Critical Success Factors for SMEs in Big Data Analytics

Allison Adams

Seattle Pacific University

Table of Contents

Abstract

Small to Medium Size Businesses represent the majority of companies within the United States, but are still not fully participating in big data analytics. These companies are uniquely poised to make changes within their business models that will directly benefit revenue and provide a competitive advantage. This research paper provides a literature review of academic studies providing a comprehensive overview of the challenges and opportunities for these businesses within big data.

Keywords: SME, Big Data, Cloud, Analytics

Critical Success Factors for SMEs in Big Data Analytics

Data provides companies with the ability to make sense of the chaos and information around them. When companies lack the fundamental data-literacy needed to transform data into information, they are unable to start the necessary dialogue that drives future business decisions and solves complex data-driven problems. This rapid generation and subsequent collection of data is not new. In fact, 90% of existing data has been generated in the past two years alone (Marr, 2018). This substantive generation forces companies to determine how they will use data to deliver the right capabilities, products and solutions to their consumers. As such, according to the 2017 Dresner Advisory Services Big Data Analytics, 53% of companies indicate a shift towards full adoption of big data ideas and trends ("Big Data Analytics Market Study ", 2017). Additionally, the study discovered that there is a considerably higher adoption rate of Big Data ideology among larger corporations. When examining the adoption rates among small to medium-size enterprises (SMEs), there is a decrease of approximately 10%, with a fluctuation of adoption rates between 43-45% ("Big Data Analytics Market Study ", 2017). This means that there is a considerable opportunity for SMEs to adopt of big data practices to create a competitive advantage.

SMEs do not claim ignorance of the importance of the growing data storm, but rather are inundated by the 2.5 quintillion bytes of data produced daily (Marr, 2018) and are faced with the challenge of positioning their company amongst competitors with more resources, technological know-how, and data-native employees.

The purpose of this paper is to explore how non "data-native" SMEs are competing in the big data arena and integrating data into their core competencies. First, I establish a working understanding of common themes and terminology as it pertains to big data and enterprise

activity. Second, I present a literature review summarizing the critical success factors for SME

working with big data. Third, I explore the challenges that these companies face in establishing a

mature data science programs. Finally, I present research on the current solutions and behaviors

of such teams within small to mid-size companies.

Working Definitions

Small to Medium Enterprise

This paper focuses on companies that fit into the classification of a small – to – medium

size enterprise (SME). The international definition of a SME fluctuates, but primarily classifies

businesses that have an employee base of 500 or less (Merritt, 2018). In 2018 SMEs are

predicted to continue experiencing an increase of growth, with 70% of SMEs identifies areas of

growth in the coming year (Exemplas, 2018) and account for 99.9% of businesses across the

United States (2018 Small Business Profile, n.d).

Big Data

Big data traditionally consists of four main tenants, together which comprise the "4 V's

of Big Data":

- *Volume*: Amount of data that is collected
- *Variety*: Diversification of data – both structured and unstructured
- *Velocity*: Frequency at which data is generated
- *Veracity*: Integrity of the data collected

While these 4-Vs are certainly important, for SMEs the newly added 5th 'V' of *Value* is

critical when making business decisions. Value represents a company's ability to turn data into

tangible benefits and gain a competitive advantage (Marr, 2017). For companies that have

limited resources ensuring that investments into new technologies have a direct capital gain is imperative for success.

Literature Review

The digitization of the customer behavior, consumer wants and operating constraints provide a playground for data science. However, these mid-range companies do not have the capacity to devote corporate level strategy and funding towards the building of a mature data

Figure 1: Common Words in Academy Studies

science program. Several academic research studies have been conducted examining the influence of big data across international SMEs. To form a foundation for this paper a literature review has been conducted and results aggregated into challenges and opportunities for SME.

Results have been grouped into 10 clusters, 5 of which explore the challenges for SMEs and 5 of which explore the most common solutions and recommendations for SMEs (See Exhibit 1). These clusters are further examined in the next section of this paper.

Challenges

The challenges faced by SMEs as identified across academic studies closely aligns with broader industry research examining the biggest challenges to becoming data driven include people, process and technology (Big Data Executive Survey, 2018). When compared to the

percentage of references across the selected academic studies, the result dispersion and ranking closely aligned with the broader multi-industry executive survey.

Challenge	Big Data Executive Survey – Overall Percentages	SME Literature – Frequency of Mention
People	48.5%	85%
Process	32.4%	42%
Technology	19.1%	28%

The following section presents the common themes of challenges found within SMEs as it pertains to utilizing big data. These are as follows:

- Lack of Financial Resources
- Lack of Technical Resources
- Lack of Business Cases
- Complex Data Integrations
- Security & Legal Concerns

Lack of Financial Resources

The most common constraint facing SMEs as they engage in big data analytics is the high capital and start-up cost of investment in tools and data processing. The lack of financial security for SMEs permeates into each subsequent challenge cluster, adding to the complexity and potential impact for data-business decisions. This increase in operating costs is twofold; first limiting SMEs access to building in-house custom solutions (Coleman, et al., 2016) while secondly limiting their ability to invest in the digitization of their data due to competing priorities across the enterprise. This increase in operating costs to store and analyze scalable multidimensional data through traditional databases is often a barrier to companies working with a reduced financial bankroll (Kalan & Unalir, 2016). As a result, SMEs must actively seek cost-effective solutions to manage their increasing amounts of data (Schaeffer & Olson, 2014).

Lack of Technical Education

Companies that are not data-native struggle to employee individuals who have the knowledge and depth of skills required for data science. While organizations may strive to transform their company to be data-driven, without data literate employees this goal is unachievable. This is exacerbated by the lack of financial capital to attract the top talent, but is also coupled with the lack of domain knowledge of data in SMEs. Additionally, SMEs do not have the privilege that larger organizations have to hire data-science specific employees. Typically, employees within the SME job roles act with cross-functional job duties, increasing the challenge to staff a functional data science (Iqbal, et al., 2018). As a result, SMEs face difficulty implementing complex software solutions (Coleman, et al., 2016) and must conduct a cost-benefit analysis for investing in potentially uncertain results from a data-naive team.

Lack of Business Cases

It is hard for a small with limited resources company to take a risk in a domain that is relatively unknown (Coleman, et al., 2016) When exploring cloud-based big data algorithm and data processing 42% SMEs are not adequately using cloud-based data tools, and a striking 27% do not confidently understand the functionality of such tools (Kalan & Unalir, 2016).

Without a solid understanding of big data analytics, SMEs are faced with the challenge of leveraging big data for uncertain business cases across the enterprise. Not only is there a challenge for companies to see internal use cases for big data analytics but there is a shortage of external success stories for SMEs to model their business implementation after (Iqbal, et al., 2018). Additionally, the maturity of a company's business systems in regard to data analytics must be considered when shifting to a data-driven perspective. This potential lack of

organization structure at a fundamental level poses a risk for developing a granular data strategy across business units (Iqbal, et al., 2018).

Complex Data Integrations

Another barrier to entry into big data analytics faced across industries by SMEs is the complex data integrations and cleaning that is required to power BI, Machine Learning and data visualization programs. With companies that are not data-native, data systems and architectures are not interoperable. Instead, data is shared between employees on desktop computers through excel files, word documents or PDFs. Outdated data sharing capabilities coupled with legacy applications not suited for cloud-based integration lead to data latency and the inability to derive confident analysis from data (Kalan & Unalir, 2016). In a growing digital world, the growth of disparate data is exponential. Once data is separated into these silos individual systems and processes the ability to meld data into a homogenous information, thus converging business function and value, grows substantially harder (Wilder-James, 2017). These complications necessitate the expertise of the Extract-Transform-Load (ETL) process within data sources, furthering the complexity of data science projects for smaller companies. Data quality is integral to the success of data science program within a company of any size. For SMEs that are not as familiar with data-driven processes these complex data integrations have the risk of relying on legacy tools to provide new big data conclusions.

Security & Legal Issues

When breaking into the arena of data science, SMEs face a considerable challenge when it relates to the security and storage of enterprise data. Without the resources of larger companies, SMEs are faced with balancing the risk of data breaches or attacks with the cost of storing data on premises (Iqbal, et al., 2018). As such, the most frequented option for SMEs is to rely on a

third-party vendor for data storage which increases the risk in data accessibility, confidentially and privacy (Kalan & Unalir, 2016).

Solutions & Opportunities

Academic studies have been conducted to explore the ways SMEs can position themselves for success within big data. The following section explores five clusters of opportunity for SMEs which are as follows:

- Adoption of Cloud Computing
- Transformation of Business Processes
- Transformation of Strategy
- Transformation of Culture
- Leverage Company Agility

Adoption of Cloud Computing

Perhaps the most widespread solution for SMEs is the embracing the evolution of cloud technologies and the ability to utilize big data as a service. This two-pronged approach to data science allows for previously complex and unattainable algorithms to be implemented by a non-data native employee. Cloud-based services such as Hadoop or AWS EMR provide SMEs with elastic and parallel resource availability with pay-as-you-go service models, reducing the high cost of entry into data science (Kalan & Unalir, 2016). This cost-effective solution to process and analyze structured and unstructured data (Sen, Ozturk, & Vayvay, 2016) allow for the implementation of the entire big data ecosystem such as data cleaning, storage, processing, analytics and business intelligence (Kalan & Unalir, 2016) within SMEs without attached costs for support and domain specific knowledge (Schwertner, 2017). The notion of cloud-based "Data Science as a Service" (DSaas) is an emerging trend which represents the commoditization of data science (McKendrick, 2017). Providing companies who previously were unable to weave a data-

fabric into their business processes, the DSaaS market segment is predicted to triple in size by revenue by 2025 (Global Big data as a Service Market Size, Status and Forecast 2025, 2018).

While the cloud infrastructure for SME seems like the best decision when considering the cost and expertise factor, it is pertinent to consider the increased risks with data security and veracity when utilizing an untrusted host for storage (Kalan & Unalir, 2016). It is also important to consider the new terminology the learning curve for cloud technologies. Smaller companies, especially if considering doing an in-house cloud hosted service should be keenly aware of questions to ask vendors when engaging in cloud-resource relationships (Schaeffer & Olson, 2014).

Transformation of Strategy

A solid data strategy is paramount when using data to drive decisions. Marr defines strategic decision making as, "anything that moves the organization closer to achieving its strategic goals" (Marr, 2017, pg 37) and suggests that the bedrock of a synchronous data strategy is the fundamental understanding of use cases for data analytics. This will allow for the linking of data strategy to measureable results and clear KPIs across the enterprise. By defining business critical questions that should be prioritized, drive a focused work effort that is aligned from the CEO to the individual contributors performing the analysis. This corporate narrative helps to set the tone and encourages employees to deliver key insights and trends. For SMEs to implement a strategy with the previously outlined limited resources, an effective balance between technology and resources (Kalan & Unalir, 2016) must be reached.

It is also important to consider the strategy as it pertains to data science maturity exploring which organizational model is best fit for the organization. There are three widely accepted

organizational structures for data centers within companies of all size (Grossman & Siegel, 2014):

- *Centralized*: All data scientists in a single unit
- *Decentralized*: Group of data sciences in each business unit
- *Center of Excellence*: Critical mass within one data science unit, rest distributed across enterprise

Within SMEs there is a pattern of employees who maintain a wealth of business knowledge which helps to navigate the high volume and variety of data collected. This leads to a high adoption rate of the Center of Excellence strategy, capitalizing on the ability for close collaboration between business units and empowering data science to be transformed into a core competency (Do, 2017). However, SMEs should leverage whichever data organization model best fits their needs while matching business requirements to the directives and processes across the company (Coleman, et al., 2016). This ensures that the business strategy narrative will be driven by data, instead of retrofitting data to fit preconceived decisions and business process.

Transformation of Business Process

The transformation of business processes creates a pathway for success in data analytics. Generating a systematic way to process data allows for businesses to transform data into tangible information (Sen, Ozturk, & Vayvay, 2016) acting as a catalyst for real-time analysis and decisions. One example of a business process within SMEs that has the opportunity to benefit from a transformation of business processes is that of data visualization. Creating cohesive business reports that utilize the company's logo and use consistent color pallets provide visual, smart direct and immediate tools to increase the integrity (and subsequent acceptance) of data reports (Ryan, 2017).

Leverage Agility of Company

Companies within the SME realm benefit from their smaller size relative to their larger competitors, providing the ability to experience, "more flexible IT infrastructure, few legacy issues and quick adaptability nature." (Sen, Ozturk, & Vayvay, 2016, pg 165). This allows for higher efficiency in change management when taking on a new directive such as data science. When companies are able to take data science as an agile process, one that will evolve as a company grows in maturity and experience, they are able to realize benefits through continuous integration, delivery and value (Swanson, 2017).

Since SMEs are in the beginning the processes of understanding data science, coupled with the fast changing landscape of their business economy the ability to quickly adapt to change, pivot strategy and rapid decision making is a critical advantage (Vajjhala & Ramollari, 2016).

Transformation of Culture

The fashion in which a company builds a data-friendly culture is equally as important as the technical foundation for data driven systems. This transformation of culture can be measured against, "how supportive and motivating is the company leadership and established culture, towards the effective use of data for running the operations and business processes" (Coleman, et al., 2016, pg 8). While this is true a company of any size, if there is not a culture of acceptance, the benefits from data will not be realized and the ability for a company to succeeded in the modern digital age is, "increasingly driven by how well it can leverage its data" (Marr, 2017, pg 16). Additionally, it is critical that this cultural transformation occurs at all levels of the organization. The digital transformation's success relies on "all levels of the hierarchy, managers and owners [being] directly involved in the processes" (Schwertner, 2017).

Many SMEs face hesitation towards building a culture of data due to the fact relying on data removes the "human element" from business processes and decisions. Companies must leverage the data-driven culture and weave it into every business process across the company with the confidence of all employees. This can only be successful if it is not splintered with tight deadlines and unreasonable expectations of data management. A culture of data includes providing employees with tangible benefits of data, all allowing for them to see for themselves how data will further enhance their job roles (Marr, 2017).

Conclusion

The increasing rise of big data and the parallel rise of small business is a clear indicating that big data does not require a big company to make an impact. The realm of big data is no longer restricted to larger firms, enabling smaller companies to undergo digital transformations and provide capabilities for large scale data analytics. SMEs must address the challenges faced across the industry of financial constraints, technical restrictions, lack of business cases, complexity of data integrations and the security concerns. SMEs have the opportunity to position themselves for success within big data through proactively transforming the agile business process, strategy and culture coupled with the adoption of cloud technologies. When a SME can take advantage of these changes they will realize the same direct benefits from big data technologies that has been seen across industries of all sizes.

References

2018 Small Business Profile. (n.d.). Retrieved from

https://www.sba.gov/sites/default/files/advocacy/2018-Small-Business-Profiles-All.pdf

Big Data Analytics Market Study (2017, December 20). Retrieved July 6, 2018, from

MicroStrategy website: https://www.microstrategy.com/getmedia/cd052225-be60-49fd-ab1c-

4984ebc3cde9/Dresner-Report-Big_Data_Analytic_Market_Study-WisdomofCrowdsSeries-2017

Big Data Executive Survey 2018 (2018). Retrieved July 8, 2018 from NewVantage

Partners website: http://newvantage.com/wp-content/uploads/2018/01/Big-Data-Executive-

Survey-2018-Findings.pdf

Big data as a service Market to triple it's Size by Revenue, now Standing at USD16

Billion. (2018, July). Retrieved from http://www.digitaljournal.com/pr/3843363

Coleman, S., Göb, R., Manco, G., Pievatolo, A., Tort-Martorell, X., & Reis, M. S. (2016).

How Can SMEs Benefit from Big Data? Challenges and a Path Forward. Quality and Reliability

Engineering International, 32(6), 2151-2164. doi:10.1002/qre.2008

Do, C. (2017, December 14). What is the most effective way to structure a data science

team? Retrieved from https://towardsdatascience.com/what-is-the-most-effective-way-to-

structure-a-data-science-team-498041b88dae

Exemplas. (2018, March 9). Retrieved from https://www.exemplas.com/news/smes-

remain-positive-about-outlook-of-2018/

Grossman, R., & Siegel, K. (2014). Organizational Models for Big Data and

Analytics. Journal of Organization Design, 3(1), 20-25. https://doi.org/10.7146/jod.9799

Iqbal, M., Kazmi, S. H., Manzoor, A., Soomrani, A. R., Butt, S. H., & Shaikh, K. A.

(2018). A study of big data for business growth in SMEs: Opportunities & challenges. 2018

International Conference on Computing, Mathematics and Engineering Technologies (iCoMET).

doi:10.1109/icomet.2018.8346368

Leetaru, K. (2016, February 04). The High Costs Of Hosting Science's Big Data: The

Commercial Cloud To The Rescue? Retrieved from

https://www.forbes.com/sites/kalevleetaru/2016/01/03/the-high-costs-of-hosting-sciences-big-

data-the-commercial-cloud-to-the-rescue/#b3b97df28c09

Marr, B. (2017). Data strategy how to profit from a world of big data, analytics and the

internet of things. London: Kogan Page.

Marr, B. (2018, July 09). How Much Data Do We Create Every Day? The Mind-Blowing

Stats Everyone Should Read. Retrieved from

https://www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-

the-mind-blowing-stats-everyone-should-read/#5d2211f60ba9

McKendrick, J. (2017, December 18). 'Data Science As A Service' Is Almost Here,

Making It Even More Important To Understand Data. Retrieved from

https://www.forbes.com/sites/joemckendrick/2017/11/06/data-science-as-a-service-is-almost-

here-making-it-even-more-important-to-understand-data/#2983a7f37029

Merritt, C. (2018, June 26). What Size Company Is Considered a Mid-Size Company?

Retrieved from https://smallbusiness.chron.com/size-company-considered-midsize-company-

71776.html

RYAN, L. (2017). INFORMATION VISUALIZATION IN TABLEAU: Story points,

telling compelling data narratives. S.l.: ADDISON-WESLEY.

Schaeffer, D. M., & Olson, P. C. (2014). Big Data Options For Small And Medium

Enterprises. Review of Business Information Systems (RBIS), 18(1), 41.

doi:10.19030/rbis.v18i1.8542

Schwertner, K. (2017). Digital Transformation of Business. Trakia Journal of Sciences, 15(1),

388-394. doi:doi:10.15547/tjs.2017.s.01.065

Sen, D., Ozturk, M., & Vayvay, O. (2016, October 28). An Overview of Big Data for

Growth in SMEs. Retrieved from

https://www.sciencedirect.com/science/article/pii/S1877042816315452

Shokri Kalan, Reza & Murat, Osman. (2016). Leveraging Big Data Technology for Small

and Medium-Sized Enterprises (SMEs). 10.1109/ICCKE.2016.7802106.

Swanson, B. (2017, November 02). Taking an Agile Approach to Data Science. Retrieved

from https://www.datascience.com/blog/agile-data-science

Vajjhala, N. R., & Ramollari, E. (2016). Big Data using Cloud Computing - Opportunities

for Small and Medium-sized Enterprises. European Journal of Economics and Business

Studies, 4(1), 129. doi:10.26417/ejes.v4i1.p129-137

Wilder-James, E. (2017, February 22). Breaking Down Data Silos. Retrieved from

https://hbr.org/2016/12/breaking-down-data-silos

Figures

Figure 1: Academic Study By Topic

Author(s)	Title	Challenges					Solutions				
		Lack of Financial Resources	Lack of Technical Education	Lack of Business Use Cases	Complex Data Integration	Security & Legal Concerns	Adoption of Cloud	Transformation of Culture	Transformation of Business Processes	Transformation of Strategy	Agility of Company
Coleman, S., Göb, R., Manco, G., Pievatolo, A., Tort-Martorell, X., & Reis, M. S. (2016)	How Can SMEs Benefit from Big Data? Challenges and a Path Forward	X	X	X		X	X	X	X	X	
Iqbal, M., Kazmi, S. H., Manzoor, A., Soomrani, A. R., Butt, S. H., & Shaikh, K. A. (2018)	A Study of Big Data for Business Growth in SMEs: Opportunities & Challenges	X	X	X		X		X	X		
Schaeffer, D. M., & Olson, P. C. (2014)	Big Data Options For Small And Medium Enterprises	X	X				X				
Shokri Kalan, Reza & Murat, Osman. (2016)	Leveraging Big Data Technology for Small and Medium-Sized Enterprises (SMEs)	X	X		X	X	X			X	
Vajjhala, N. R., & Ramollari, E. (2016)	Big Data using Cloud Computing - Opportunities for Small and Medium-sized Enterprises	X	X				X				X
Sen, D., Ozturk, M., & Vayvay, O. (2016)	An Overview of Big Data for Growth in SMEs		X		X	X	X		X		X
Schwertner, K. (2017)	Digital Transformation of Business	X		X			X	X	X	X	