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Business Intelligence and Analytics in Small and Medium-sized Enterprises: A Systematic Literature Review

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Abstract

Despite much interest in business intelligence and analytics (BI&A), empirical research shows that small and medium-sized enterprises (SMEs) are still lagging behind in the proliferation of BI&A. However, there are no studies found on literature reviewing research on BI&A in SMEs. This paper collects, categorizes, synthesizes, and analyzes 62 articles related to BI&A in SMEs. The identified research topics being addressed in BI&A include: BI&A components, BI&A solutions, Mobile BI&A, Cloud BI&A, BI&A application, BI&A adoption, BI&A implementation, and BI&A benefits. Further, research gaps and directions for future research are presented to facilitate the progression of BI&A in SMEs research.

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Keywords: Business intelligence and analytics; SMEs; BI&A review; BI&A solutions; BI&A adoption; BI&A implementation; BI&A benefits.

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1. Introduction

“Small and medium-sized enterprises (SMEs) account for about 90 percent of businesses and more than 50 percent of employment worldwide according to the International Finance Corporation”¹ (p.1). They play a major economic and social role, and therefore, they have become a source of economic development². Thus, the need to improve SMEs’ competitiveness worldwide is crucial. However, SMEs are typically vulnerable and not robust enough to withstand the onslaught of economic and global competition³. In order to survive, they must be able to monitor their business and use all their resources efficiently, especially information resources⁴.

“Business intelligence (BI) is a set of methodologies, processes, architectures, and technologies that transform the raw data into meaningful and useful information which allows users to make informed business decisions with real-time data”⁵. According to Yeoh⁶ the term “business intelligence” was first coined by Luhn in 1958⁷. However, as Burstein and Holsapple⁸ recalled, the term “business intelligence” was reintroduced by Howard Dresner when he defined BI as “a broad category of software and solutions for gathering, consolidating and analyzing, and providing access to data in a way that let enterprise users make better business decisions”⁹.

The new term business analytics (BA) emerged in the late 2000s and focused on the analytical component of BI¹⁰. Thus, business intelligence and analytics (BI&A) was used as a unified term to describe information-intensive concepts and methods for improving business decision making¹¹. According to Gartner’s survey, BI&A appears to be the top CIO’s technological choice for increasing competitiveness in the past few years^{12, 13}. Therefore, Chaudhuri et al stated that “Today, it is difficult to find a successful enterprise that has not leveraged BI&A technology for their business”¹⁴ (p.91). Moreover, for the rest of the paper, the term BI&A is used.

Notwithstanding its importance, there is a dearth of literature on BI&A in SMEs¹⁵, as the majority of the BI&A systems are mainly adopted in large, multinational, and international enterprises and thus, the research work on BI&A has largely been focused on them^{16, 17}. Jourdan et al¹⁸ conducted a literature review on BI&A research. They collected and analyzed articles related to BI&A published from 1997 to 2006 in ten leading Information Systems (IS) journals. However, their study focused mostly on BI&A in general and not on BI&A in SMEs. An extensive literature search yielded no extant literature reviewing research on BI&A in SMEs. Therefore, the objective of this paper is to provide a comprehensive review of the literature on BI&A in SMEs. By collecting, analyzing, and synthesizing all extant literature within this domain, this review presents the current state of research topics on BI&A and reveals prospective gaps that require further research. More specifically, the following research question guides this review:

RQ: What are the research topics of BI&A in SMEs that have been addressed?

Kitchenham’s guidelines for a systematic literature review (SLR) will be applied to allow the completeness of the search to be assessed, achieve effective results, and explain them in a more intelligible manner¹⁹. This means that the research procedures of this review follow a strict sequence and well-defined methodological steps that include (1) illuminate the search strategy process, (2) identify the inclusion and exclusion criteria, (3) study the selection process, (4) study the quality assessment, and (5) use data extraction and synthesis. Subsequently, 62 articles that focus on BI&A in SMEs were selected and reviewed.

The remainder of this work is structured as follows. Section 2 outlines the research methodology procedures used to conduct this research study. Section 3 reports the SLR results, and the research question results from the reviewed articles are presented in section 4. Section 5 presents the discussion and directions for future research. Finally, section 6 concludes this research.

2. Research Methodology

This research comprises an SLR that was undertaken based on the guidelines proposed by Kitchenham¹⁹. The Kitchenham’s guidelines were applied due to its more structured method in informing the status of the literature. In the following sub-sections, the steps followed during the review are described.

2.1. Search Strategy

The search strategy consists of two stages: automatic and manual research. During the first stage, the following databases were queried: Scopus, Web of Science, IEEE Xplore, ScienceDirect, Tandfonline, ACM Digital Library,

and Emerald Insight. These online databases were selected as they were considered the most pertinent and provide the highest-impact journals and conference proceedings that cover the field of BI&A. The effectiveness of online database search rather than the defined set of journals and conferences was empirically driven by suggestions from Dieste and Padua²⁰. The keywords used in the search encompassed BI, BA, BI&A, Business Intelligence, Business Analytics, SMEs, Small Business and Medium Business, and combination were used to identify as many related articles as possible. Once the initial data was acquired, the articles were analyzed according to the defined objectives. Thus, for storing all citations, EndNote was used to keep the results of the searches of each database, as well as to circumvent duplicate studies. In addition to automatic research, a manual search was performed to ensure that no studies were missed. Thus, all the primary studies' references were reviewed while exclusion criteria were applied. Finally, the studies obtained from this manual search were added to EndNote, which yielded the final set of primary studies.

2.2. *Inclusion and exclusion*

The purpose of identifying the inclusion and exclusion criteria was to make sure that only relevant articles would be used in this study. Research articles from journals, workshops, conference proceedings, and book chapters in the English language retrieved in the online databases were considered. The articles that were either not clearly related to BI&A, not related to the research question, or had their full texts not available were eliminated. Duplicate reports of the same study were also eliminated. Further, when different versions of an article exist, only the complete version of the article was included while the others were excluded. Note that the selected studies must satisfy all the inclusion criteria and must not satisfy any exclusion criteria.

2.3. *Quality assessment*

In addition to inclusion and exclusion criteria, assessing the quality of the primary studies was considered crucial¹⁹. The principle of the quality assessment was to assess the overall quality of the selected studies. To guide the interpretation of the findings and determine the strength of the inferences of the selected studies, the following quality assessment questions were used:

QA1: Are the research topics addressed in the paper directly related to BI&A?

QA2: Does the context of the study clearly pertain to SMEs?

2.4. *Study selection process*

After the search was conducted, 306 articles were identified. Of these 306 articles, 127 articles were duplicates and were removed by using EndNote. The remaining 179 articles were checked based on the inclusion and exclusion criteria, then 115 articles were excluded, and 64 articles remained. Once the first stage of research was completed, the second could start. The idea of the manual search was to gain confidence in the comprehensiveness of the search results. Thus, all the 64 remaining articles' references were screened while the exclusion criteria were applied, and 17 additional articles were identified. This process of pursuing references of references is known as snowballing as suggested by Jalali and Wohlin²¹. Subsequently, these 17 articles were retrieved through Google Scholar and added to EndNote to produce the pre-final set of primary studies. In total, there were 81 articles. Then the quality assessment criteria were applied, and 19 articles were removed. Finally, 62 articles were identified as the final set of primary studies and formed the basis for the next steps in this review. Table 1 presents the distribution of the primary studies and their sources, before and after the selection process.

2.5. *Data extraction and synthesis*

The process of extraction and synthesis of the collected data was performed by carefully reading each of the 62 articles pulling out related data that was managed by EndNote and MS Excel. Designing data extraction forms to accurately record the information obtained from the primary studies was the aim of this step. Consequently, Webster and Watson's²² concept-centric method was used to identify the study context. The other columns, which were considered in this review, include the study title, date, research method, number of citations, and publishing location.

Table 1. Distribution of articles before and after the selection process.

Online database	Before	After
Scopus	170	39
Web of Science	38	1
IEEE Xplore	52	6
ScienceDirect	18	1
Tandfonline	8	2
ACM Digital Library	13	0
Emerald Insight	7	1
Google Scholar	(17)	12
Total	295	62

3. Systematic Literature Review Results

This section provides the necessary statistical results based on the selected studies before the data analysis discussion for our SLR. Thus, the publication sources, citation status, temporal review, and applied research methods are presented.

3.1. Publication sources

Most primary studies were published in journals and conferences. There were few studies published in symposiums, workshops, and book chapters. The distribution of the primary studies derived from their publication sources is shown in Fig. 1(a).

3.2. Citation status

Fig. 1(b) shows the overview of the citation counts of the selected studies. The citation statistics were obtained through Google Scholar and Scopus. By looking at the data presented in Fig. 1(b), 49 of the studies were cited by other sources. Among these studies, only a few had more than 30 citations while the rest of the studies had fewer than 30 citations or no citations at all. The increase in the citation rates can be expected, as the majority of the selected studies were published in recent years.

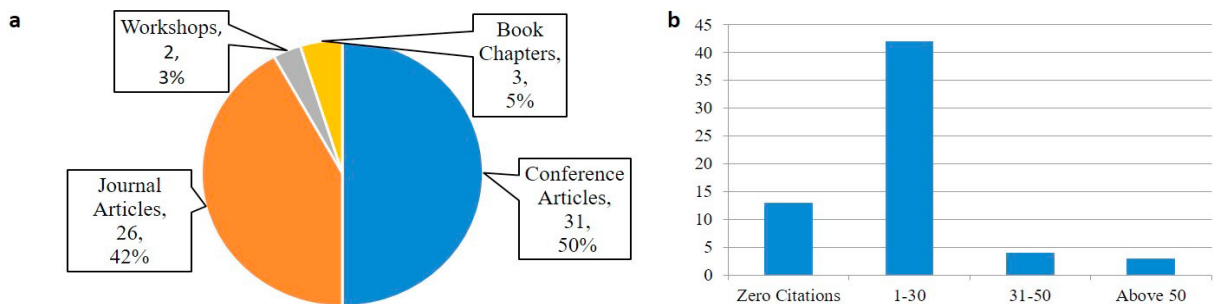


Fig. 1. (a) distribution per publication source; (b) citation count

3.3. Temporal review

The distribution of the final set of selected studies over the years is shown in Fig. 2(a). It is apparent that there was a significant increase in BI&A interest from 2010-2012. However, studies in 2014 slipped back to 3 in 2015. Overall, the number of studies included is low.

3.4. Research method

The classification of the included studies with reference to their research methods is shown in Fig. 2(b). By looking at the data presented in Fig. 2(b), it is clear to see that the research methods in the primary studies were dominated by design research, followed by case studies, surveys, interviews, field inquiries, and descriptive research. However, 42% of literature studies did not implicitly or explicitly mention which methods were applied. This suggests that the research field is still immature.

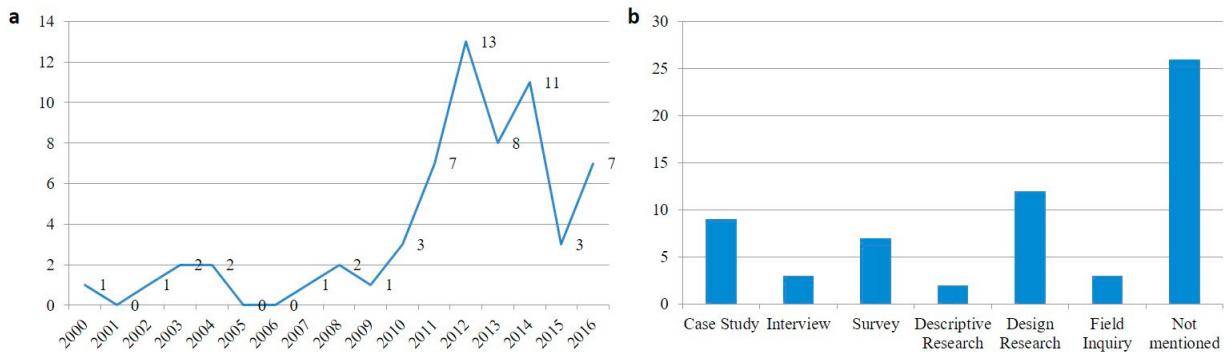


Fig. 2. (a) distribution of the primary studies throughout the years; (b) distribution per research methods

4. Research Question Results

After the primary studies were selected and extracted, it was possible to address the research question of this study derived from the 62 articles analyzed. The concept-centric method was applied during the data extraction and synthesis phase. The identified research topics were: BI&A Components, BI&A Solutions, Mobile BI&A, Cloud BI&A, BI&A Application, BI&A Adoption, BI&A Implementation, and BI&A Benefits, which will be further discussed in the following sub-sections. Moreover, the research topics identified are summarized in Table 2.

Table 2. Research topics identified in the study.

Research Topics	Issues	Reference articles
BI&A components	Data warehouse and reference models	[17, 24-28]
	KPIs	[27, 28]
	OLAP	[17]
	Data mining	[29, 30]
	Dashboard	[31, 32]
BI&A solutions		[17, 33-40]
Mobile BI&A		[46-53]
Cloud BI&A	SaaS frameworks, architectures, models	[45-52]
	SaaS prototype	[54, 55]
	Critical success factors	[40, 56]
	Other issues	[57-59]

BI&A application		[61]
BI&A adoption	Frameworks, maturity level, determinants, models	[15, 38, 62-65]
	Other adoption issues	[16, 66, 67]
BI&A implementation	Critical success factors	[36]
	Frameworks, development cycle, models	[67-71]
	Prototype	[39, 72-77]
	Other implementation issues	[4, 78-80]
BI&A benefits		[16, 84, 85]

4.1. BI&A components

A typical BI&A system includes identification of key performance indicators (KPIs), data warehousing, data mining, OLAP, digital dashboards, and reporting through data visualization²³. There are studies on data warehouse, KPIs, OLAP, data mining, and dashboard in the literature. Sharma et al²⁴ proposed Data warehousing as a Service (DaaS) as an attempt to reach a new level of BI&A. While, the actual use of data warehousing systems in 45 SMEs of the Udine district in Italy was studied through a survey analysis by Pighin and Marzona²⁵. Grabova et al¹⁷ reported the importance of data warehousing for SMEs and presented different web-based data warehouse technologies. Collaborative business systems provide a competitive advantage to companies that operate in a joint business structure. However, traditional BI&A is not designed for collaboration; therefore, Olaru and Vincini²⁶ provided a methodology for heterogeneous data warehouses to aid this shortcoming. Many SMEs refrain from adopting BI&A technology, however, reference models allow SMEs to overcome the obstacles associated with the introduction of BI&A solutions as argued by Schuetz et al²⁷. Schütz and Schrefl²⁸ proposed a four-layered reference model for data warehouses to lower the obstacles that inhibit SMEs from adopting BI&A technology. More specifically, explicit modelling and calculated KPIs, as well as the definition of reference data marts for report building were addressed. Further, Schuetz et al²⁷ followed up a study that specifically addressed the explicit modeling of KPIs by introducing the BI&A reference modeling for data analysis (BIRD) approach.

Another BI&A component is OLAP. OLAP extracts knowledge from a data warehouse or data marts to provide navigation through data to non-expert users. However, traditional OLAP technology is cumbersome and storage costly; therefore, Grabova et al¹⁷ presented a comparison of different OLAP technologies that work in the main memory and with web interfaces. BI&A based on data mining has been one of the popular and indispensable tools for identifying business opportunities in sales and for marketing new products. Cheung and Li²⁹ implemented a BI&A prototype named correlation coefficient sales data mining system (CCSDMS) and the results showed that the proposed solution provides higher accuracy, better computational effectiveness, and higher predictive power. While, Kitayama et al³⁰ presented the use of data mining techniques based on customer profile data in the power electric industry in Japan. A dashboard is an easy-to-read summary of the analysis of the information. Korczak et al³¹ implemented an Intelligent Dashboard for Managers called InKoM. Consequently, an evaluation method based on a scorecard framework oriented toward BI&A systems and projects was presented by Dyczkowski et al³² to evaluate the decision support system applied in the InKoM project.

4.2. BI&A solutions

The industrial use of open source BI&A has become increasingly common. Talend OpenStudio, Mondrian Pentaho, and Pa-Lo are some of the web-based open source solutions that are suitable for SMEs according to Grabova et al¹⁷. Similarly, Bernardino³³ analysed seven of the most frequently used open source BI&A tools. While, Lapa et al³⁴ made a comparative analysis of the BI&A tools to assist the selection of BI&A platforms and identified the most suitable solutions for SMEs. Few papers discussed other BI&A solutions for SMEs. A study by Tutunea and Rus³⁵ identified the BI&A solutions for SMEs in the global market and in the Romanian market. Whereas, Olszak and Ziemba³⁶ identified the known BI&A systems in the Polish market. Moreover, other BI&A solutions-related issues have also been presented in the literature. Nyblom et al³⁷ proposed a simple model for BI&A performance evaluation which was

based on the case studies of eight Swedish SMEs. A study by Gibson and Arnott³⁸ explored why BI&A application are not widely used in small business. In addition, a table of BI&A system classification outlined by Mallach in 2000 was also presented in this study. Further, Khan et al³⁹ and Emam⁴⁰ presented a comparison between the major BI&A vendors and BI&A technologies.

4.3. Mobile BI&A

A mobile BI&A system is an application that can offer similar functionality as traditional BI&A. The mobile system is one of the trending topics in this domain; however, there is still little conceptual work in this field⁴¹. A study by Dubravac and Bevanda⁴² in Croatia explored mobile BI&A adoption in 83 SMEs. The results indicated budget constraints as one of the biggest barriers in mobile BI&A adoption. Other issues were discussed in the mobile BI&A literature. Talati et al⁴³ presented a model for mobile BI&A and Motta et al⁴⁴ proposed a low-cost system architecture for mobile BI&A in SMEs. The core idea of both studies was to design a system based on low-cost open source technologies that would suit the different requirements of small businesses and help SMEs to achieve similar opportunities that BI&A offers to large enterprises. Further, Adeyelure et al⁴⁵ presented a mobile BI&A framework for SMEs in developing countries and identified problems related to the deployment of mobile BI&A.

4.4. Cloud BI&A

Cloud computing and BI&A are becoming increasingly important in gaining and maintaining a competitive edge⁴⁶. Studies have discussed cloud BI&A or Software as a Service business intelligence (SaaS BI) in SMEs by proposing frameworks such as conceptual framework for cloud-based open platform analytics⁴⁷, theoretical framework for cloud BI&A⁴⁸, and framework for consolidated cloud BI&A⁴⁹. Similarly, a study by Liyang et al⁵⁰ proposed a unified five-layered framework which includes: infrastructure, data service, business service, user interface service, and operational service layer. Other authors presented an application architecture for BI&A⁵¹ and proposed a model for cloud BI&A to address the problems associated with traditional BI&A^{46, 52, 53}. Ouf et al⁵⁴ did a follow up study by implementing a BI&A SaaS system. Moreover, Hassanien and Elragal⁵⁵ proposed a novel approach by using tokenization as a security mechanism to address the security issues in cloud BI&A. Their results showed that tokenization can largely replace the traditional encryption techniques toward securing BI&A data in the cloud. Other BI&A cloud-related issues have also been discussed in the literature. Agostino et al⁵⁶ identified the key success factors of cloud-based BI&A. Similarly, Emam⁴⁰ presented the most important critical success factors (CSFs) and proposed a CSF model for implementing BI&A over cloud. A study by Kazeli⁵⁷ presented the concepts of cloud BI&A and addressed the corresponding benefits, problems, and challenges. Deepak et al⁵⁸ proposed a pre-packaged configurable workflow for BI&A as a means of endearing cloud-based analytics to SMEs in developing regions. Further, Rozehnal and Tvrdivkova⁵⁹ studied the applicability of the BI&A SaaS model in the Czech SME segment.

4.5. BI&A application

BI&A has permeated various industries, such as retail, insurance, banking, finance and securities, telecommunications, and manufacturing⁶⁰. However, few studies have been conducted on how BI&A can be applied in different industries. Through a survey analysis, Tyrychtr et al⁶¹ examined the relation between 135 agricultural enterprise structures and the use of BI&A in the Czech Republic. They found that only few respondents use any type of the BI&A application although the research results showed a high probability for the potential use of BI&A among the respondents. The authors also evaluated how BI&A could be applied to assist agricultural enterprises to strengthen their production potential and technical efficiency.

4.6. BI&A adoption

In order to better understand BI&A adoption, some studies presented frameworks, maturity level, models, and adoption theories. While, other studies identified factors and determinants that affect BI&A adoption in SMEs. Boonsiritomachai et al⁶² proposed a research framework to identify the current state of BI&A adoption in Thailand,

including the enabling factors that impact the adoption of BI&A in SMEs. The same authors continued the study by proposing different maturity levels for BI&A and identified factors that influenced BI&A adoption in Thai SMEs¹⁵. A study by Gibson and Arnott³⁸ presented a model and a table of BI&A adoption factors that affect small businesses. Puklavec et al⁶³ identified the determinants of BI&A adoption to serve as a guide through the development and testing of BI&A adoption frameworks. Similarly, Chichti et al⁶⁴ identified determinants of BI&A adoption within the framework of the relation between SMEs and Tunisian public organizations. Hatta et al⁶⁵ proposed a BI&A system adoption model for Malaysian SMEs and identified two prominent adoption models used by SMEs: diffusion of innovation (DOI) theory and technology, organization, and environment (TOE) framework.

Few BI&A adoption-related issues were discussed in the literature. A qualitative study conducted by Hill and Scott⁶⁶ with 11 small businesses based in Northern Ireland proposed a set of recommendations for successful BI&A adoption. While, Scholz et al¹⁶ carried out an exploratory analysis to examine BI&A adoption in German SMEs to distinguish underlying constructs related to the perception of the BI&A benefits, challenges, and organizational factors. Through an empirical survey with 20 French companies, Sadok and Lesca⁶⁷ identified seven necessary acceptance conditions (NACs) of a BI&A model. The authors proposed to use the model to help set up an environmental intelligence system for SMEs.

4.7. BI&A implementation

Several papers discussed BI&A implementation from different angles, including presenting CSFs, frameworks, development cycle, and models. Olszak and Ziembra³⁶ conducted in-depth interviews with 20 SMEs from Upper Silesia and discovered three perspectives of CSFs in BI&A implementation: organization, process, and technology. Guarda et al⁶⁸ proposed a framework that demonstrates the applicability of BI&A as a driving force for SMEs. Likewise, Sohail et al⁶⁹ proposed a framework that provides automated data mapping, validation, and data loading from user application to offer convenience of use and effective cost saving. Raymond⁷⁰ proposed a conceptual and operational framework that focuses on the competitiveness of SMEs. While, Haque and Lutzer⁷¹ presented a BI&A development cycle and performed a real-world functional application to demonstrate its concepts. Further, Sadok and Lesca⁶⁷ proposed a BI&A model based on the mobilization of corporate tacit knowledge and informal information.

Several authors implemented BI&A systems that were discussed in the literature. Bajo et al⁷² implemented a multi-agent system for innovative web BI&A tools. Iqbal et al⁷³ developed a prototype using an expert system method that suited Indonesian SMEs' characteristics. Moreover, Campos et al⁷⁴ presented the design and programming details of the BI&A system named Eagle. While, Baransel and Baransel⁷⁵ proposed the bilişimBI and reported its outstanding features. A recent study by Devi and Priya⁷⁶ developed a BI&A solution using open source technologies for Sriram Industries and Sriram Wire Products. Arrieta et al⁷⁷ implemented an advanced BI&A system methodology specifically tailored for SMEs in the machine-tool sector. Similarly, Khan et al³⁹ proposed a web support system for BI&A and demonstrated the convenience of its use and effective cost savings.

Other implementation-related issues were discussed in the literature. Horakova and Skalska⁷⁸ presented how BI&A can be built in a small company. While Bergeron⁷⁹ went further and conducted a study on BI&A implementation in SMEs and large enterprises, as well as the cultural sector and argued that BI&A requires a holistic approach. Raj et al⁴ examined the challenges in BI&A implementation within an SME in the United Kingdom and discussed how these challenges can be overcome. Further, Gil and Sousa⁸⁰ developed a method for a successful BI&A implementation using performance indicators based on business activities.

4.8. BI&A benefits

Several studies can be found in the literature regarding the multiple benefits of business intelligence, for example, faster and easier access to information⁸¹, savings in IT infrastructure cost⁸², and greater customer satisfaction⁸³. However, only three studies have discussed BI&A benefits for SMEs in the literature. First, a study by Hočevár and Jaklič⁸⁴ assessed the potential benefits of BI&A in an SME called Melamin. They argued that the first and most common purpose of benefits evaluation is to demonstrate that BI&A is worth the investment. Second, Lueg and Lu⁸⁵ illustrated how standard BI&A solutions can help SMEs to increase their efficiency in budgeting within short time frames. They performed a case study in a Danish SME to demonstrate the most pressing problems in budgeting

efficiency and proposed a model for future research. Lastly, Scholz¹⁶ presented important BI&A benefits for SMEs.

5. Discussion and Future Research Avenues

This study presented an overview of publications on BI&A in SMEs through a systematic literature review of studies published between 2000 and 2016. 62 articles met the inclusion criteria, however, 26 articles did not clearly define which research methods were applied. This is an indication of an immature research field, and calls for more empirical research on BI&A. The subsequent discussion presents research gaps and future research avenues.

The various BI&A components presented can form different BI&A technologies and tools. Before developing a BI&A system, having a detailed understanding of these various components can lead to a solid architecture design for a successful implementation. According to Schuetz et al²⁷, many SMEs refrain from adopting BI&A technology, but reference models allow these SMEs to overcome the obstacles associated with the introduction of BI&A solutions. Therefore, further research should address the development of additional reference models for BI&A components.

The mature set of BI&A open source solutions presented in this study offers most areas of BI&A functionality. Therefore, it has become a solid option for any organization, especially SMEs, to achieve and surpass their BI&A needs. Studies on what opportunities that open source BI&A can offer to SMEs would be a useful avenue for future research.

Mobile phones have become an integral part of enterprises, especially SMEs, due to their communication and computing capabilities. The ability to access services ubiquitously on the move is truly remarkable. However, there are important aspects that need further attention, such as, deployment methods, information display and interaction, information exploration, context awareness, offline mode exploration, rich application functionality, and multiple device support. Moreover, an explicit focus on leveraging mobile security capabilities, delivering secure authentication, Virtual Private Network (VPN) and Hypertext Transfer Protocol Secure (HTTPS) support, and application sandboxing for BI&A developers is vital. Therefore, more studies in this area could help avoid user frustration and promote BI&A adoption.

In addition to open source solutions, cloud BI&A was also considered a low-cost licensed alternative solution for SMEs. Although factors, frameworks, and models have been presented to address successful implementation of cloud BI&A in the literature, no empirical studies have shown its benefits. The cloud is a good option; however, SMEs' reluctance to enter the cloud due to issues of security and control, particularly ownership, is still an obstacle. Thus, future studies should focus on these issues.

BI&A when done right can deliver knowledge, efficiency, better and timelier decisions, and profit to almost any organization. In the area of BI&A application, the studies are often about traditional manufacturing SMEs employing BI&A. Studies on BI&A applications in other types of industries are also needed. Such studies may yield different research findings and help make BI&A more mainstream in SMEs.

Understanding what BI&A is, why one would apply it, and the corresponding benefits are significant in adopting BI&A across the enterprise. Although some studies examined BI&A adoption determinants and theories, not enough studies extend the knowledge regarding SMEs' readiness for BI&A adoption. Such knowledge can be valuable for owner managers or senior management to become more proactive in promoting BI&A. Additionally, more empirical studies on determinants and barriers in BI&A adoption would be valuable.

Several frameworks and models have emerged to provide guidance in terms of identifying factors that support successful BI&A implementation. However, there was no clear definition of success. In addition, how BI&A solutions are used has not been extensively studied relative to the benefits realized. Further, the need to deliver significant return on investment (ROI) has not yet been fully discussed, as well as how to minimize the total cost of ownership (TCO).

BI&A benefits are often greater than what appears at first sight. Similar to large organizations, SMEs' most-sought outcome for BI&A is to make better decisions, according to Howard Dresner⁸⁶. Surprisingly, only one study focused on BI&A benefits within SMEs. According to Gibson et al⁹, there has been limited academic research on benefits evaluation of BI&A. Therefore, further studies on assessing and evaluating benefits of BI&A is important.

More studies in this domain will increase understanding of the value of BI&A and how these systems are utilized to create intelligence. In addition, capturing the value of BI&A can open different perspectives as it requires SMEs to go beyond the technical implementation. BI&A technologies and applications in other industries are still at a nascent stage of development. To make BI&A more mainstream for SMEs, issues such as establishing standards and

governance, safeguarding security, guaranteeing privacy, usability, and flexibility, and continually improving the technologies need further attention. Moreover, the several challenges highlighted above must be addressed. Finally, it would be beneficial to present empirical success and failure reports to understand the disparate capabilities of BI&A available, to assist SMEs in circumventing common pitfalls during implementation periods, and to facilitate the selection of BI&A solutions.

6. Conclusion

This study provides a comprehensive literature review of BI&A in SMEs. Most studies focused on frameworks, architectures, models, critical success factors, determinants, and barriers that affect the implementation and adoption of BI&A. This provides promising evidence for the contribution to practitioners that can guide them in their future projects. For BI&A vendors, this can help to improve their BI&A solutions, for example, offering improved usability, integration into other systems, and ease of deployment.

For researchers, this study identified research topics, research gaps, and several important directions for future research in this field. More specifically, there is an opportunity for studies that explicitly focus on (a) the development of reference models, (b) benefit evaluation, assessment, and realization (c) the factors that influence adoption and implementation (e.g., TCO, ROI, and security issues), and (d) different uses of BI&A in various business fields and industries. Furthermore, cloud-based and mobile-based BI&A solutions are promising application areas for SMEs.

This study suffers from some limitations. Even though the paper has conducted a very thorough review of the literature, I note however, that I cannot guarantee to have captured all the materials in this area.

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