**Qualitative Study on Barriers of Adopting Big Data Analytics for UK SMEs**

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**Abstract**

Big Data Analytics have been widely adopted by large companies to achieve competitive advantage. However, small and medium-sized enterprises (SMEs) are underutilising this technology due to the existence of a number of barriers to adoption including financial constraints and lack of information. Previous research identified 69 barriers to SMEs adoption of Big Data Analytics, rationalised to 21 barriers categorised into pillars based on theoretical frameworks. The barriers identified through the research were validated quantitatively, through a survey and also qualitatively, through semi-structured interviews with UK SME representatives. This paper describes the qualitative validation of the barriers to SME adoption of Big Data Analytics and discusses how these barriers were incorporated into an SME Big Data Adoption framework.

Keywords: Big Data Analytics, SMEs, barriers to Big Data Analytics adoption, strategic framework

# Introduction

This paper discusses the way in which qualitative validation was carried out to examine the barriers which limit the adoption by SMEs (small and medium-sized enterprises) of Big Data Analytics. SMEs account for 90% of all businesses in the world (The World Bank, 2022), including 99% of businesses in both the USA (Organisation for Economic Cooperation and Development, 2022) and the EU (European Commission, 2021). In the UK SMEs account for 99.9% of businesses (5.6 million), 61% of the workforce and 52% of the UK’s turnover (Gov.uk, 2021) . However, only one in 10 SMEs utilise Big Data (Bianchini and Michalkova, 2019) in the EU and another study suggests this is the same of the UK (Willetts, Atkins and Stanier, 2022b). A wide range of benefits have been achieved by large companies which have adopted Big Data Analytics including: quicker and cheaper product development (Tan and Zhan, 2017), customer demand forecasting, supplier defect tracking, digital decision analysis model (Song *et al.*, 2022), dynamic pricing, fraud detection, improved stock control and performance management (Danziger, 2019). SMEs who have adopted Big Data Analytics are achieving benefits including being able to sense opportunities and threats, expand into new markets and achieve competitive advantage by operating more efficiently (Côrte-Real, Oliveira and Ruivo, 2017). The Big Data technology market is continuing to increase, despite the COVID-19 pandemic, with the market being expected to reach $116.07 billion by 2027 (Fortune Business Insights, 2020). This increase is partly driven by homeworking and a surge in the volume of online data (Fortune Business Insights, 2020). In Europe, the Big Data and business analytics market is expected to reach $105.82 billion by 2027 with certain markets showing increased demand such as healthcare, education, retail and e-commerce (Allied Market Research, 2020). Impact Networking (2021) provide the following statistics on Big Data in North America:

* 95% of businesses cite the need to manage unstructured data as a problem for their business
* 58% of businesses in North America have adopted Big Data Analytics
* 79% of executives believe that failing to embrace Big Data in the future will result in bankruptcy
* 45% of companies utilise Big Data workloads in the Cloud

The Organisation for Economic Co-operation and Development (OECD) (2021) report that the gap between SMEs and larger firms is more pronounced in the adoption of sophisticated technologies such as data analytics. As described in (Willetts, Atkins and Stanier, 2020b), barriers to adoption were identified from the literature and thematic analysis was used to group the barriers into pillars within a strategic framework. The barriers and the pillars were validated through a survey of SMEs. In order to examine the barriers in more depth, a qualitative validation was then carried out. The paper commences by describing the design of the qualitative validation process, the participant selection and the interview procedure. The paper then follows with a qualitative analysis of the data collected and closes with a discussion of the findings of the analysis results.

# Literature Review and Research Methodology

## Background

Big Data is defined as ‘an umbrella term used to describe a wide range of technologies that capture, store, transform and analyse complex data sets which can be of a high volume, generated at a high velocity in a variety of formats’ (Willetts, Atkins and Stanier, 2020a, p. 3034). Big Data Analytics refers to the variety of software tools and techniques such as data mining and social media analytics which are utilised to extract insights from Big Data sources. A widely used definition of Big Data Analytics is*: ‘a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high velocity capture, discovery and/or analysis’* (Mikalef *et al.*, 2018, p. 1). Big Data Analytics capability is seen as important means for SMEs to achieve competitive advantage, however the current literature is primarily focuses on large companies (Song *et al.*, 2022). Despite being widely adopted by large companies, SMEs have adopted Big Data to a much lesser extent (Willetts, Atkins and Stanier, 2022a). Barriers to adoption were documented in the literature, however there did not appear to be a holistic list of barriers. Therefore, the focus of the research was to identify the barriers to adoption which would be utilised to build a framework to help SMEs to overcome the barriers identified (Willetts, Atkins and Stanier, 2020b).

In previous research, 21 barriers to the adoption of Big Data Analytics were identified from a thematic analysis based on a literature review (Willetts, Atkins and Stanier, 2020b) and were validated quantitatively though a survey (Willetts, Atkins and Stanier, 2022b). For the purposes of triangulation, a qualitative study was performed to obtain richer feedback from SMEs in the UK to support the development of a framework (the HBDAF-UKSMEs) to underpin a software tool to support practitioners in the adoption of Big Data Analytics in SMEs. The feedback from the SMEs was utilised to support weightings of the barriers for the purpose of developing an assessment framework. It was essential to understand relative importance attached by SMEs to the different barriers so that appropriate weightings can be applied. The HBDAF-UKSMEs was developed based on an extensive literature review of barriers to Big Data Analytics adoption (Willetts, Atkins and Stanier, 2020a). These barriers were themed into five pillars derived from three theoretical frameworks: TOE, HOT-fit and ISST (Willetts, Atkins and Stanier, 2020b). The five pillars used in this research are the Business, Environmental, Human, Organisational and Technological pillars. Prior to the development of the framework, a literature review of existing framework was conducted, however only 11 frameworks were identified of which 10 were for large scale enterprises. Only one of which was developed for SMEs, however the data collected was from Iranian SMEs (Maroufkhani *et al.*, 2020). There was no consistency between the 11 frameworks as the number of factors or barriers varied with only one overlapping barrier which was ‘top management support’. This suggested that there was an opportunity for a framework for UK SMEs to be developed.

## Research Design

Semi-structured interviews were utilised to investigate the barriers to SMEs adopting Big Data Analytics from the perspective of senior staff working for SMEs. The interview questions were reviewed by an IT professional for feedback on the content. A pilot interview was conducted with the same individual to time the duration of the interview.

The interview questions were structured into three parts. Part one, entitled Profile Questions, captured demographic information including the participant’s role in the business, the sector the business operates in and how many staff they employ. Part two, entitled About Your Business, included questions capturing: how IT is supported in the business; who makes IT decisions; and whether there is a budget for IT. Part three, was titled, Barriers to Adopting Big Data Analytics. At this stage, a statement was provided explaining the difference between Big Data Analytics and Business Intelligence and the framework was presented to the participant. Participants were then asked for their comments on the barriers, allowing them to expand on their comments and suggest additional items.

## Research Methodology

Belbin (1981) suggested that an interviewing panel of experts from 8 to 10 is sufficient and this is supported by Beecham *et al.* (2005). Nielsen (1993) proposed five participants as the ideal number for conducting interviews while a focus group can be conducted within the range of six to nine participants. Lazar, Feng and Hochheiser (2010) suggested that five participants in interviews will be sufficient. In this research, eight participants were selected for interview. All the participants were directly involved in SME operations, and all had expertise in the use of IT in business processes and held senior positions within their organisations, suggesting that they would be able to answer the interview questions. The participants the researcher selected were mainly through personal connections gained through work. Seven different sectors were represented during the interviews, with a mixture of micro, small and medium-sized businesses, providing a diverse sample.

## The Interview Procedure

An interview protocol similar to Runeson and Höst (2008) was followed, which included consent to participate and for the recording of interviews. Participants were given a five-minute presentation to introduce the framework and the barriers. Following the interview, the audio recording of the interview was played back and the interview transcript was reviewed. The transcript was emailed to every participant with a message asking them to review the transcript for correctness. The Thematic Analysis technique (Braun and Clarke, 2006) was utilised to analyse the interview transcripts. NVivo was utilised to import the interview transcripts and code themes and subthemes. Two of the interviews were conducted in person and six of the interviews were conducted utilising either Microsoft Teams or Zoom because of Covid-19 restrictions.

# Results

## Profile Questions

Demographic information and the range of expertise of the participants is displayed in Table 1.

Table 1 – Participants

|  |  |  |  |
| --- | --- | --- | --- |
| **Participant Code** | **Role** | **Sector** | **No. of Employees in Organisation** |
| P1 | Head Transport Planner | Logistics | 50 to 249 |
| P2 | IT Manager | Education | 50 to 249 |
| P3 | Office Manager | Automotive  | 10 to 49 |
| P4 | Accountant | Financial services | 10 to 49 |
| P5 | Director | Recruitment | 10 to 49 |
| P6 | Director | Technology | 1 to 9 |
| P7 | Project Manager and Estimator | Manufacturing | 50 to 249 |
| P8 | IT Manager | Education | 50 to 249 |

## About Your Business

Part two was titled About Your Business, which included questions capturing: how IT is supported in the business; who makes IT decisions; and whether there is a budget for IT. The results of the interview questions are shown in Appendixes 1 to 5.

## Holistic Big Data Analytics Framework for UK SMEs

The final part of the interview gave the participants the opportunity to provide their feedback on the HBDAF-UKSMEs. During the presentation at the start of the interview, participants were introduced to HBDAF-UKSMEs. In this final part of the interview, they were again shown the HBDAF-UKSMEs and were asked to comment on each of the barriers and in particular, whether they believed the barriers were in the correct pillar or if they felt any barriers were missing or redundant. The participants provided supplementary feedback for several barriers, which expand on the definitions for each barrier defined in previous research (Willetts, Atkins and Stanier, 2020b) and this is discussed further below.

### Business Pillar

Six of the eight participants believed that ‘*Financial barriers’* were an issue; statements included ‘*Financial barriers*’ being described as “particularly important” and a “key barrier”. However, two participants did not believe financial barriers were a barrier for their business. P5 stated that it is “*not an issue, wouldn’t spend if I didn’t think it was worthwhile*”. P6 stated that ‘*Financial barriers*’ are “*less important with [the availability of affordable] platforms*”. This suggests that if a low-cost solution or affordable solution is identified which meets the requirements of the SME, finance may not always be a barrier to adoption. However, the majority of participants suggested that for most SMEs, finance is likely an issue. One participant commented, in relation to COVID-19, that financial barriers were very important during a pandemic, as technology adoption may not be prioritised.

All eight participants agreed that the ‘*Lack of business cases’* is a barrier to adoption. The comments included: “*I would be interested in a business case …. to see how they achieved ROI” (P5), “it is difficult to find business cases*” (P6), “*yes, need to know what benefits you will get from adopting Big Data Analytics*” (P7) and “*applicable, in the sense there is no need at the moment to invest in this type of analytics*” (P8). This feedback suggests that ‘*Lack of business cases’* is a prominent barrier for SMEs.

### Environmental Pillar

Six of the participants (P1, P2, P3, P4, P5, P6) agreed that *Ethical concerns in data use* was a barrier to adopting Big Data Analytics. P6 provided supplementary feedback that this is “*a huge issue for predictive analytics. We need to make sure systems don’t make the recruiting decisions on their own, needs to be human involvement in the process*”.

The ‘*Inability to assess and address digital risks’* was recognised as a barrier by six participants (P1, P2, P3, P5, P6, P8). Participants believed that their businesses “*do not have the expertise*” (P8) and it may be challenging “*especially if there is not a large governance department*” (P6). However, two participants felt that this was not an issue. All participants agreed that ‘*Regulatory issues’* are a barrier. Comments included “*security is a key concern. We currently have inadequate firewall and antivirus protection*” (P1) and “*Regulatory issues is a key barrier, particularly relating to data security e.g. General Data Protection Regulation (GDPR)*” (P2). GDPR was specifically mentioned by 3 participants (P2, P4, P8).

‘The *lack of common standards’* was acknowledged by five participants (P1, P2, P3, P5, P6). P6 believed it was “*definitely a barrier, related to regulatory issues*”. However, none of the other participants discussed this in any detail.

### Human Pillar

Three participants believed that ‘*Shortage of consultancy services’* was a barrier (P1, P2, P3), with P1 stating that “*we do not use or would not know where to go*”. The participants who did not believe that the ‘*Shortage of consultancy services’* was a barrier believed that acquiring knowledge internally within their business was more important and “*the lack of time to do the training required can be an issue for companies*” (P6).

Seven participants (P1, P2, P3, P4, P5, P6, P7) stated that ‘*Lack of in-house data analytics expertise’* is a barrier. Comments relating to this included: “*do not have anyone with the ability to interrogate data beyond the basic levels of the current off the shelf Big Data Analytics solution*” (P1) and “*this will be an issue for us*” (P7). One participant (P6) highlighted that some technology vendors provide training material to support their customers: “*We give development time to our employees and encourage teams to undertake projects or courses to upskill. Also, the lack of time to do the training required can be an issue for companies*”. The one participant who did not believe this to be a barrier (P8) has their own dedicated in-house Data Manager role for data analytics but not specifically for Big Data Analytics as they have not adopted this technology.

### Organisational

Three participants believed that ‘*Change management’* was a barrier (P1, P2, P3). The majority of participants believed that being smaller businesses allows them to adapt to change quickly indicating that they are more agile. P6 believed that being a small company they could easily adapt to change and P4 stated that: “*don’t think it [change management] would be an issue*”. Further supplementary feedback provided relating to the ‘*Change management’* barrier was internal communication. P3 stated: “*One barrier appears to be missing, Communications. Issues arise when communication breaks down between individuals and teams such as not knowing what data people need or making IT decisions*”. This appears to relate to ‘*Change management’* which already exists as a barrier within the HBDAF-UKSMEs.

*‘Cultural barriers’* were recognised by four participants (P1, P2, P3, P7). One participant (P7) expanded on this by stating that: “*we do not have a big information or data gathering culture, [we are] focused on making money*”. However, as with Change management, several participants felt that their businesses are open to change, particularly P4: “*our business doesn’t have a “stuck in the past” culture and is open to change.*” Another (P6) believed that *‘Cultural barriers’:* “*would be difficult for larger organisations [to overcome] but not for us*”.

Five participants (P1, P2, P3, P4, P7) believed that ‘*Insufficient volumes of data to be analysed’* is a barrier to adoption. The comments made included: “*we don’t store huge amounts of data currently. Would need to collect more for it to be viable*” (P4) and “*minimal datasets including invoices and customers’ orders mostly stored on paper or in emails. We also rely on a legacy database system*” (P7). However, one participant (P6) elaborated why ‘*Insufficient volumes of data to be analysed’* is not a barrier for their business: “*[‘Insufficient volumes of data to be analysed’] is an issue for smaller start-up companies. We are in a fortunate position to have 10 years’ worth of data*”.

Six participants (P1, P2, P3, P6, P7, P8) believed ‘*Lack of managerial awareness and skills’* was a barrier, with one participant (P8) stating that their management: “*would not be aware of Big Data Analytics and not have skills*”. However, as with the Change management and Cultural barriers, one participant (P4) stated: *“[‘Lack of managerial awareness and skills’] wouldn’t necessarily be an issue, one of the business partners would be aware of the technology*”.

*‘Lack of top management* *support*’ was recognised as a barrier by six participants (P1, P2, P3, P6, P7, P8) with a theme from the comments that it is essential for top management to be aware of Big Data Analytics and its benefits for them to support its adoption. The comments made included: “*top management drive everything so if it would happen, they would drive it so support would not be an issue*” (P4), “*is important as it may not immediately be recognisable in terms of how Big Data can benefit*” (P6), “*yes, this would likely be an issue, wouldn’t buy something they can’t get an immediate return from*” (P7) and “t*hey are not aware of it, so would not support*” (P8).

Five participants (P1, P2, P3, P4, P7) stated that ‘*Management of technology’* is a barrier. In one interview, the participant (P1) stated that their IT support is currently outsourced and that they are the only member of staff in their office with IT expertise so management of technology is a key issue for their business. Another participant (P7) answered similarly that their business: “*probably wouldn’t have the staff required as we have a small IT department*”. However, another participant (P8) did not believe this would be a barrier for them as they have their own dedicated IT department so they believe they would be able to manage the technology.

*‘Talent management’* was reported as a barrier by four participants (P1, P2, P3, P4), particularly if their business has no dedicated in-house IT support staff (P1, P4). However, three firms with a dedicated IT department did not believe this to be an issue. Comments provided by participants include: “*we have an IT team and the company who we merged with have their IT team so this should not be a major issue*” (P7) and “*if we were using an off the shelf product we would be ok but we wouldn’t be able to develop our own solution*” (P8).

### Technological

*‘Complexity of data’* was acknowledged as a barrier by five participants (P1, P2, P3, P5, P6). One participant commented: “*where would you start how would you get it in readable format*” (P5) which appears to highlight the lack of knowledge regarding Big Data Analytics technology. Another theme which appeared was that not all SMEs store complex data, or they do not consider it to be complex. One participant (P4) commented: “*we don’t currently have complex data so it is not an immediate barrier*”.

Six participants (P1, P2, P3, P4, P5, P7) stated that ‘*Data scalability’* is a barrier, with one participant commenting that they currently work on smaller datasets (P7). However, one participant (P7) commented that scalability would not be an issue if they adopt a cloud based Big Data Analytics solution. Another participant (P6) who had adopted a Zoho Big Data Analytics solution stated that: “*Thought it [‘Data scalability’] would be a major issue but was easier to resolve than expected*”.

*‘Data silos’* was acknowledged as a barrier by five participants (P1, P2, P3, P5, P6), as it was commented that if the business has different platforms or sources of data then unifying it would be a challenge (P6). A participant commented that they did not believe this would be an issue if they utilised cloud computing (P8).

Six participants (P1, P2, P3, P4, P5, P7) agreed that ‘*Infrastructure readiness’* would be a barrier for their organisation. A reoccurring theme from the answers was that participants would prefer to adopt cloud solutions or cloud infrastructure. P4 commented they: “*would prefer to use a cloud infrastructure if they were willing to adopt. Current infrastructure would not support*”. Similarly, P8 stated: “*if we were going with a cloud solution it would not be a barrier but would be for onsite solution due to the volumes of data*”.

*‘Lack of suitable software’* was acknowledged as a barrier by seven participants (P1, P2, P3, P4, P5, P7, P8) with all the participants stating that they would not know what software is available. This suggests that *‘Lack of suitable software’* is an important barrier. However, the one participant (P6) who did not agree this was a barrier stated: “*lucky with what we wanted to do with Zoho, the product had all the required functionality out of the box*”.

Six participants (P1, P2, P3, P5, P6, P7) agreed that ‘*Poor data quality’* is a barrier. One participant (P7) stated that data is primarily stored in emails outside of their legacy enterprise application so there is no standardised system for storing data. Another participant (P6) highlighted the issue of dirty data: “*dirty data is a challenge for example, reseller partners and staff undertaking demos generating data*”. However, one participant (P4) did not believe that poor data quality would be an immediate issue, as lack of data is more important than the quality. Another participant (P8) did not believe that ‘*Poor data quality’* is an issue for their business as: “*most data we stored is good quality as it is reviewed. Data can get out of date but better quality than other businesses*”.

## Other Comments

P6 suggested that the HBDAF-UKSMEs proposed could be of practical use by: “*Helping the non-technical senior stakeholders understand the technology, for example the Financial Director wouldn’t be interested unless you can demonstrate benefits, ‘what can it do for us?*’”. They also wanted to emphasise at the end of the interview that the key areas of concern were “*Lack of training, regulatory issues around Big Data, expertise and management time*”.

## Motivation to adopt Big Data Analytics

Several of the participants had already adopted Big Data Analytics solutions. P1 had adopted Dynafleet as their business are capturing a variety of data including sensor data from vehicles transporting goods. P5 has adopted a Zoho Big Data Analytics solution and they stated that this meets all of their business’ current needs. P6 was from an SME who have invested in technology such as sector specific tracking software and remote desktop infrastructure. They are currently implementing Google Analytics and would like to expand the use of social media to review their effectiveness to support continuous improvement.

Not all SMEs aim to grow their business. P3, P4, P7 and P8 stated that they have no current requirement to adopt Big Data Analytics. P4 stated: “*[the business] doesn’t advertise they are taking on work, not turning it away but not actively trying to grow the business. Work continues for example, yearly accounts so that the client base remains stable*”. This suggests that not all SMEs want to grow; as with this business they may be happy to maintain the current level of work. P8’s business is currently using social media is but is happy with their current level of analytics and are not currently interested in social media analytics or Google Analytics. This suggests that motivation to adopt Big Data Analytics must be considered as a factor.

# Discussion

All the 21 barriers were validated through the interviews conducted with SME practitioners. However, it is evident from the results that some barriers are seen as more important than others, for example all eight participants agreed that ‘*Regulatory issues’* and ‘*Lack of business cases’* were barriers but only three participants stated that ‘*Shortage of consultancy services’* and ‘*Change management’* were barriers. This is similar to the results found during the quantitative analysis. The highest-ranking barriers from the quantitative analysis were ‘*Data Scalability’*, ‘*Insufficient volumes of data to be analysed’* and ‘*Financial barriers’*. The advantage of undertaking the qualitative interviews was that the participants provided a richer vocabulary, which provided context and further supplementary details regarding each of the barriers which was not possible through the questionnaire. The feedback provided insight beyond the secondary data found in the literature as the SME participants were able to provide up-to-date detail regarding the current challenges they are encountering, which was particularly important during the on-going COVID-19 pandemic.

Some participants identified particular barriers as especially relevant to their business, for example the Organisational barriers were more important for P1, this may depend on factors such as the sector in which the business operates and the level of computing knowledge within the business.

It was expected that the feedback obtained through the interviews would impact the 21 barriers identified through the literature review and thematic analysis, for example new barriers may have been suggested or participants may have suggested that barriers should be removed. The feedback from the focus group participants confirmed that the 21 barriers identified were valid, with no additional barriers required or the removal of barriers. However, supplementary information was provided and this has been utilised to strengthen the definitions for each barrier (Willetts, Atkins and Stanier, 2020b). No changes were made to the barriers as a result of the interviews. However, applying Cronbach’s Alpha to the results of the quantitative analysis, led to a realignment of the pillars which were reduced to four, namely Environmental, Human, Organisational and Technological (Willetts, Atkins and Stanier, 2022b). The revised pillars and barriers are described as follows.

## Environmental Pillar

The Environmental barriers to adopting Big Data Analytics were agreed by an average of 6 interview participants, suggesting that these barriers are very important. Environmental barriers relate to the issues outside a business’ control, including legal, ethical, privacy and regulatory issues. ‘*Financial barriers*’ has now been included in this pillar as access to finance is an environmental issue due to the finance required to invest in technology.

*‘Ethical concerns’* in data use refer to the fears relating to the collection and usage of Big Data (Ahmed *et al.*, 2017), as there has been criticism of breaches of privacy including targeting products at individuals which they do not need. Businesses may not want to automate all their decision-making processes using predictive or prescriptive analytical techniques. The General Data Protection Regulation (GDPR) legislation requires businesses which will be utilising automated decision making, including profiling, to undertake a Data Protection Impact Assessment to demonstrate that any associated risks have been identified and assessed to clarify how they will be addressed (Information Commissioner’s Office, 2020). Similarly, information needs to be provided to individuals, such as customers, at the point of collecting data to clarify how their data will be used and how automated decisions will be made. Individuals will also need to provide their consent to allow their data to be processed for the purposes stated. A business also needs be prepared for automated decisions to be challenged and it is likely that individuals may request for the automated decisions made to be transparent.

*‘Financial barriers’* appear to be very important as six of the participants were very strongly in agreement. *‘Financial barriers’* are defined as the investment required to adopt Big Data Analytics and it is documented that SMEs may have restricted borrowing capacities, therefore they are cautious when investing in technology (Coleman *et al.*, 2016). Costs relate to the infrastructure and software required to process and analyse Big Data but also include factors such as cybersecurity and training (Engels, 2017). This is a widely documented barrier which was identified during the literature review in a number of studies (Lee, 2017; O’Connor and Kelly, 2017; Arunachalam, Kumar and Kawalek, 2018; Iqbal *et al.*, 2018; Noonpakdee, Phothichai and Khunkornsiri, 2018; Olufemi, 2018; Bianchini and Michalkova, 2019; Smith *et al.*, 2019). ‘*Financial barriers’* was originally positioned in the Business pillar but was moved to the Environmental pillar when the pillars were realigned, based on the results of the Cronbach’s Alpha test carried out on the quantitative data. Financial barriers may be more important during a major economic event such as a pandemic, as mentioned by one of the participants. *‘Financial barriers’* are important as executives may feel that the investment costs may outweigh the tangible benefits, regardless of the potential intangible benefits (Lee, 2017).

The *‘Inability to assess and address digital risks'* was identified as an important barrier. This barrier relates to the capability of an SME to effectively respond to external security threats including hacking, phishing and ransomware, as the adoption of Big Data Analytics may require the business to open their infrastructure to integrate with new sources of Big Data, including social media or third party datasets, as security policies and procedures will be required (Bianchini and Michalkova, 2019). It is likely that training or additional personnel will be required if this is lacking, adding further to the investment costs.

‘*Regulatory issues’* are defined as the legal, security and privacy concerns of collecting and analysing Big Data. Every participant interviewed agreed that ‘*Regulatory issues’* were a barrier. This suggests that it is the most important Environmental barrier and will be a challenge for every business. There was a specific reference to the GDPR legislation, suggesting that businesses may be concerned that capturing, storing and analysing data requires the business to be compliant with legislation, with non-compliance potentially resulting in a substantial fine depending on severity. As discussed in the ‘*Ethical* concerns’ barrier, automated decision making also imposes legal obligations under GDPR legislation. SMEs which operate in the European Union are required to comply with GDPR legislation; this extends to UK SMEs during the Brexit transition and may continue to apply (IT Governance, 2020). This is significant because Big Data Analytics will likely require collection of personal data relating to an individual for a specific purpose. If this is combined with other data sources and utilised in a way which violates the agreed purpose, there may be legal and ethical implications (Alharthi, Krotov and Bowman, 2017).

*‘The lack of common standards’* was identified as an important barrier. Big Data can be derived from many sources including internal data and external data acquired through third parties including social media platforms.

## Human Pillar

The Human pillar was revised following the quantitative analysis (Willetts, Atkins and Stanier, 2022b) now consists of a single barrier. This pillar relates to the knowledge and skills required to adopt and utilise Big Data Analytics.

*‘Shortage of consultancy services’* appears to be one of the least important barriers to the adoption of Big Data Analytics. *‘Shortage of consultancy services’* refers to SMEs who do not have the required skills and knowledge in-house to adopt Big Data Analytics may require assistance from consultancy services. The participants interviewed perceived that developing the skills required internally within the organisation are more important than hiring consultants to assist them, which may not be financially feasible. Vendor training was referred to in the supplementary information relating to the barrier *‘Lack of suitable software’* in the context that vendors who provide training can help to address the skills gap required to adopt Big Data Analytics. However, SMEs do not generally hire consultants for management and business analytics (Iqbal *et al.*, 2018) and they may be unaffordable for SMEs as consultancy firms often work with large companies (Coleman *et al.*, 2016; Iqbal *et al.*, 2018).

## Organisational Pillar

The Organisational barriers were each agreed by an average of 5 participants. Six of the Organisational barriers to Big Data Analytics adoption appeared to be very important with five or more participants agreeing with the barriers. The pillar considers the internal barriers within an organisation which may prevent an SME from adopting Big Data Analytics including top management support, culture and change management.

*‘Change management’* appears to be a less important barrier for SMEs with three participants agreeing this is a barrier. The ‘*Change management’* barrier is defined as a business’ ability to adapt to change, as the adoption of Big Data Analytics may require an organisation to make major changes to its operations (Arunachalam, Kumar and Kawalek, 2018). Internal communication in particular may be a key challenge in implementing organisational change. From the feedback obtained, it appears that the majority of SMEs believe that their smaller size allows them to adapt to change quickly, enabling them to adopt new technologies more easily than large businesses.

*‘Cultural barriers’* also appear to be less important with four participants stating that this is a barrier. ‘*Cultural barriers’* relate to the business’ internal culture which may impact its strategy, structure and process. Several participants believed that their business has a culture which supports change and innovation driven by senior management. Additionally, some SMEs may be willing to take financial risks in favour of adopting new technology, whereas others may be more risk averse. However, half of the participants agreed that ‘*Cultural barriers’* are an issue. This suggests that not all of the 21 barriers identified are applicable to every SME. Changing an SME’s culture may be difficult as SMEs are rarely interested in management trends and may view Big Data Analytics as hype rather than an opportunity for competitive advantage (Coleman *et al.*, 2016; Iqbal *et al.*, 2018).

*‘Insufficient volumes of data to be analysed’* was identified as a barrier by five focus group participants. This barrier highlights the issue that not all SMEs have large volumes of data and may therefore believe that Big Data Analytics is not relevant for their business. (Noonpakdee, Phothichai and Khunkornsiri, 2018).

*The ‘Lack of business cases’* was identified as one of the most important barriers to the adoption of Big Data Analytics for SMEs. ‘*The Lack of business cases’* barrier refers to the lack of case studies which document how other SMEs have adopted Big Data Analytics, including the solution implemented and the benefits achieved. Every participant agreed that lack of business cases is a barrier, suggesting that it is important for case studies of SMEs operating in the same sector under similar constraints adopting Big Data Analytics and resulting in measurable benefits to be available as these are required to convince SMEs to adopt the technology. It has been documented in the literature that there is a critical shortage of SME case studies (Coleman *et al.*, 2016; Iqbal *et al.*, 2018).

*‘Lack of managerial awareness and skills’* was recognised as a barrier by six participants. This barrier represents the lack of understanding by SME managers and entrepreneurs as to what is required to change traditional business practices and adopt Big Data Analytics to gain competitive advantage (Bianchini and Michalkova, 2019). It has been documented that leadership teams that set a clear goal succeed in adopting Big Data Analytics (Mcafee and Brynjolfsson, 2012), therefore it is important that they have an understanding of the technology to achieve its benefits.

Another important barrier is the ‘*Lack of in-house data analytics expertise’*, with seven participants agreeing that this is a barrier. The participant who disagreed with this barrier stated that their business hired a dedicated Data Manager for the purposes of reporting and analytics, which is not feasible for every SME. However, an opportunity has arisen in the form of training provided by vendors. Despite the support provided by vendors, it may be more difficult for businesses without dedicated IT or analytical staff to implement a Big Data Analytics solution. The barrier ‘*Lack of in-house data analytics expertise’* incorporates all the issues relating to the lack of skills and awareness required to adopt Big Data Analytics. It has been documented that it is unusual for SMEs to employ data analysts and data scientists are unfeasible due to scarcity and cost (Engels, 2017).

*‘Lack of top management support’* was an important barrier with six participants in agreement. ‘*Lack of top management support’* is defined as the support required from the key decision makers to implement Big Data Analytics including resources, finance and authority (Sejahtera *et al.*, 2018). The feedback received suggested that top management ultimately make the decision on the adoption of technology in most SMEs, so they would need to be aware of Big Data Analytics and have a desire to adopt it. If top management or the owner do not support the adoption of Big Data Analytics, then they may obstruct its implementation (Olufemi, 2018).

*‘Management of technology’* was acknowledged as a barrier by five participants which indicates it is important. This barrier refers to the skillsets required to administer the hardware and software required to utilise Big Data Analytics, for example IT staff who may be required to support the infrastructure and data analysts to manipulate the data. However, if businesses have inhouse IT or data analytics expertise, this may be a lesser barrier than for a business which outsources their IT support.

*‘Talent management’* was found to be a less important barrier as although four participants agreed that this was a barrier, half of the businesses have dedicated IT support staff. The ‘*Talent management’* barrier refers to the management of technical personnel required to utilise Big Data Analytics. Depending on the complexity of the Big Data Analytics solution adopted, developers or data scientists may be required to work with the large volumes of data and possess the ability to clean and organise these Big Datasets, therefore the individual managing them is required to have an understanding of their work (Mcafee and Brynjolfsson, 2012).

## Technological Pillar

Each of the six Technological barriers appear to be important, with an average of 6 participants agreeing with each barrier. The Technological pillar considers the issues relating to the hardware and software on which Big Data Analytics solutions reside.

*‘Complexity of data’* was recognised as a barrier by five participants. The feedback from participants was varied as some of the participants do not store complex data whereas others are analysing Big Data including sensor data and social media. ‘*Complexity of data’* is defined as the challenge of managing data from a variety of sources, including structured and unstructured formats which can include SMS, images videos, audio files and emails (Alharthi, Krotov and Bowman, 2017).

*‘Data scalability’* was identified as another important barrier with six participants in agreement. This barrier is defined as the challenge of storing large volumes of Big Data which can grow at high velocity, particularly sources such as social media and sensor data. Many businesses currently have to delete historic data to allow newly created data to be stored (Arunachalam, Kumar and Kawalek, 2018). SMEs may be utilising ‘on-premise’ relational database technology which provide limited scalability, although some relational database vendors provide scalable cloud storage capability including Microsoft Azure SQL Database, Amazon Relational Database, Oracle Database Cloud and Google Cloud SQL (Drake and Turner, 2020).

*‘Data silos’* was recognised by five focus group participants as a barrier. This barrier highlights the issue that data may be stored in different locations or situations, therefore the challenge for SMEs is to integrate these isolated datasets for the purpose of utilising Big Data Analytics. It has been documented that different departments within an SME may be using different software applications or databases, resulting in duplicate data or inaccurate reports, resulting in further complications (Noonpakdee, Phothichai and Khunkornsiri, 2018).

*‘Infrastructure readiness’* was identified as an important barrier with six participants in agreement. ‘*Infrastructure readiness’* is defined as the development of the IT infrastructure required to facilitate Big Data Analytics, which will likely require significant investment to procure the necessary hardware and software as the existing technologies utilised by SMEs are unlikely to support Big Data Analytics (Alharthi, Krotov and Bowman, 2017). However, several participants stated that cloud computing could provide an opportunity to procure affordable and scalable infrastructure to host their Big Data Analytics solution, as they were already utilising cloud computing for infrastructure and/or software as a service (SaaS). A potential solution for SMEs may be to utilise cloud infrastructure and SaaS solutions.

*The ‘Lack of suitable software’* is a prominent barrier, identified by seven participants. ‘*Lack of suitable software’* relates to the challenges associated with SMEs adopting suitable Big Data Analytics software solutions. It appears that SMEs may be unaware of the software solutions available (Willetts, Atkins and Stanier, 2022b)'. This barrier appears to be related to the ‘*Lack of business cases’* barrier as if case studies of SMEs adopting Big Data Analytics were widely available, the significance of this barrier may be reduced as more SMEs will be made aware of available Big Data Analytics software. There is a lack of software targeted at SMEs and SMEs are not likely to be aware of solutions which are currently on the market and used by larger companies which may be suitable for their business as well (Bianchini and Michalkova, 2019). However, the primary data collected through the interviews identified two SMEs which have adopted Big Data Analytics, which suggests that suitable software may be available for SMEs in specific sectors.

Lastly, ‘*Poor data quality’* was recognised as a barrier by six participants. ‘*Poor data quality’* is defined as the issues relating to the suitability and integrity of the data captured. From the feedback obtained, it appears that SMEs may not be storing data in standardised locations, which may introduce duplication or redundant data. The quality of the data is important for SMEs as this provides confidence to decision makers (Lee, 2017). Data quality issues may include incorrect formatting, lack of unique identifies, duplication, missing data mis clarification and poor data quality control at the point of input (Sejahtera *et al.*, 2018), which may be further complicated through the collection of unstructured data originating from a wide range of sources (Lee, 2017).

Table 2 shows the focus group’s affirmation of the barriers categorised into the revised pillars (Willetts, Atkins and Stanier, 2022b). The three barriers which moved between the two versions of the framework are shaded in the original pillar’s colour. ‘*Lack of business cases’* and ‘*Financial barriers’* originated from the Business pillar*,* which was removed previously (Willetts, Atkins and Stanier, 2022b) and are shaded in yellow. *‘Lack of in-house data analytics expertise’* originated from the Human pillar and is coloured blue.

Table 2 – Participants’ agreement with the barriers to SMEs adopting Big Data Analytics

|  |  |  |  |
| --- | --- | --- | --- |
| Pillar | Barrier | Participant Code | Count |
| Environmental | Ethical concerns in data use | P1, P2, P3, P4, P5, P6 | 6 |
| Financial barriers | P1, P2, P3, P4, P7, P8 | 6 |
| Inability to assess and address digital risks | P1, P2, P3, P5, P6, P8 | 6 |
| Regulatory issues | P1, P2, P3, P4, P5, P6, P7, P8 | 8 |
| The lack of common standards | P1, P2, P3, P5, P6 | 5 |
| Human | Shortage of consultancy services | P1, P2, P3 | 3 |
| Organisational | Change management | P1, P2, P3 | 3 |
| Cultural barriers | P1, P2, P3, P7 | 4 |
| Insufficient volumes of data to be analysed | P1, P2, P3, P4, P7 | 5 |
| Lack of business cases | P1, P2, P3, P4, P5, P6, P7, P8 | 8 |
| Lack of in-house data analytics expertise | P1, P2, P3, P4, P5, P6, P7 | 7 |
| Lack of managerial awareness and skills | P1, P2, P3, P6, P7, P8 | 6 |
| Lack of top management support | P1, P2, P3, P6, P7, P8 | 6 |
| Management of technology | P1, P2, P3, P4, P7 | 5 |
| Talent management | P1, P2, P3, P4 | 4 |
| Technological | Complexity of data | P1, P2, P3, P5, P6 | 5 |
| Data scalability | P1, P2, P3, P5, P6, P7 | 6 |
| Data silos | P1, P2, P3, P5, P6 | 5 |
| Infrastructure readiness | P1, P2, P3, P4, P5, P7 | 6 |
| Lack of suitable software | P1, P2, P3, P4, P5, P7, P8 | 7 |
| Poor data quality | P1, P2, P3, P5, P6, P7 | 6 |

## Framework Refinement

The first version of the HBDAF-UKSMEs was developed utilising qualitative analysis and a thematic analysis of secondary data obtained from a literature review. (Willetts, Atkins and Stanier, 2020a, 2020b). The qualitative analysis of the focus group interviews documented in this paper has confirmed the 21 barriers to SMEs adoption of Big Data Analytics, with no changes to the pillars or the barriers suggested. The final version of the HBDAF-UKSMEs is shown in Figure 1.



Figure 1 – Final version of the HBDAF-UKSMEs following the qualitative analysis

Supplementary feedback was provided for several barriers and this has been incorporated into the definition of the barriers. The focus group interviews and the supplementary feedback provided a richer understanding of the issues which was used to enhance the definitions of the barriers to adoption. The most important barriers identified through the qualitative analysis were: ‘*Regulatory issues’* and ‘*Lack of business cases’*. In Figure 1, some barriers are shown with tips. This is to support the allocation of weightings to the barriers, as the barriers with tips required different weightings as they were recognised as important by SMEs, for example ‘*Lack of Business cases’* which every participant interviewed agreed is a barrier*.* Three barriers originated from other pillars: ‘*Financial barriers’*, ‘*Lack of business cases’* and *‘Lack of in-house data analytics expertise’.* To differentiate these barriers, the corners are tipped with the colour of the pillar they originated from, yellow for Business and blue for Human as shown in Figure 1.

# Research Limitations

A potential limitation of the study is that the majority of the SMEs who participated were from the author’s network of SME contacts which may have resulted in biased responses. However, the research to develop the first Big Data Analytics Framework for UK SMEs utilised a mixed methods approach, therefore both a literature review (Willetts, Atkins and Stanier, 2020b) and a quantitative analysis (Willetts, Atkins and Stanier, 2022b) were undertaken for the purposes of triangulation. Therefore, the barriers to adoption which formed the framework were validated from three perspectives, minimising the limitations of using one approach. Lastly, the impact of Covid-19 meant that the majority of the interviews were conducted utilising Zoom or Microsoft Teams, however it is not believed that this affected the outcome.

# Conclusions

The aim of this paper was to validate the barriers to SMEs adoption of Big Data Analytics from a qualitative perspective. The paper has described the process of designing the interviews, the selection of participants and the analysis of the data. Utilising qualitative interviews allowed participants to provide more detail using a richer vocabulary than a questionnaire, which facilitated understanding of the context in which their business operated or the issues which were more important to them. The qualitative study has shown that some SMEs are adopting the Big Data Analytics as one participant from a micro company (P6) and one participant from a medium-sized company (P1) were already using Big Data Analytics. Moreover, a participant from a recruitment company (P5) stated that they are currently implementing Google Analytics and are utilising SaaS applications, having a desire to expand the use of computing to grow their business and create efficiencies.

The barriers to SMEs adoption of Big Data Analytics have been triangulated, initially identified from a secondary literature review, then verified from primary quantitative and finally qualitative data. The qualitative analysis has confirmed that all of the barriers identified are valid with no additional barriers required or further refinement to the pillars. However, it is evident that certain barriers are more prominent than others, with the ranking of importance differing between the quantitative and qualitative studies. Several limitations of the study have been identified including bias and conducting interviews remotely. Following this study, the framework was applied to two UK SME case studies (Willetts, Atkins and Stanier, 2021, 2022a) by converting the framework into a scoring tool which allowed the SMEs to identify their current Big Data Analytics readiness and identify how they can improve their capability. Future publications will document the development of a scoring tool and its application to real-world case studies, consultancy work will also be undertaken to further improve the tool.

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# Appendices

Appendix 1– Analyse data and software applications

|  |  |  |
| --- | --- | --- |
| **Participant Code** | **Does your business analyse data using computer software applications?** | **If yes, which applications are you currently using?** |
| P1 | Yes | Stratum Business and Dynafleet |
| P2 | Yes | Excel, Microsoft Flow |
| P3 | Yes | GDS, Excel |
| P4 | Yes | Iris (accountancy application which includes analytics and reporting such as client trends) |
| P5 | Yes | Application Tracking System (for Recruitment), Cashflow (finance application) and lead generation software (for recruitment) |
| P6 | Yes | Zoho Analytics and Google Analytics |
| P7 | Yes | Excel |
| P8 | Yes | Excel |

Appendix 2 – Types of data analysed

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Participant Code** | **Customer data** | **Sales data** | **Supplier data** | **Competitor data** | **Social media data** | **Website data** | **Sensor data** | **Plans, drawings, photographs or similar** | **Other** |
| P1 | ü | ü | ü |  |  |  | ü |  | Sensor data from trucks for Dynafleet software. Also capture drivers’ activity such as breaks. |
| P2 | ü |  |  | ü | ü |  | ü | ü |  |
| P3 | ü | ü |  |  | ü |  | ü | ü |  |
| P4 | ü | ü |  | ü | ü |  |  |  |  |
| P5 | ü | ü | ü | ü – Not enough at present |  | ü |  |  |  |
| P6 | ü |  |  |  |  | ü |  |  |  |
| P7 | ü | ü |  – supplier database |  |  |  |  | ü | “Don’t really utilise the website as we are trying to sustain current level of work with existing customer base” |
| P8 | ü | ü | ü | ü | ü |  |  |  |  |

Appendix 3 – IT support, IT decision makers and IT budget

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Participant Code** | **IT Support** | **IT Decision Maker** | **IT Budget** | **IT Budget Amount** | **IT Budget % of Turnover** |
| P1 | Outsourced | The owner | Yes | > £50,000 | 1% <= 5% |
| P2 | Dedicated IT department or staff | IT Manager or senior management | Yes | > £50,000 | I do not know |
| P3 | Combined with another role | Office Manager | No – buy when required | N/A | N/A |
| P4 | Outsourced and in-house support from non-IT staff | The owner | Yes | £10,000 <£50,000 | 5% <= 10% |
| P5 | Outsourced | Senior management | Yes | > £50,000 | 20% |
| P6 | Dedicated IT department or staff | Senior management | No | N/A | N/A |
| P7 | Dedicated IT department or staff | IT Manager. They may escalate items which require significant cost to senior management | Yes | I do not know | I do not know |
| P8 | Dedicated IT department or staff | Day-to-day decisions made by IT Manager. Senior management make decisions on large purchases. | Yes | > £50,000 | I do not know |

Appendix 4 – Understanding of Big Data and Big Data Analytics

|  |  |  |
| --- | --- | --- |
| **Participant Code** | **Do you know what Big Data is?** | **Do you know what Big Data Analytics is?** |
| P1 | Yes | Yes, our business currently uses Big Data Analytics |
| P2 | Yes | I have heard of Big Data Analytics but I am not sure if my company is using it |
| P3 | Yes | I have heard of Big Data Analytics but I am not sure if my company is using it |
| P4 | Yes | Yes, but my organisation does not currently use Big Data Analytics |
| P5 | Yes | Yes, our business currently uses Big Data Analytics – implementing |
| P6 | Yes | Yes, our business currently uses Big Data Analytics |
| P7 | No | No |
| P8 | Yes | Yes, but my organisation does not currently use Big Data Analytics |