data-driven culture and have a bigger potential in organizational performance due to the agility nature in most SMEs. Consistent with the view from Rising et al. (2014), Chase (2013) states that decision-making based on intuition in supply chain management, especially in demand planning, are usually not as effective as decision-

making based on data and analytics. SMEs should transform from demand management based on intuition to demand management based on more advanced techniques and data-driven approach (Chase, 2016). Sen et al. (2014) provoke that the use of big data in SMEs can allow those enterprises to gain the big picture of both internal operation and external market. Coleman et al. (2016) urge SMEs to adopt big data to avoid falling behind, suffers from competitive disadvantages. Ogbuokiri et al. (2015) claim that the growth of SMEs nowadays depends on their advancement in big data and analytics.

Majority of such studies are based on either conceptual, theoretical, or descriptive methods. There seem to be no empirical studies in the field to explore the impacts of analytics in SMEs, or specifically supply chain analytics in SMEs. It is essential to conduct exploratory studies at first to provide the foundation for later study in this serious gap in knowledge.

More specifically, in recent years, there is an increasing number of papers which illustrate case studies or propose methods in applying analytics into different areas of supply chain management (Arunachalam et al., 2017; Tiwari et al., 2017). Most common areas of supply chain management have been improved by analytics application are strategic sourcing, supply chain network design, product design, and development, demand planning, procurement, production, logistics, and distributions (Tiwari et al., 2017). However, the majority of those papers are focused on larger companies and there are no case studies which provide how SMEs can apply supply chain analytics to improve each of any areas of supply chain management. Such gap is unfortunate and can be considered as one of the barriers for SMEs in adopting such analytics into supply chain management.

2.4.3. Challenges of SMEs

In general, due to its complex characteristics of big data and analytics, adopting and using analytics and big data present challenges for both big companies and SMEs. Arunachalam et al. (2017) state that general challenges in implementing analytics include organizational challenges, technical challenges. Those challenges also are faced by SMEs organizations, however, due to the limitations in the different type of necessary resources, challenges in SMEs can be in larger extents. Such barriers can be categorized

into 5 main areas: human resources, strategy and awareness, finance, IT infrastructure, and Lack of Facilitating conditions.

Human resource: in general, Arunachalam et al. (2017) argue that the successful integration of data analytics requires the collaboration between IT expert who manage technical issues and data and analytics experts such as data analysts and data scientists. Besides, such data analysts and data scientists need to have different sets of skills and knowledge: domain knowledge in the supply chain, analytics skills, programming skills etc. The requirement for the deployment of supply chain analytics in SMEs is relatively the same. However, human resources for analytics in SMEs seem to be larger due to their poor position in analytics talent market. They have low competitiveness in competing with larger firms in recruiting data analytics talents (Coleman et al., 2016; Rising et al., 2014).

Strategy and awareness is another challenge for SMEs. In general, different reports indicate that SMEs generally have a lower understanding of analytics than larger organizations. (Coleman et al., 2016; Ardagna et al., 2016). In addition to that, decision-making and strategy based on intuition rather than data-driven may be disadvantageous for SMEs in term of integrating supply chain analytics to different organizational functions. (Chase, 2016; Rising et al., 2014).

Finance is a noticeable limitation for SMEs. According to above review in the literature, employment supply chain analytics require certain investments in IT infrastructure and human resources. SMEs with the limited budget has constrained choices in the type of technologies to adopt and talents to hire (Coleman et al., 2016).

IT infrastructure is another issue for SMEs because according to the literature review, the current maturity of digitalization and BI in SMEs are still generally lower than the larger organizations. IT infrastructure affect the quality of raw data available for analytics (Arunachalam et al., 2017).

Lack of Facilitating conditions is claimed to be one of the reasons behind the poor adoption in SMEs. Certain important issues are the lack of business cases, customize

software and solution for SMEs to employ data analytics which is suitable for their current capabilities (Coleman et al., 2016).

2.5. Recommendations for SMEs in big data and analytics adoption

The current literature has provided different recommendations for SMEs to implement supply chain analytics and big data. However, due to the shortage of research, such recommendations are solely based on conceptual and descriptive methods and are lack of confirmation from empirical studies such as case studies in real SMEs.

The right IT architecture for big data SMEs

Despite the overall complex requirements for analytics in term of IT infrastructure, the majority of papers which focus on the intersection between BDA and SMEs have claimed that there are there are available tools which provide the affordable tools for the SME in term of BDA adoptions.

Ogbuokiri et al. (2016) propose characteristics of big data solutions which SME should seek (table 1).

| | |
|-------------------------------|--|
| Flexibility and choice | Allow small companies to choose only certain capabilities rather than changing their whole existing system. |
| Simplicity | Should be simple not so complicated to implement. Allow the SMEs to employ additional features in the solutions without training |
| Cost | SME should pay only the solution that they need, allow them to gradually scale up the solutions. |

Table 1 Characteristics of big data solutions which SMEs should seek

Whereas, Coleman et al. (2016) state that the right decision for IT infrastructure for big data and analytics should consider skills of current internal analytics talents and data engineers, the scope of the data, and the requirement for collaboration and integration. Besides, the majority of those papers propose that cloud seems to be a cost-effective solution for big data in SMEs providing their limited budget and poor existing IT infrastructure and limited expertise (Coleman et al., 2016; Rising et al., 2014). Those studies argue that with the availability of cloud solutions, SMEs have less constraint in

upfront investments. Besides, the open source of analytics projects and tools also allow SMEs to take advantages of supply chain analytics to benefit from their supply chain data.

Human resource: as elaborated above, the IT investment for big data analytics seems to be less difficult for SMEs in nowadays. However, talents for analytics still remain the main challenges for most companies, especially SMEs as elaborated in barrier section above. The main propositions from extant literature in term of addressing this issue are to either outsourcing their analytics for solution providers (Ardagna et al, 2016) or finding the right internal talents for training (Rising et al., 2014). For example, in supply chain domain, SMEs can gradually adopt data analytics by offer training program for their existing employees in supply chain management. Those employees already have domain knowledge, so the more expertise in analytics would benefit them and the companies in transform to a data-driven culture. Even though the companies cannot implement the analytics all by themselves, those employees who have possessed expertise in both fields will accelerate the integration of analytics.

2.6. Conclusion & Conceptual Framework

According to the literature review, analytics can improve different areas of the supply chain such as demand planning, inventory management, logistic, procurement, etc. (Arunachalam et al., 2017; Nguyen et al., 2016). Though supply chain management in SMEs still needs improvement in such areas, the barriers for SMEs seem to be larger than those for large businesses, and such barriers may prevent SMEs from potential benefits of analytics and big data.

In addition to those barriers, unfortunately, the knowledge in the extant literature on factors which affects the adoption of supply chain analytics in SMEs is still modest due to the lack of empirical studies focused on how small-to-medium companies adopt data analytics and big data into their supply chain management. More specifically, it remained ambiguous of the motivations behind the adoption of data analytics in pioneer SMEs. Most research papers related to challenges and barrier for SME to adopt data analytics and big data usually employ concept conceptual methods, and there is lack of studies which employ empirical research method to explore the challenges.

Various studies have proposed suitable solutions for SME companies. However, such propositions are usually lack of confirmation from empirical evidence. Therefore, it remains a high uncertainty for small and medium companies to follow such practices and ensure the success.

In conclusion, it remains a big gap in the literature related to the use of big data and analytics in supply chain management in SMEs. The adoption of data analytics and big data is still rare, and there is the lack of empirical studies which explore the different characteristics of such adoption. The figure 1 Conceptual Framework (on page 14) help to better summarize both current literature gaps and theoretical foundations discussed in this chapter.

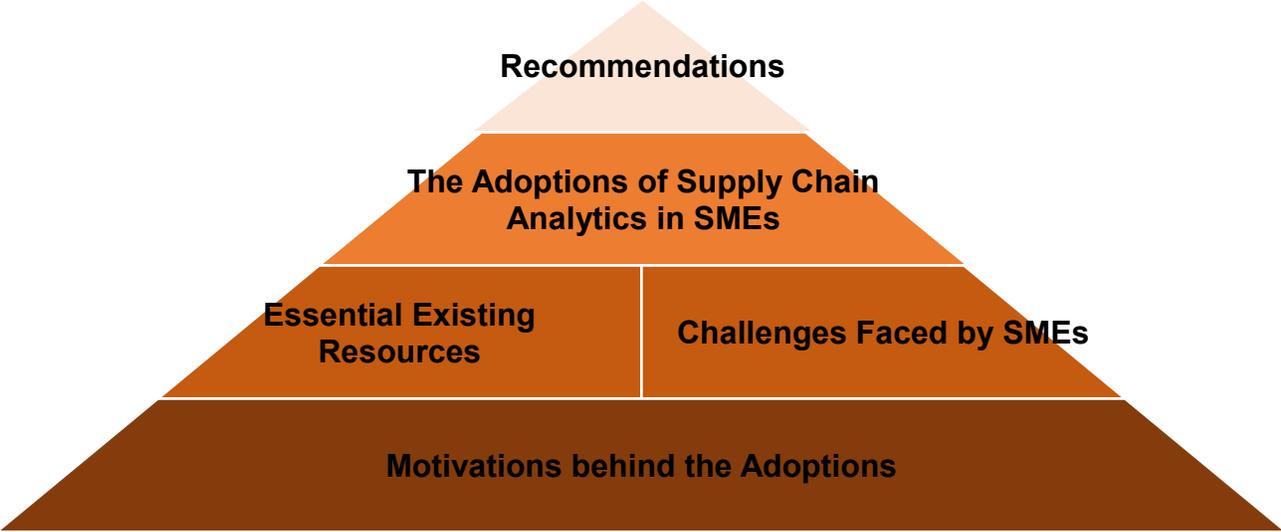


Figure 1 Conceptual Framework

3. METHODOLOGY

With the existing gap in the literature related to data analytics and SME supply chain, it is advantageous to conduct an exploratory study to address the gap and provide the foundation for the future research in the field. More specifically, the thesis is aimed to uncover the different characteristics of pioneer SME who implement data analytics in the supply chain management and thus provide recommendations for the future SME to adopt data analytics. This chapter will elaborate on the rationale behind the chosen methodology in this thesis, explain the data collection methods, and clarify the data analysis method used to interpret the findings.

3.1. The rationale behind research design and methodology

There are two major research strategies available: quantitative and qualitative approaches which have distinctive characteristics and are suitable for different type of studies (Brymant & Bell, 2007). For this exploratory study, the qualitative approach seems to be more appropriate because the qualitative approach is commonly chosen to uncover new characteristics and generate deep knowledge for observing events and objects. Rather than existing before data collection phrase (in quantitative approach), concepts and theories in qualitative approach are constructed after the data collection (Bryman & Bell, 2007), so this approach is plausible for exploring new characteristics and concepts. Secondly, a qualitative approach is generally claimed to generate rich data and thus are used to understand how and why things happen (Cooper & Schindler, 2014).

Because target group in this study who provide the needed information is data management and data analyst experts from multiple consulting companies in different countries, the individual depth interview is chosen among available qualitative methodologies such as focus group or group interview as a cost-effective and convenient research methodology which also avoids possible exposing of sensitive and competitive information related to the businesses of participants.

3.2. Sample selection

To study the adoption of data analytics to SME companies, the data analytics and data engineering experts from solution provider companies are chosen.

The first reason for choosing adoption providers as targeted group of this exploratory study is that they have the thorough expertise of the field and wide range of experience with data analytics adoption projects for SMEs in different industries and in different areas of the supply chain, so their knowledge and insights have a more generalization level than individual SMEs which have adopted supply chain analytics and big data.

The second reason for such choice is that it is convenient for this time-constraining projects to interview solution providers because, in the case of the thesis, the researcher recognizes that it is easier to target and approach solution providers. Due to the nature of consulting business, it is easier to target the experts who possess the needed expertise and experience for this thesis. Nonetheless, it is more time-consuming and difficult to target and approach SMEs who have implemented supply chain analytics and big data to support their internal supply chain management because SMEs may not publish much information about their internal technologies.

Solution providers are from different markets in the world such as Finland, India, US, and Germany. Such location variety in the profile of respondents benefits the study in terms of providing diversified input of opinions and not affected by the constraints of a particular economy or market. Detail information of participants in the interview is provided in table 2: Respondent profile below.

| | Title | Company's industry | Location |
|---------------------|-----------------------------|---------------------------|-----------------|
| Respondent 1 | Supply chain Data analytics | Consulting | US |

| | | | |
|---------------------|--|------------|---------|
| Respondent 2 | Head of Analytics | Consulting | Finland |
| Respondent 3 | Senior Data scientist | Consulting | India |
| Respondent 4 | Chief Executive Officer and Data management expert | Consulting | UK |
| Respondent 5 | Senior data scientist | Consulting | India |
| Respondent 6 | Supply chain consultant | Consulting | Germany |

Table 2: Respondents' profile

3.3. Data collection process

Individual depth interviews are conducted from February to March of 2018 from different solution providers all over the world (see the detailed interview questions in appendix 1 of the thesis). Semi-structured interviews were chosen because it provides some general directions for the respondents but also allows respondents to provide their new insights and tell own story which is beneficial for exploring new insights from the industry (Cooper & Schindler, 2014). To collect data from respondents, the call interviews were conducted because it is a convenient and cost-effective method to interview multiple participants from different locations around the world.

3.4. Qualitative Data analysis

The interview in audio and video files are transcribed word-by-word into text files. After that, content analysis techniques for qualitative data are employed to analyzing those text files.

The analysis is followed the common process in content analysis: “a systematic process for coding and drawing inferences from texts” (Cooper and Schindler, 2014: 385). More specifically, raw data from texts are coded into different categories: the coding process is followed to coding rules in which categorized should be “appropriate to the research problem, exhaustive, mutually exclusive, derived from one single classification”. (Cooper and Schindler, 2014: 385).

Four type of text data unit will be analyzed include syntactical (refers to words, phrases, and sentences), referential (described by syntactical unit and refers the particular expression linked to specific events, objects), propositional (refers to the assertion from respondents to a specific studying objects, events), and thematic unit (refers to abstractions and themes associated with examining objects and events) (Cooper and Schindler, 2014). Such unit type is the basis for coding texts into categorizing. After coding, themes and patterns are examined and thus the inference is drawn from such pattern and themes as the finding in this thesis.

4. FINDINGS

4.1. Motivations behind the adoption

Based on data collected from the interviews, the **Table 3** illustrates a summary of mentioned motivations behind the adoption of analytics and big data in supply chain management by each respondent and **Table 4** represents the frequency of each code appeared in the Table 3.

| | Perceived benefits (5) | External factors (2) | Others (1) |
|---------------------|-------------------------------|-----------------------------|---------------------|
| Respondent 1 | Solve existing problem | Adoption trend | Data-driven culture |
| Respondent 2 | Visibility | Competitive advantages | |
| | Solving existing problem | | |
| | Cost cutting | | |
| Respondent 3 | Solving existing problem | Adoption trend | |
| Respondent 4 | Visibility | | |
| | Better decision-making | | |
| Respondent 5 | Cost cutting | | Data-driven culture |
| Respondent 6 | Visibility | | |
| | Solving existing problems | | |
| | Better decision making | | |

Table 3: Motivation behind the adoptions: summary by respondents' answers

| Perceived benefits (6) | External factors (2) | Others (2) |
|---|--|-------------------------|
| Solving existing problems (4) Visibility (3) Better decision-making (2) Cost cutting (2) | Competitive advantages (2) Adoption trend (2) | Data-driven culture (2) |

Table 4 Motivations behind the adoptions: content analysis' result summary

Perceived benefits (6) are the most common theme proposed by solution providers (table 3 and 4). Solution providers in this research believe that the main motivation behind the adoption is the awareness of benefit provided by the adoption of data analytics in SME supply chain.

One of the perceived benefits starts from the fact that SMEs realize that data analytics can help them in *solving existing problems (4)*. SMEs can either realize that the current data are too large and become hard to manage (solution provider 1) or have some problems at hand (solution provider 2 and 3) such as customer retention or false demand prediction which cause companies to suffer. *Gaining visibility (3)* and *improve better decision-making (2)* is other perceived benefits by SMEs which can be expected to improve overall operational efficiency. *Cost-cutting (2)* (especially net-working capital) are also believed to be an important motivation behind the adoption.

To better understanding the perceived benefit factors in supply chain analytics, we should also examine **the areas of supply chain management** in which analytics have been applied in SMEs according to the findings in this thesis. The Table 5 below illustrates the answers from 6 respondents with the question that which areas of supply chain management that your past project in supply chain analytics adoption in SMEs related to:

| | Demand Forecasting (4) | Inventory Management (3) | Logistics Optimization (4) | Procurement (2) |
|---------------------|-------------------------------|---------------------------------|-----------------------------------|------------------------|
| Respondent 1 | x | | | |
| Respondent 2 | | | | X |
| Respondent 3 | x | X | x | |
| Respondent 4 | X | | x | |
| Respondent 5 | x | X | X | |
| Respondent 6 | | X | x | X |

Table 5 Areas of supply chain management of analytics applications

Supply chain management is complex, and all steps are related to each other: changing one of those steps, the chains will be either suffered or positively influenced by that decision (solution provider 3, 5, and 6). Therefore, according to most of the solution providers, analytics should be applied in different areas of the supply chain to optimize the benefits gained; however, it seems that areas of analytics application also depend on the industry of the firms and the available data those firms possess (solution provider 5). Due to its business scale, the majority of SMEs do not store a large amount of data as the larger enterprises do: however, they can still benefit from doing analytics based on their existing data (solution provider 3). *Demand forecasting (4) and logistics optimizations (4)* is most common areas mention by the solution providers. According to solution provider 3, and 5, by predicting future demand, demand management will affect all other processes such as procurement, inventory management, etc. Whereas, improvement in *logistics optimization (4) and procurement (2)* by applying analytics are claimed to affect both visibility of upstream and downstream chains and cost-cutting for SMEs (Solution provider 2, 5, and 6). Whereas, *inventory optimization (3)* plays a vital role in cost-cutting in the net-working capital in supply chain management. (solution provider 3, and 5).

External Factor (3) appears in 3 out of 6 solution providers' answer. Those 3 solution providers believe that few SME clients are trying to invest in data analytics because of the trend in the industry. Solution providers 1 and 3 claim that it is not necessary that SME is threatened by the adoption of data analytics from other big companies, they just follow the *adoption trend (2)* and try the techniques which other big players in the field have tried. It can be concluded based on the sets of the interviews that for the SME clients

of solution providers in this study, the rate of adoption in data analytics in SME supply chain is still not high enough for SME to feel the direct threatens from the market to adopt big data or else they will leave behind.

Explaining this situation, solution provider 5 claims that though most big players have adopted big data and analytics, it takes time to see the clear market effect of the digital divide between who adopt data analytics and who do not. So those SMEs in the studies seem to follow the big players in the field to adopt big data analytics to gain possible *competitive advantages (2)* over their peers rather than the perceived of competitive pressure to adopt.

Data-driven culture (2) is proposed by 2 out of 6 providers. Respondent 1, 5 believe that data analytics adoption is a natural process for the data-driven and innovative SMEs. Those solution providers believe that analytics adoption is the result of data driven-culture.

4.2. Necessary resources for the adoption

The **Table 6** illustrates a summary of respondents' opinions on essential resources for SMEs in adopting supply chain analytics and **Table 7** represents the frequency of each code appeared in Table 6.

| | Human resource (4) | Strategy and awareness (4) | Finance (2) | IT infrastructure (3) | Data Sources (4) |
|--------------|---------------------------|-----------------------------------|---------------------|------------------------------|-------------------------|
| Respondent 1 | Data analysts | Awareness | Budget for IT | | Available data |
| | | | Budget for training | | |
| Respondent 2 | | | | | Available data |
| Respondent 3 | Data engineers | Data strategy | | | Available data |
| | Data analysts | Top Management support | | | |
| | Project managers | Change management- | | | |

| | | | | | |
|--------------|-----------------|-------------------|-------------------|--|----------------|
| Respondent 4 | Data engineers | Awareness | | | Available data |
| Respondent 5 | Data engineers | | Budget for the IT | | |
| | Data analytics | | | | |
| | Project manager | | | | |
| Respondent 6 | | Change management | | | |

Table 6 Necessary existing resources for supply chain analytics adoption in SMEs: summary of respondent's answer

| Human resource (4) | Strategy and awareness (4) | Finance (2) | IT infrastructure (3) | Data Sources (4) |
|---|--|--|------------------------------|-------------------------|
| Data analyst teams (2) Data engineer teams (3) Project managers (2) | Awareness (2) Change management (2) Top Management support Data management policy | Budget for training Budget for IT (2) | | |

Table 7 Necessary existing resources for supply chain analytics adoption in SMEs: summary of content analysis' results

Data sources (4): It is interesting that 4 out of 6 respondents state that the companies should have a good source of data before moving to adopt data analytics. Data are the new oil which can be considered as a new important type of asset for the firm and can influence the value of the firms (Respondent 2). Before, doing data analytics and adopt big data, firms should have strong data resources, especially those related to supply chain management.

Human resource (4) Following that, 4 out of 6 solution providers think that human resources are essential for SMEs. Specifically, Majority of solution providers state that no

matter what analytics solutions which SMEs choose to adopt, such SMEs should have a *data engineers (3) or data analysts (2)*: in this thesis, *data engineers* refer to the those who are responsible for manage the supply chain data and company database, whereas *data analysts* are talents who run analytics techniques with available data to turn those raw data into actionable insights. Respondents 3 and 5 also add that besides data talents, companies should also have good *project managers (2)* in charge of data analytics adoption and analytics projects to facilitate the best results.

Strategy and awareness (4) are also claimed to be a necessary requirement for the data analytics adoption according to the majority of solution providers in the interviews. Respondents 1 and 4 believe that it is essential for companies to have a certain *awareness (2)* of the technology to understand what they need from analytics: *awareness* in this study refers to the basic understanding and knowledge of the companies, especially the decision-makers prior to the adoptions. According to respondents 1 and 4, the lack of expertise and focus from the companies, especially from the top managers, can negatively influence the process of data analytics solutions. On the other hand, *change management (2)* strategy are stressed by respondents 3 and 6 as the essential resources for the adopting data analytics in supply chain management. Respondent 3 also states that good *data management strategy and top management support* in new technology projects are essential resources which ensure the success of the adoption and usage of data analytics.

IT infrastructure (3), in conjunction with internal data team and data, 3 out of 6 solution providers believe that SMEs should have maturity in a certain level of IT infrastructure. The respondent 2 use the term “digitalization” to describe the maturity of the organizational IT structure. Digitalization is associated with the quality of the data, companies should turn their data into digital format by facilitating the digitalization process (respondent 2) in order for the successful integration of big data and data analytics.

4.3. Challenges needed to be addressed in the adoption

The **Table 8** illustrates a summary of respondents' opinions on barriers for SMEs in adopting supply chain analytics and **Table 9** represents the frequency of each code related to barriers for SMEs which appeared in Table 8.

| | Human resource (4) | Strategy and awareness (2) | Finance (3) | IT infrastructure (4) | Others (1) |
|---------------------|---------------------------|-----------------------------------|---------------------------|------------------------------|------------------------------|
| Respondent 1 | Analyst teams | | No budget for training | | |
| | | | Return on equity | | |
| Respondent 2 | Analyst teams | | | Poor IT infrastructure | Lack of customized solutions |
| Respondent 3 | Data Analyst teams | | Budget for new technology | Poor IT infrastructure | |
| | Data engineers | | | | |
| Respondent 4 | Data analysts | | | Poor IT infrastructure | |
| | Data engineers | | | | |
| Respondent 5 | Data engineer | Data-driven culture | Budget for new technology | | |
| | | Change management | Return on equity | | |
| Respondent 6 | | Change management | | Merge of new IT technology | |

Table 8 Challenges for SME adopter: summary of answers by respondent

| Human resource (4) | Strategy and awareness (2) | Finance (3) | IT infrastructure (4) | Others (1) |
|---|--|---|--|------------------------------|
| Analyst teams (3) Data engineers (3) | Data-driven culture (1) Change management (2) | No budget for training (1) The budget for new technology (2) Return on equity (2) | Poor IT infrastructure (3) Merge of new IT technology (1) | Lack of customized solutions |

Table 9 Challenges for SME adopters: summary of content analysis's result

Human resources (4): are mentioned by 4 out of 6 solution providers as the main challenges for SMEs in adopting supply chain analytics. SMEs have difficulties in hiring both *data analysts (3)* to conduct analytics techniques and *data engineers (3)* to manage their IT infrastructure and databases who is responsible for the data management (Solution providers 1, 2, 3, 4, and 5). Most importantly, the majority of solution providers point out the fact that there is a serious shortage in supply chain data analytics talents who have both advanced analytics skills and supply chain domain to be able to work with supply chain analytics projects. Respondents 2, and 4 state that SMEs have little competitiveness with the big companies in analytics talent war. According to respondent 3, 4, to implement data analytics projects, SMEs should at least have certain IT staffs who manage the databases and data acquisition processes to provide data which are free of errors. Respondents 4 and 5 believe that firms even though have little analytics expertise should even have internal data teams who SMEs can trust on to work with outside solution providers to upgrade their current analytics adoption.

Finance (3): are claimed as one of the main barriers for SMEs in adopting data analytics in supply chain management (solution provider 1, 3, and 5). SMEs can either have not enough *budget for training (1)* people or *budget for new technology (2)* in order to implement data analytics projects. However, solution providers 1, and 5 claims that cost invested for new technology have been more affordable for SMEs; therefore, the return on investment is the main factors in barrier related to finance. According to solution provider 1 and 5, they claim that SMEs may have enough financial resources to invest in SMEs; however, in most cases, the weighted benefits in related to costs are low. The

benefits of cost-cutting in SMEs might be not large enough for the cost of investment in analytics.

IT infrastructure (4): are mentioned by 4 out of 6 solution providers. Solution providers 2, 3, and 4 state that poor IT infrastructure or the low level of current digitalization maturity cause the serious difficulties for SMEs to integrate required technology for supply chain analytics adoptions. However, respondent 5 believes that technical issues are not a big problem provided that companies have enough financial resources and strategy in data analytics. Respondent 6 has a similar to respondent 5 that technical issues are not. that big challenge for SMEs anymore providing the availability of support from solution providers: however, this respondent also stresses that the SME supply chains have to overcome the challenges related to the merge of new technology into existing IT infrastructure.

Strategy & awareness (2): are less frequently referred as the barriers for SMEs even though it is the most common areas mentioned by solution providers as essential resources for SMEs in integrating analytics into supply chain management. From solution providers point of view, while the technical and financial issues become less severe thanks to the availability of solution providers, what remains big challenges for SMEs for adopting data analytics are *change management (2)* and *data-driven culture* (solution provider 5, and 6). Though SMEs seems to be more flexible in term of strategy and project implementation comparing to larger companies (solution provider 4); due to the lack of awareness in analytics technology from most of SMEs, especially from top-management (solution provider 5) the change management from decision-making based on intuition into decision-making based on analytics and data are hard to be implemented.

Others: in conjunction with SME's limited resources such as finances, talents, and strategy & awareness, *the lack of customized solutions* for SMEs which are suitable with their current capability in analytics can be considered as another barrier for adoption in SMEs (solution provider 2).

4.4. Recommendations for future adopters

Below is the **Table 10** which illustrates a summary of recommendations for adopting supply chain analytics by each respondent and **Table 11** shows the frequency of each code which is shown in table 10.

| | Human resource (3) | Strategy and awareness (5) | Finance (3) | IT infrastructure (4) |
|---------------------|---------------------------|-----------------------------------|------------------------------|------------------------------|
| Respondent 1 | Training people | Awareness | Budget for training | IT infrastructure |
| Respondent 2 | | Data policy | | IT infrastructure |
| Respondent 3 | Internal data management | Awareness | | IT infrastructure |
| Respondent 4 | Internal data management | Data policy | Budget for adoption | IT infrastructure |
| Respondent 5 | | Awareness | Analysis of return on equity | |
| | | Change management | | |
| Respondent 6 | | Alignment strategy | | |
| | | Change management | | |

Table 10 Recommendations for future SME adopters: answer summary by respondent

| Human resource (3) | Strategy and awareness (5) | Finance (3) | IT infrastructure (4) |
|--|--|--|------------------------------|
| Training people (1) Internal data engineers (2) | Awareness (3) Data management policy (2) Change management (3) Alignment strategy (1) | Budget for training (1) Budget for adoption (1) Analysis of return on equity (1) | |

Table 11 Recommendations for future SME adopters: summary of content analysis's result

Solution providers in the study provide a variety of recommendations based on their diverse expertise and experiences from data analytics and big data adoption projects in SMEs.

Strategy and awareness of top management (5) are the most common areas in which the respondents in this research recommend to. Solution providers 1, 2, and 3 recommend that top management should at least understand some basic *awareness (3)* of analytics and what they need from analytics application. Due to the missing of awareness of analytics and big data, some SMEs are lack of focus on utilizing tools in data analytics and investment for big data analytics: they do not understand what they need from analytics and big data (solution provider 1). So, the generalization and basic knowledge of big data and analytics should be the first step in adopting data analytics for SMEs.

The *data management policy (2)* is another aspect should be adopted before adopting big data. Data should be treated as an asset: the companies should have the right data management policy to ensure the high quality of data for analytics (solution provider 2 and 4). To ensure that, the role of internal data engineers is also important to facilitate the data management policy (solution provider 3).

Human resource (3), in conjunction with the finding of challenges and necessary resources, human resource is the area received recommendations from 3 out of 5 solution providers. Respondent 1 proposes that SMEs should find the right existing person in the companies to train in conjunction with appropriate with a proper budget and top management support. Companies should have some priority in data strategy to facilitate the successful adoption and usage of analytics.

Respondents 3, 4, and 5 believe that even though SMEs receive help from solution providers in integrating analytics. They need at least some internal data engineers to deliver the effective collaboration with external consulting firms. Such data engineers have to understand the data sets within the companies, they are aware of which data are plausible for the analytics in this ad-hoc solution (Respondent 3). On the hand, respondent 4 states that in such analytics projects, SMEs companies may need some internal data experts who they can trust to facilitate the best outcome for the adoptions.

Finance (3) is stressed by respondent 1, 3, 5. All of these 3 solution providers believe that SMEs should be able to allocate internal fund for the adoption of data analytics. For

companies which want to expand into analytics, they should consider analytics budget as a priority.

IT infrastructure (4) respondents have different opinions about which IT infrastructure and solutions should be employed by SMEs. Respondent 2 claims that companies should digitalize their data before data analytics adoption. Respondent 1 states that right solution for SMEs should not be free or cheap one because it is hard for them to employ, such opinions are relatively consistent with those from respondent 4 who argues that most of SMEs have low expertise in analytics, so the upgrading new technology is not as difficult for SMEs as knowing how to use them. SMEs only benefits from available open sources and technology only when they have good internal talents in both data management and data analytics.

Supply chain analytics in SMEs can be categorized into 2 paths: the first path is to adopt data analytics which used existing data in advanced analytics to provide insights, the second is continuing from data analytics to implement big data into organizations (solution provider 3). The second one seems to be harder and requires more investment in term of IT infrastructure to meet the scale required by big data.

Regarding the right IT infrastructure for big data, solution providers in this research have different opinions about that. Respondent 5 believes that RDBMS (relational database management system) does not meet the requirement by big data, whereas respondents 4 believe that RDBMS still acceptable for certain data analytics projects. Respondent 3 believe it does not matter for analytics in what tools are employed provided that data are well managed for analytics. Regarding cloud, respondent 3 believe it is expensive for SMEs, whereas respondent 5 believe cloud is essential for analytics adoption in SMEs. Respondent 3 argue with the main claim toward RDBMS that this technology does not have enough scalability for data analytics. Respondent 3 claims that “the only weakness of RDBMS is in term of fastness in the performance; scalability and variety of data type are currently supported by RDBMS.” However, respondent 5 claims that cloud has some long-term drawbacks not only for SMEs but also for the whole industry in term of moving data out of clouds when unneeded.

5. DISCUSSION

5.1. SMEs' adoption of supply chain analytics

Regarding the adoption of supply chain analytics in SMEs, the findings from interviews with solution providers in the field, generally, have been consistent with the discussion in the literature review. However, due to the qualitative methods, such findings provide more detailed insights into elements, concept, and observations discussed in the literature review chapter.

5.1.1. Motivations behind the adoptions

As elaborated earlier, there seem to be no empirical studies which have examined the adoption of supply chain analytics in SMEs. So, the findings related to the motivations behind the adoption in this thesis provide the foundations for later research in this area.

Indeed, the most closely related to this topic is the study by Verma & Bhattacharya (2017) about the adoption of big data analytics in emerging economies: however, this study mainly focuses on companies with medium-to-large sizes. Perceived strategic value and benefits, environmental factors have the positive relationship with the adoption of big data analytics in different companies. Consistent with such finding, the thesis finds the similar results in the adoption of supply chain analytics from SMEs in supply chain management.

Findings in this thesis are able to clarify different benefits for the existing adoption from SMEs: solving existing problems, visibility, better decision-making, and cost-cutting. According to the analysis of findings above (section 4.1 motivations behind the adoptions), SMEs' motivations to adopt supply chain analytics usually start from their problem at hand. According to Solution provider 1, 2, and 3, the supply chain management have certain problems related to demand planning, inventory management, and logistics that cause a lot of cost for the companies, so SMEs consider the adoption of supply chain analytics as a way to avoid such problems. Visibility is another perceived benefit from the supply chains, the solution providers 2 and 4 associate the visibility with the perception creating new opportunities and improve the current design and practices ins supply chain management of SMEs. Decision-making is stated from only one solution provider, definitely, supply chain management can be overload with information and

turbulent from external environment, so better decision-making seems to be a reasonable benefit from data analytics adoption. Cost cutting is among the most common benefits proposed by solution providers which prompt SMEs to adopt supply chain analytics. SMEs usually expect cost-cutting from current operation by employing analytics. However, as stated by the solution provider 5, the estimated cost-cutting benefits have to be more than the amount of required investment to prompt the companies to integrate data analytics and big data.

In additions to perceived benefits, external factors such as adoption trend, competitive advantages also contribute to the adopt of data analytics. This finding seems to be consistent with the last finding from Verma et al. (2015) about the external factors which affect the adoption of larger enterprises in big data analytics. Solution provider 1 and 3 also emphasize that though the adoption may be influenced the adoption trend in the industry, the SMEs are not directly affected by competitive pressures from other SMEs due to the low adoption of SMEs this field. Those SMEs seem to follow what big player in the field to gain competitive advantages from their competitors rather than perceiving a direct threat to adopt the technology or else the companies will be left behind. This finding is contracting with Chen et al. (2015) study in which competitive pressure is claimed to moderate the usage of big data analytics in, generally, the sample of larger companies. Such differences can be explained by the poor rate in adoption supply chain analytics in SMEs and the fact that SMEs' strategies are to position themselves in niche segment rather gaining the larger shares like the larger enterprises.

Surprisingly, the interviews with solution providers in this thesis also found that data-driven culture also plays a role in the adoption of certain firms. Solution provider 1 and 5 believe that the supply chain analytics is a natural outcome of a data-driven culture and innovative companies. Such solution providers believe those innovative SMEs have been early aware of the benefits of analytics, they seem to have fewer difficulties in adopting analytics and big data into supply chain management than other SMEs.

Because this study has a small scale of the sample and is conducted using a qualitative approach, so we cannot make quantitative and numerical conclusion about the motivation behind the adoption. However, it can be summarized that the thesis has provided the

foundation for the future study in this field by recognizing certain factors which are important to the adoption of supply chain analytics in SMEs currently. Therefore, it is reasonable to conclude that, this thesis, to some extent, have completed the first research objectives related to exploring the main motivation behind analytics and big data adoption in SMEs. However, to fully address the current gap in the literature related to SMEs adoption of supply chain analytics, future research should be implemented: a quantitative approach with a larger sample of pioneers SMEs would be beneficial to test the finding in this study and generate a more robust conclusion.

5.1.2. Necessary existing resources for SMEs

After exploring the motivation behind the adoption, it is essential to recognize the necessary existing resources can facilitate the adoption and ensure successful integration and usage of supply chain analytics. According to the majority papers investigating the adoption of new technology in businesses, the perceived compatibility and technical challenges in adopting new tools and technology is directly affecting the adopting decision from businesses (Rogers, 2003; Ramanathan et al., 2012; Wang et al., 2010). The necessary existing resources will provide insights on compatibility and complexity of the technology to the firms. In addition to that, examining the necessary resources will allow to figure out the recommendations for SMEs in how to prepare for the adoption of data analytics in the companies.

According to the finding section above, most solution providers believe that data, human resource, and strategy and awareness for analytics are important existing resources for the adoption of supply chain analytics.

Most noticeable, the adoption supply chain analytics require companies to have a certain source of data which allow them to turn those data into actionable insights. Respondent 4 also notice that those data have to be of good quality to be ready for analytics which is ensured by data management policy and good IT experts who manage the data. According to solution providers 1, 3, 4, and 5, the adoption of data analytics should be facilitated by the availability of IT experts or data analytics talents to ensure the employment of the new technology. Solution provider 4 emphasize that even though firm

can implement the data analytics with support from solution providers, they still need someone from the internal team to ensure the smooth collaboration.

Awareness and strategy are also important resources for the adoption of analytics. Such finding is consistent with the study by Akter et al., (2016) and Chen et al., (2016): those two studies have claimed that successful usage of data analytics partly explained by the role of top management support and data-driven culture. In this thesis, it is found that 4 out of 5 solution providers believe SMEs should have a certain level of awareness or even strategy alignment for the use of data analytics, top management support.

Importantly, the study also indicates that budget for training people during the integration and budget for adopting IT infrastructure are also demanded existing resources for the adoption. 3 out of 5 solution providers believe that IT infrastructure is desired. It is noticeable that adoption of supply chain analytics can be either adoption of big data analytics or just implementing analytics solution to companies' existing data. Therefore, in case of the conduct analytics project for existing supply chain data, SMEs should be in the certain level of digitalization maturity to provide good quality of data for analytics processes. Besides, it also can be explained that firms with the high maturity in IT infrastructure would require less investment in big data and analytics adoption with firms with a lower level of IT infrastructure or zero IT infrastructure.

Among those existing necessary resources for SMEs in integrating analytics and big data, there are certain aspects which are can easily address by the SMEs itself such as the awareness of technology from top management support. Availability of data in good quality or IT infrastructure takes time to gradually build on. On the other hand, human resources such as data engineers, data analyst talents, or alignment strategy seem to be only available in innovative and data-driven organizations.

The thesis has addressed the second objective in this studying by identifying the necessary resources from SMEs for the adoption of data analytics. However, because the study is based on opinions of 5 solution providers, such findings cannot be generalized in larger context due to the limitation of the size of the sample and some possible bias introduced by solution providers. Further studies which gather opinions from SMEs in the larger sample should be conducted.

5.1.3. Challenges for SME supply chains

The earlier part has identified the necessary resources for the adoption and to better answer the research question that “under what situation, SMEs decide to adopt supply chain analytics”, the thesis continues to examine the challenges or barriers for SMEs in adopting supply chain analytics.

The findings related to barriers for SMEs are consistent with the literature review. Human resource is the most common barriers proposed by solution providers during the studies. Firstly, it is difficult for SMEs to recruit data analyst talents because there is a shortage of data analysts in the field, and the disadvantages in “talent war” with larger companies (solution provider 2, 3, and 4). Secondly, SMEs should have data engineers who can manage their data and be able to learn new technologies. Such lack of talents, according to solution providers 5, can lead to the high dependence on the solution providers in the longer term. Such finding is consistent with the main challenges stated by Coleman et al. (2016) and Arunachalam et al. (2017).

Challenges from strategy and finances mentioned by solution providers are consistent with Ardagna et al. (2016), Chase (2016), and Rising et al. (2014). Solution provider 1 states that the lack of focused strategy in adopting data analytics is a barrier for his client SMEs. Such shortage of focused strategy indicates that although those SMEs do not understand what they need from the adoption of data analytics, they do not have the focused strategy on which technology they need, what should they expect from the adoption of such technology. In addition to that, solution provider 5 emphasizes that SMEs should be able to conduct change management and adapt to data-driven culture to unleash the benefits of supply chain analytics. In term of IT infrastructure, according to solution provider 3, 4 the technical issues are not that serious anymore. The challenges for big data present a larger barrier in term of management and analytics than scalability and investment for hardware (solution provider 3).

Regarding finance, solution provider 1 state the SMEs do not have enough budget for training. Another barrier related to finance which is not thoroughly addressed in the literature review is that the return on equity for the investment is the main barrier. Solution provider 5 argue that SMEs can be able to adopt big data and analytics, especially some

the upper companies in term of size in the sectors. However, due to their industry type and the scale of their supply chain, the benefits from the adoption of big data and supply chain analytics are not large enough to compensate for the initial investment they have to provide for data analyst teams and the new technology. Adoption of such new technology and analytics, for example in procurement, seems to be more beneficial for larger companies because the larger companies have a much large scale of production: thus, they can cut much larger cost from the adoption of data analytics with relatively the same cost. Such findings extend the discussion by Coleman et al. (2016) who state that SMEs has limited choices of analytics solutions and talents to hire due to limited financial resources.

In addition to that, the lack of available customized and suitable solutions for SMEs also presents an additional barrier for SMEs, such claim is consistent with Coleman et al. (2016) who state that facilitating condition is one of the main challenges for SMEs. Solution provider 2 states that usual solution for larger firms do not fit with small companies because they do not have existing resources like larger firm.

In conclusion, the findings from this section are consistent with proposed challenges by the majority of scholars in the field. So, it is fair to say that the finding of challenges of SMEs in adopting data analytics provide empirical evidence for the discussion in the extant literature review, even though such this study has a limitation in sample size.

5.2. Implications for SME supply chain management

Overall, based on both literature review and finding sections, though most research studies state that analytics will change the nature of supply chain management and improve supply chain performance, the adoption of analytics in SMEs is in still modest rate comparing to larger companies, and this gap is claimed to cause the digital divide between SMEs and larger enterprise, especially in term of supply chain management (Arunachalam et al., 2017).

Firstly, regarding the impacts of analytics on SME supply chain management, perceived benefits such as solving existing problems, improving supply chain visibility, and optimizing supply chain cost can be considered as the potential effects of analytics on

supply chain performances in SMEs. However, according to the findings in this thesis, firm's scale seems to moderate such effects as solution providers 5, 6 state that decisions to adopt in SMEs depend on economic value unlocked from the adoption in comparing with the required investment. Indeed, for example, the benefits of cost cutting per product over the analytics investment to improve procurement and inventory management processes become more significant when companies produce more products. Such findings are consistent with Harris & Katz (1991), Jayaram et al. (2010) who claim that firms' sizes affect the usage and the spending of IT investment and the effect of such investment on organizational performance. On the other hand, those findings seem to contradict with earlier discussion by Chae et al. (2014) who state that among medium to large firms, size of the firms does not affect the relationship between business analytics applications and organizational performances. It can be considered that the dependence of the impacts of analytics adoptions on firms' sizes may be one of the factors that help to explain whether the big data analytics leads to a digital divide between big companies and SMEs in supply chain management (Arunachalam et al., 2017).

Secondly, as an exploratory study, the thesis has also investigated on areas of SMEs' supply chain management in which has adopted analytics: those areas are demand forecasting, inventory management, logistics, and procurements. It seems that the areas of applications of supply chain analytics in SMEs are more limited than those in larger organizations in which data analytics are also applied into supply chain network design, product design, strategic sourcing, etc. (Tiwari et al., 2017). Although SMEs has limited data sources when comparing to larger organizations, they can still benefit from data analytics based on their existing data (solution provider 3, 5). Due to limited resources and time, the thesis cannot elaborate on how SMEs can benefit supply chain analytics into specific areas. Therefore, more research papers on how SMEs can apply analytics into each specific area such as demand planning, inventory management, and logistics should be conducted to provide empirical confirmation to such proposed impacts and provide more thorough recommendations for SMEs. Solution provider 5 states that the adoption of supply chain analytics in SMEs would be higher in the future once those larger companies successfully use big data analytics and they become agiler. This finding is consistent with Rossman et al. (2017) who state that majority of large firms are trying to

adopt big data analytics and such adoptions will let larger organizations be more effective in most areas of supply chain such as demand forecasting, inventory management, and procurement.

5.3. Framework construction

Verma & Bhattacharyya (2017) find that the decision of adoption big data analytics in companies is the result of consideration of perceived benefits brought by big data analytics adoption with the perceived of cost generated by the adoption; in addition to that, study from Chen et al. (2015) and Chae et al. (2014) show that external environment and internal data-driven culture have an impact on the successful usage of big data and affect the relationship between big data analytics adoption and organizational performances. Based on such existing study and theory in the field, we can construct a new model to examine different factors to the adoption of supply chain analytics to SMEs.

According to the findings in this thesis, motivation of adoption is affected by 3 themes: perceived benefits, external environment, and internal data-driven culture which seems to be consistent with the finding from all of Verma & Bhattacharyya (2017), Chen et al. (2015), and Chae et al. (2014) studies. Studies by Chen et al. (2015) and Verma & Bhattacharyya (2017) reveal that dynamic environment which is measured by the rate adoptions of the supplier, customers, competitors of the firms may influence the firm's adoptions of analytics and the effect of analytics on organizational performance. Findings in this thesis indicate that SMEs are not under competitive pressures to adopt data analytics due to the low rate of adoption in SME; however, those pioneer SME adopters are affected by adoption trends and follow the big player in the field to gain competitive advantages over other SMEs. The interviews with solution providers also reveal that innovative SMEs with existing data-driven culture face less hassle in adopting supply chain analytics and improving their supply chain performance. Therefore, data-driven culture and external environments seem to play the moderating rate in the relationship between perceived benefits and the adoption of supply chain analytics in SMEs.

Necessary existing resources and challenges of data analytics adoption can together allow us to examine the cost of data analytics investment in the companies. Indeed, the SMEs has some barriers to benefits from analytics compared to larger firms. As

elaborated in the last chapter, the cost-cutting benefit of SMEs is smaller than that of larger firms. Usually, SMEs choose not to make a big investment in analytics because the benefits from investment do not out-weight the costs. However, it is important that the cost of analytics seems to depend on existing resources of the firms. As finding indicates that some innovative companies with available resources in data-driven culture, analyst teams, the expertise in analytics have less cost and difficulty in the integration of data analytics.

According to the theory about the diffusion of innovation (DOI), decision-makers in the organization will make decisions of the adoptions of new technology based on their perception of different characteristics of the technology (Rugers, 1995). More specifically, the decision to adopt a technology will depend on how decision makers weight the benefits gained from the adoption in compared with the cost required (Verma & Bhattacharyya, 2017). Based on DOI theory and findings from interviews with solution providers, we can propose the framework that the perceived benefits in comparison with the cost of the adoption for supply chain analytics (calculated by the existing available resources and challenges for SMEs) can decide whether SMEs will adopt the technology, and data-driven culture and external environment seems to play moderating roles in this relationship. The figure 2 below provides an illustration of such framework.

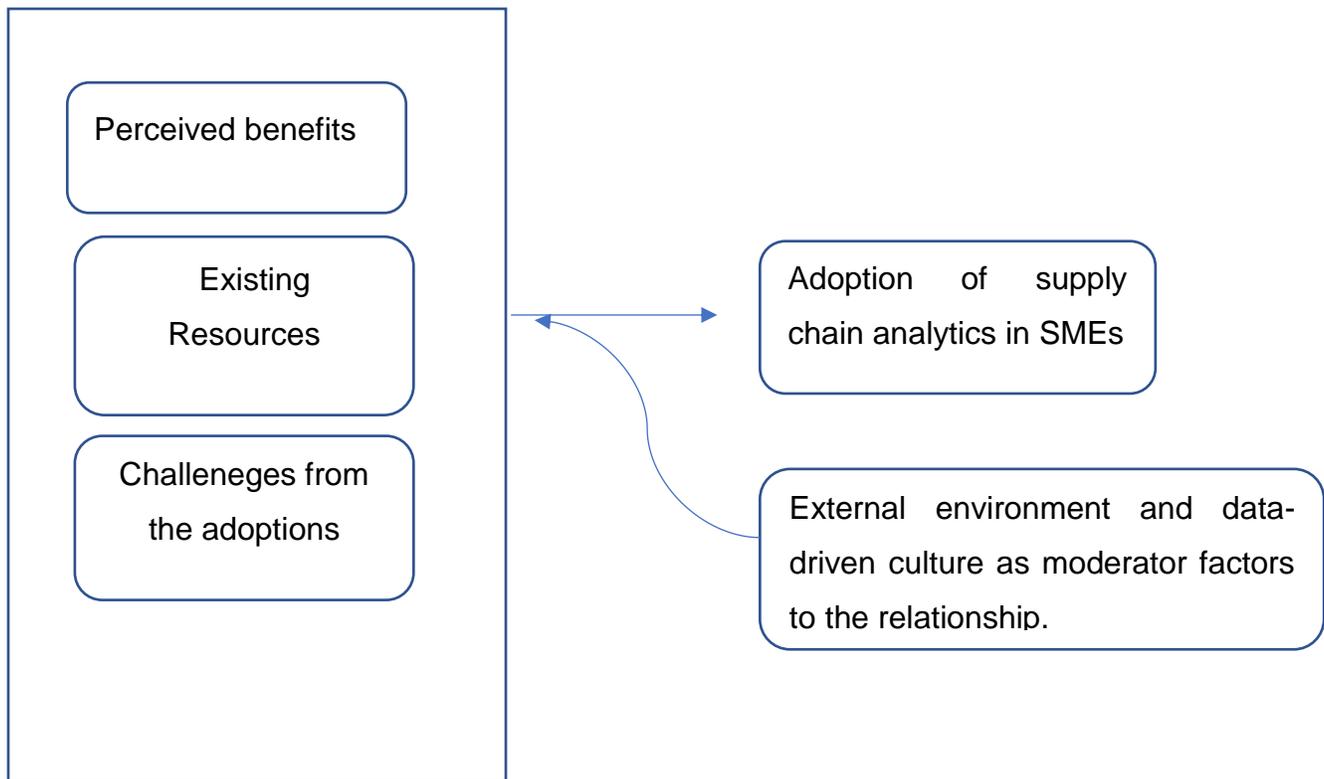


Figure 2 Proposed framework for future research on adoption of supply chain analytics in SMEs

5.4. Recommendations for SMEs in supply chain analytics adoption

Overall, the solution providers give recommendations which are consistent with those provided by the literature. However, thanks to the qualitative approach, the findings related to recommendations, to some extent, has added deep insights to the current knowledge on best practices for SMEs.

Human Resources are an important aspect to be considered to ensure the success of supply chain analytics adoption in SMEs (solution providers 1, 3, 4). The findings in this thesis has extended the discussion by Rising et al. (2014) who state that SMEs should build data analytics team based on existing talents within the companies or Ardagna et al. (2016) who propose that SMEs can outsource analytics to external solution providers. Indeed, Solution provider 4 claims that either SMEs choose to adopt supply chain analytics by themselves or by external solution providers, they should have internal analytics talents or at least an IT expert who is responsible data management in the companies. To address the challenges related to talent recruitment competition and to unleash the benefit of supply chain analytics for the SMEs, companies should provide training to the right people within the companies. It is advantageous that supply chain specialist or supply chain managers who already have domain knowledge related to supply chain and possible understanding of statistics to learn analytics.

IT infrastructure is an important resource needed to be focused before and after the integration of supply chain analytics, but solution providers have different opinions about which is the right technology for SMEs in the supply chain. However, there is a consensus among them is that though big data may require complex IT infrastructure: those for analytics is not an issue for SMEs. Availability of open source of analytics projects and affordable tools such as Tableau and Qlik enable the firms to adopt analytics techniques. However, different from the literature review, opinion of solution providers on clouds are varied. It is noticeable that solution provider 5 believe cloud may have some threats to

businesses in long-term when companies need to take data out of cloud due to the high dependence on cloud providers. While solution providers 5 believe that cloud is the necessary technology for analytics, solution provider 4 believe the decision whether to use cloud or not depend on whether the SMEs have good data engineers to manage the data in existing database or the performance requirement of storing data. According to solution provider 4, the cloud is beneficial in term of providing an easy solution for companies with low expertise in IT. Solution provider 4 also provide contradicting with extant literature about the effectiveness of relational databases system (Hu et al., 2014; Arunachalam et al., 2017), with his experience in data management, relational database system has improved and provided scalability of data storage and ability to store data in different data types (either unstructured or structured). The only area in which relational database system is weak is the speed for real-time analytics.

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The recommendations from solution providers in these two areas are also consistent with the extant literature review. Solution provider 3, 4 believes that top-management should have a basic understanding of analytics and big data before the trying to adapt the supply chain analytics. Besides, data-driven culture and data policy also recommended to transform the decision-making based on intuition to data-driven decision-making and capitalize the benefits of supply chain analytics. Moreover, in term of finance, solution provider 5 claims that SMEs should conduct scientific analytics to determine whether the investment for analytics is reasonable.

5.5. Limitations

Because of exploratory nature and the time and resources constraint, this thesis has various limitations in its methodology and such limitations could negatively influence the reliability and validity of such thesis.

Firstly, though the research has tried to collect data from solution providers from different areas in the world, the size of the study sample is still relatively small. Due to such small sample size, the conclusions of findings in this thesis cannot be further generalized and

future research with much larger sample size should be conducted to test the findings from this thesis.

Secondly, even though qualitative methodology with content analysis provides findings with deep and rich insights into the observing events and objects in this study (Cooper & Schindler, 2014), such chosen approach may introduce bias from both respondents and the researcher who conducts a content analysis of available data.

More specifically, the content analysis and result interpreting are conducted by the author who is an inexperienced coder, so the finding in this study may be influenced by the possible bias from the author. Despite strong expertise and experiences in the adoption of supply chain analytics in SMEs of solution providers who participated in this study, the finding generated from this research cannot avoid certain biases introduced by this choice of studying group because though those solution providers directly participate in the supply chain analytics adoption in SMEs, they are not decision-makers of the adoption decisions. For example, those solution providers may have some biases into difficulties and barriers faced by SME supply chains or they do not fully understand the actual motivation behind the adoption. To strengthen the findings from this thesis, group of pioneer SMEs who already adopted supply chain analytics should be added in future studies.

6. CONCLUSION

6.1. Main Finding

Due to its nature as an exploratory study for the current literature gap in the adoption of supply chain analytics in SMEs, the main findings provide the foundation and directions for future research in examining the factors which affect the adoption of analytics in supply chain management in SMEs.

More specifically, firstly, the thesis has explored the main motivations behind the current adoptions of supply chain analytics in SMEs: those motivations are perceived benefits (such as solving existing problems, gaining supply chain visibility, improving decision-making, and implementing cost-cutting), external factors (such as competitive advantages, and the adoption trend in the industry), and organizational data-driven

culture. However, with the modest adoption rate among SMEs and the nature of SME supply chain management, those early adopters are not under strong competitive pressure in which they should adopt data analytics to survive on the market. Instead, they seem to be more data-driven than their peers and are aware of the benefits of analytics and its competitive value.

Secondly, the findings on essential existing resources and barriers for the adoptions of supply chain analytics in SMEs are consistent with the extant literature. SMEs should have a certain awareness of analytics, alignment strategy for the adoption and available supply chain data and data sources to enable the adoptions of supply chain analytics. IT infrastructure, data talents, financial resources are both essential resources and barriers to the adoptions. The availability of solution providers and cost-saving solutions, the technical and financial issues for SMEs; however, with the small business scale of SMEs, one of the biggest challenges presented to SMEs is that the benefits unlocked from the adoption may not be large enough to compensate for the loss.

Thirdly, based on above findings, the thesis proposes the framework for future research in examining the factors influence the adoption of supply chain analytics in SMEs. In this framework, this study hypothesizes that perceived benefits, the available essential resources and barriers may directly affect the adoption decision of SMEs: external factor such as adoption trends and data-driven culture, on the other hands, may play a moderating effect on such relationship.

Last but not least, the main recommendations for future SME adopters are that SMEs should firstly have an awareness of analytics, should build strong internal IT and data technical capability before adopting supply chain analytics. In addition to that, prior to supply chain analytics adoption, SMEs should conduct a research on how much value can be unlocked from the adoptions and whether such value outweighs the cost of the adoption. Besides technical issues, to ensure the successful adoptions, organizations should focus on change management and adopt alignment strategy to capitalize on the benefits of analytics and big data to supply chain management in SMEs.

6.2. Implications for International Business

Due to the nature of an exploratory study, this thesis provides the foundation for the future research in this area and strong implications for the International Business due to the role of SMEs and the digitalization trend to international business.

Firstly, because the study is conducted with solution providers from different places in the world, the opinion gathered from this study is not constrained by bias introduced by choosing targeting studying group within one nation or specific geographical areas and can be expected to apply for SMEs around the world. Therefore, by providing recommendations and managerial implications for adoption of supply chain analytics in SMEs, the finding in this research, to some extent, provide essential knowledge for the growth of SMEs which is an important part of different nations and global economy.

Secondly, the digitalization is an important trend, nowadays, which is claimed to change the nature of the international business. By contributing to addressing a gap in intersection among SMEs, big data, and analytics, the study is aimed to extend the knowledge in the digitalization processes for international businesses.

6.3. Future Research

To further address the current gap in literature related to the adoption of supply chain analytics in SMEs and extend the findings from this exploratory study, several research approaches can be extended based on the findings from this exploratory study.

Regarding the literature gap related to the adoption of supply chain analytics in SMEs, an extended study which employed the framework proposed in the discussion chapter with a larger sample of pioneer SMEs can test the main findings in this thesis and provide more robust understanding to the impacts of multiple factors (perceived benefits, dynamic environment, barriers to adoption of SMEs, data-driven culture) to the adoption of data analytics in SME supply chains and supply chain performance. Such study will not only clarify on which type of SMEs will be able to take advantages of supply chain analytics but also help to address an important debate in the literature on whether the advancement of analytics and big data widen the digital divide between larger companies and SMEs. Indeed, it is beneficial to conduct such extended studies with a larger sample size of

SMEs from different industries and companies to have more profound findings which can be better generalized.

As elaborated earlier, the shortage of empirical studies on how to apply supply chain analytics into SMEs can be considered as a barrier for SMEs in adopting such technology. In addition to that, though this study provides recommendations for future SME adopters, such findings are needed to be further examined. Therefore, it is essential in term of both businesses and academia to conduct a case study of SMEs in integrating analytics and big data into different areas of supply chain management such as demand planning, procurement, inventory management, and logistics.

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APPENDIX 1: Interview questions for Solution Providers:

The purpose of this interview

This interview is a part of my bachelor thesis investigating the adoption of supply chain analytics in SMEs: an exploratory study. The study objectives are to

- Explore the motivation behind the adoption of supply chain analytics and big data in SME supply chains?
- Uncover the necessary resources and challenges of such adoption for SMEs
- Understand the role of solution providers in such adoption
- Provide recommendations for SMEs in adopting supply chain analytics
- Provide a framework and directions for future research on the adoptions of supply chain analytics in SME supply chains.

Questions

1. What is the name of the company?
2. Country and locations of your company or business unit?
3. What is your current position in the company?
4. Characteristics of the solutions? (ad-hoc analysis of certain data sets or helping address the companies to adopt big data analytics and data analytics to their internal IT teams?)
5. What areas of the supply chain do the solutions relate to?
6. Motivations behind such adoption?
7. What is the necessary existing resources for those companies to ensure successful adoption of such solutions?
8. Which are the challenges that those SME clients must address?
9. How solutions providers help them to address such challenges?
10. Are there any cases that the adoption was unsuccessful? If yes, what is the reason behind that?
11. Can you provide recommendations for future SMEs in adopting supply chain analytics?