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Big Data Analytic Concepts in Libraries: A Systematic Literature Review

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Abstract

A library has a lot of primary and secondary data with a wealth of information content. The diversity and improvement of the content can be attributed to the data that is freely available online. These include customer data, service data (loan and return), research data, citation data and other data. Therefore, libraries need to analyze these data as it provides many benefits and added value to the continuity of their services. This systematic review examines the determinants to adopt big data analytic (BDA) in organizations including libraries. The review analyses international literature on determinants to adopt BDA between January 2010 to December 2019 from databases including *Emerald, ProQuest, Sage, Science Direct, Scopus, Springer, Web of Science (WOS) and Google Scholar*. It uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. Literary quality assessments were conducted on BDA concepts based on previous theories and articles. Twenty (20) papers from countries all over the world met the inclusion criteria. The review identified three-concept of BDA in library services; BDA readiness in libraries, model to measure BDA adoption and its implication in the library, and limitations of the existing model or concept of BDA for the library. Most studies reported those BDA concepts are new concepts; data science and libraries; fundamental building block of machine learning and the software instruction set for AI, hard characteristics of data, such as the big data V-characteristics; adoption readiness; and potential to exploit BDA. Future research should focus on a variety of rigorous large-scale methodological studies. Studies should use the quantitative approach to explore specific factors related to promoting BDA adoption. This review can help academics and practitioners understand the key factors for adopting BDA in a library so that BDA activities that enable a library to make practical and strategic preparation can be effectively implemented.

Keywords: Big Data, Big Data Analytics, Big Data and Libraries, Libraries and Analytics.

Introduction

The utilization of data as important resources can be overwhelming because of the huge amount of available data. Practically, every part in every sector (private and public) has had an interest in new revelation of BDA and its unknown potential in analyzing data from 2012

(Reinhalter & Wittmann, 2014). BDA is a recent large-scale project that has identified new uses for various fields and science (Khan et al., 2017; Darwish, 2016). In library and information services, BDA is affected by two constraints: first, the huge volume, choice, and the level in understanding the data concerned, the repository and the needed procedure of the system are somewhat overpowering, and the second, the analysis processes are complex, which see BDA as a daunting undertaking.

To accommodate the huge volume of data, and the required process for BDA system, cloud storage was observed as a capable storage infrastructure. The cloud system proposes a low-cost problem solving for storage spaces, preparing and managing the Big Data for analytical processes, empowering the utilization of dispersed and parallel standards so as to fulfill the maximum potential of BDA needs. This paper intends to identify the best models, concepts and factors that can emerge in the growth and impact of BDA and its outcome on libraries found in previous literature and research.

Background of the Study

Big Data Analytics in Libraries

Libraries are progressively keen on utilizing datasets to deal with their collections, and use of space, as well as to evaluate the offered services. Chen et al. (2015), supported by Olendorf and Wang (2017) argue that conventional library processes can create large measures of data, particularly for bigger libraries. Portions of the data can be divided into circulation transaction, user, online database usage and other library data activities.

Notwithstanding, utilizing datasets to improve and fully utilize library activities is a genuine value to be considered (Günther et al., 2017). Goldberg et al. (2014) noted before plunging into data use, it is necessary for the library to capture the fundamental extent of data issues. Libraries ought to comprehend what datasets that should be included for usage. Günther and associates (2017) also stated that libraries operation should know the real expanses for staffing and the infra development that is needed for using Big Data Analytics. The management team should carefully consider the large amount of data.

Al-Barashdi and Al-Karousi (2019) stated that BDA can be of two forms, an erratic undertaking, or an existing service in the libraries. They also said that the improvement of an either will by and large make the greatest difference, that is an established aid would need increasingly tough data storage, whereas a coincidental venture may use less concentrated data stores. One-off project activities are perfect to respond to solitary issues that should be addressed once.

Data Science Concepts and Libraries

IFLA (2018) stressed Data science operates across a continuum and can cover research involving profound mathematical and software engineering skills, concentrating on engagement, policy creation, preparation of knowledge management and decision-making based on facts. Academic statistics first used the term "data science" to position the discipline regarding the large-scale data, data processing and wider trends. The earliest discussions addressed the underpinnings of mathematics and the modern mathematical approaches that critical aspects have made possible (Cleveland, 2001; Dononho, 2015). As from academic

origins, technological advance and ability to generate business insights from data have led to industrial data science.

Numerous roles in information sciences were identified closer to the area of libraries, as outlined in two related limited scale studies (Lyon & Mattern, 2017; Lyon, Mattern, Acker & Langmead, 2015) characterized by real-world requirements for actual positioning. The six roles: "*the data archivist, curator, data librarian, data analyst, data generator and data reporter"*. (Note: it is important to remember that while all these roles are constructed as data science roles, other positioning from the corporate sector seemed to portray only data scientist-type roles as data scientists) Chen et al. (2015). Kamupunga & and Yang Chunting (2019) also described data librarians learn about datasets, comprehend tools and techniques, and speak several languages to carry out the tasks closely with researchers. Data-based services can convince experts that the library persists a precious asset in technological realm (Xu, Du, Wang and Liu. (2017).

Therefore, big data prevails very much in terms of visible range, dependent on the amount and goal of an institution, and extends the work requiring the profound quantitative and applications engineering ability to develop on the promotion, policy, communication and management of data. "Data knowledge" is an integral part of most of these functions.

Big Data Analytics Readiness

With the development of data in the libraries growing, new methods are used and approached (Anirban, 2014). All industries appear to accept that big data is increasingly fruitful, progressively profitable, and have different effects across numerous sectors (Kaisler et al., 2013). However, the hidden concern is an absence of instruments and skilled staff to appropriately work with BDA. Nonetheless, Kalema and Mokgadi (2018) stated that it is significant for libraries to develop a BDA Analytics strategies.

According to Mokgadi Motau and Kalema (2016), it is difficult to physically indicate data quality guidelines because of the various sources from which for the sheer volume of data and the evolving nature of the ways data are collected and incorporated. Hence, technology barriers constitute a real problem for decision-makers. The top management should better understand the nature of their data and technologies for BDA so that the data can be processed and analyzed more effectively and efficiently and can help strategic planning and decision-making.

Planning Phase

The planning phase involves identifying the focus of the research topic; identify the review process and developing the research questions. The research objective (RO) is "What are the key components of BDA concept and readiness?" The RO is to focus on BDA concept readiness and the current issues in the context of the library

Methodology Adopted

This paper is a systematic evaluation of literature on BDA concepts that follows the SLR Guideline from "Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA)", available at www.prisma-statement.org. The literature review combines four

phases which are identification, screening, eligibility and inclusion (Moher et al., 2009). The diagram of the PRISMA method that is used in this study is showed in Figure 1.

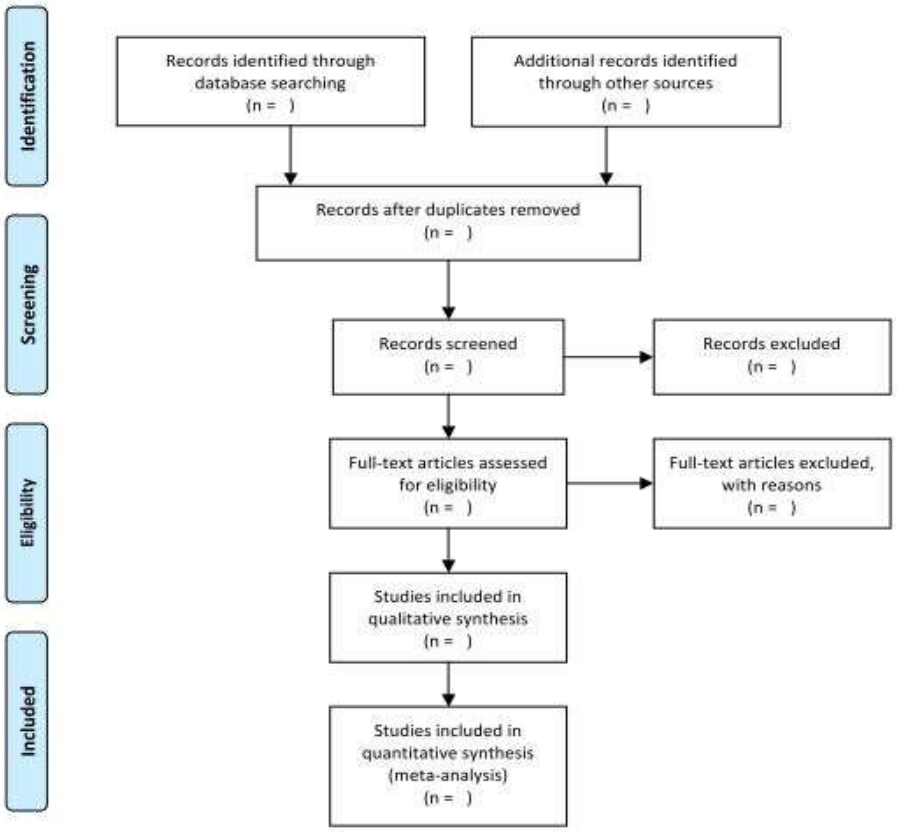

Figure 1: The PRISMA 2009 Method for SLR

Research Questions

For the identification stage, the research questions were developed using PICOS (Population, Intervention, Comparison, Outcomes, and Study Design) which was suggested in the PRISMA model. The topic areas for designing the research questions are shown in Table 1.

Table 1:
I*dentified Topics In Developing The Research Question*

Criteria	Scope
Population	BDA concepts in libraries
Intervention	Data growth progress and readiness of BDA in the library
Comparison	Data analysis models in libraries
Outcomes	BDA concepts readiness and factors that contribute to BDA usage
Study Design	Review and analyses of on previous models on BDA readiness

Four research questions (RQ) was developed based on the listed criteria in Table 1:

RQ 1 How many research focuses on BDA concepts in libraries?
RQ 2 What are the models or concepts that been created or used to measure BDA readiness in libraries.
RQ 3 What are the contributions of the models or concepts for BDA readiness in libraries?
RQ 4 What are the limitations of the existing BDA readiness models?

Planning Phase

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Search Strategy

The search strategy incorporates details of search terms, online searches of materials, scope and limitations as well as the quality of the assessment in each article.

Search Term

Search term refers to a word or phrase that is entered to search for the required information. In this study, the search term includes synonymous text/word strings using Boolean Search OR, as shown in Table 2, and search string structure using the Boolean Operator AND as shown in Table 2.

Table 2:
Integrate text string synonyms with the Boolean Operator OR

Criteria	Integration of synonyms
Population	BDA concept OR analytic process for Big Data OR data analytics
Intervention	Big Data development methodology OR readiness model OR data scientist
Methods	Model OR diagram OR framework OR process

Table 3:
Search String Structure With Word Strings Incorporated By The Boolean Operator And

(BDAOR analytic process for big data OR data analytics) AND (development methodology OR readiness model OR data scientist) AND (model OR diagram OR framework OR process)

Literature Review

The review exercise depended on eight electronic databases for academic search, for example, Emerald, Proquest, Sage, Science Direct, Scopus, Springer, Web of Science (WOS) and Google Scholar to look for the information of each article based on the title and abstract. A few papers were cited to follow the snowballing search technique of academic online databases. The applicable papers were then saved in the reference manager software for the

selection stage. The publication dates of the referred literature are between January 2009 to December 2019.

Inclusion and Exclusion Criteria

To exclude papers not applicable for analysis, inclusion and exclusion criteria were used. Table 4 defines and introduces the criteria for inclusion and exclusion of the papers.

Table 4:
Determination of inclusion and exclusion criteria by Xiao & Watson (2019)

	Inclusion		Exclusion
1	The publication of all documents is in English	1	Papers not published in English
2	The publication of all documents takes place from January 2009 to December 2018.	2	Papers published before January 2009 OR out of the period range
3	Papers that focus on BDAreadiness or end-user Big Data development in libraries	3	Papers with less than 3
		4	Papers outside the field of research
		5	Duplicate fields of study

Reporting Phase

The search results were explained in this section during the reporting phase.

Study Quality Assessment

The evaluation process was intended for evaluation and culmination of papers. Table 5 lists questions that are used to determine the quality of the information and extract the favorable data. Only 3 alternative answers are provided to every question: Yes=1, partially=0.5; and No=0.

Table 5:
The Quality Assessment Criteria

Quality ID	Quality Assessment Questions	Answer
Q1	Do the aims of the study have been clearly described?	Yes
Q2	Is the study based on the results of previous studies?	Yes
Q3	Is the paper merely an expert opinion 'lesson learned from previous studies'?	Yes/No
Q4	Does the paper detail the structure of the model?	Yes/Partially/No

Findings of the Review

The selection process was divided into 3 phases in the systemic review phase, as shown in Figure 1. Firstly, the search process is used and the process of selection is based on the title of the article. Based on the relevance of the subject, a total of 355 articles were listed. The abstract and contents of the selected papers were discussed in the subsequent steps.

Redundant and unrelated articles were dismissed and around 58 articles were listed after the filtering process, which selects articles that are related to the topic. Finally, for data synthesis of evidence following the executions of exclusion criteria and screening abstracts, content and complete text, only 12 documents (48 percent of 25 papers) were accepted. The results of the search and selection phases can be found in Figure 2. The summary for the paper using the quality assessment for 12 listed papers (Study 1 – Study 12) is showed in Table 6.

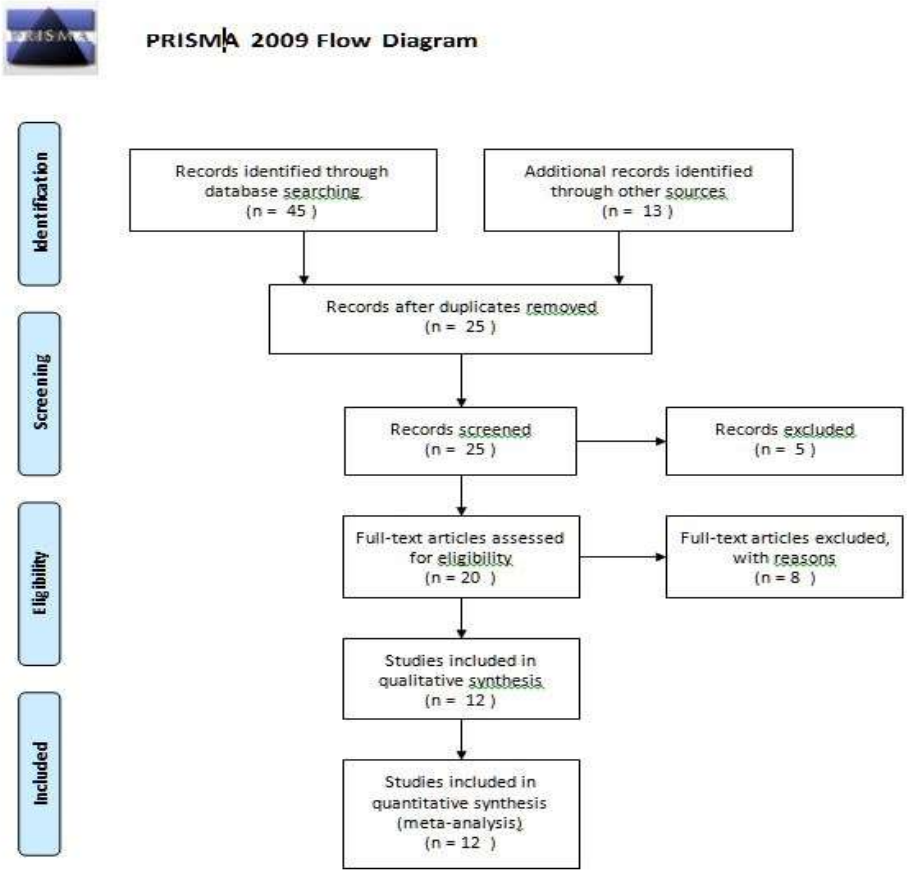

Figure 2: Paper Reviewed Result

Table 6:

Quality Assessment Result

ID	RQ1	RQ2	RQ3	RQ4	TOTAL
Study 1	1	1	1	1	4
Study 2	1	1	1	0.5	3.5
Study 3	1	0.5	1	0.5	3
Study 4	1	1	1	1	4
Study 5	0.5	1	1	0.5	3
Study 6	1	1	1	1	4
Study 7	1	1	1	1	4
Study 8	1	1	1	1	4
Study 9	1	1	1	1	4
Study 10	1	1	1	1	4
Study 11	1	1	1	1	4
Study 12	1	1	1	1	4

Table 7 shows the quality assessment of all articles that were delegated good and very good scores. Two of the articles are scored as good (16%) and the remaining ten are deemed as very good quality articles (84%).

Table 7:
Article Scored Based on Quality Assessment

Quality Scale	Very Poor (<1)	Poor (1 – 2)	Good (2 – <3)	Very Good (3 – 4)	Total
Number of Articles	0	0	2	10	12
Percentage (%)	0	0	16	84	100

This SLR activity analyzed twelve articles on the BDA concepts readiness in various subject domains and can be divided into four categories that are empirical study, case study, concept paper and content review. Only 1 publication was an empirical study and two concept papers were published between 2012 and 2014. This is followed by one case study in 2015. In 2016 the publication of empirical studies was quite impressive with four publications related to BDA readiness. The research paper has grown and evolved in publication with one content review, two empirical studies and one case study between 2017 and May 2019 publications.

Discussion of Findings

In this section, the discussion will expand the details reported in Section 3.

- How many studies are focused on for BDA concepts in libraries? (RQ1)
  This systematic literature review process managed to review twelve (12) papers from a total of 58. All twelve papers are from the academic online databases and the articles were published between 2009 and December 2019 to maintain the validity and reliability of the study. Figure 3 shows the number of the reviewed papers based on the year of publication.

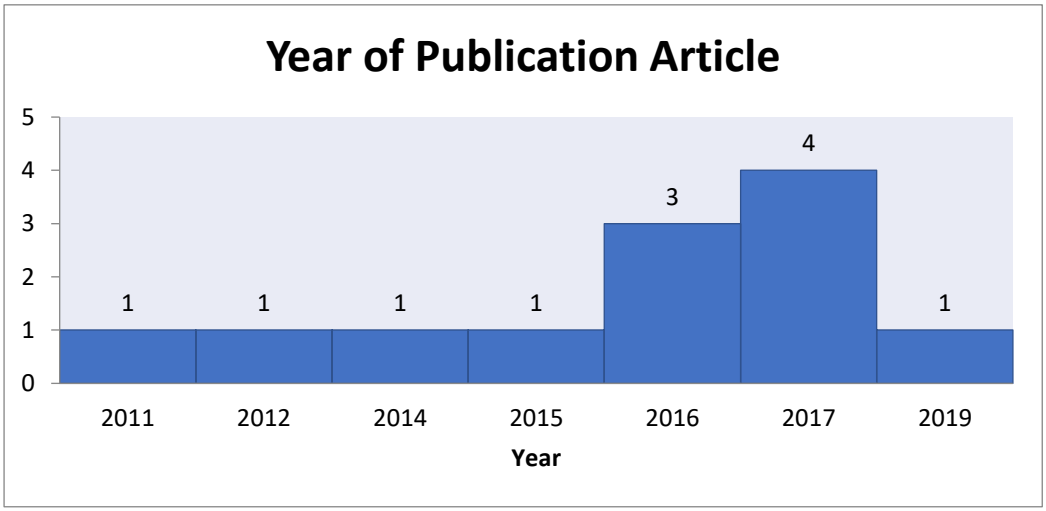

Figure 3: Total of reviewed papers based on the year of publication

- What are the models or concepts that been created or used to measure BDA readiness in libraries? (RQ2)
  This research intends to identify the models or concepts that have been used to measure the BDA readiness in organizations. Based on the twelve reviewed papers, this review has managed to identify four (4) types of models that used as a 'maturity model' for measuring BDA organizational readiness that library and information authorities should follow. Figure 6 to Figure 9 show the models that have been considered by most of the articles.

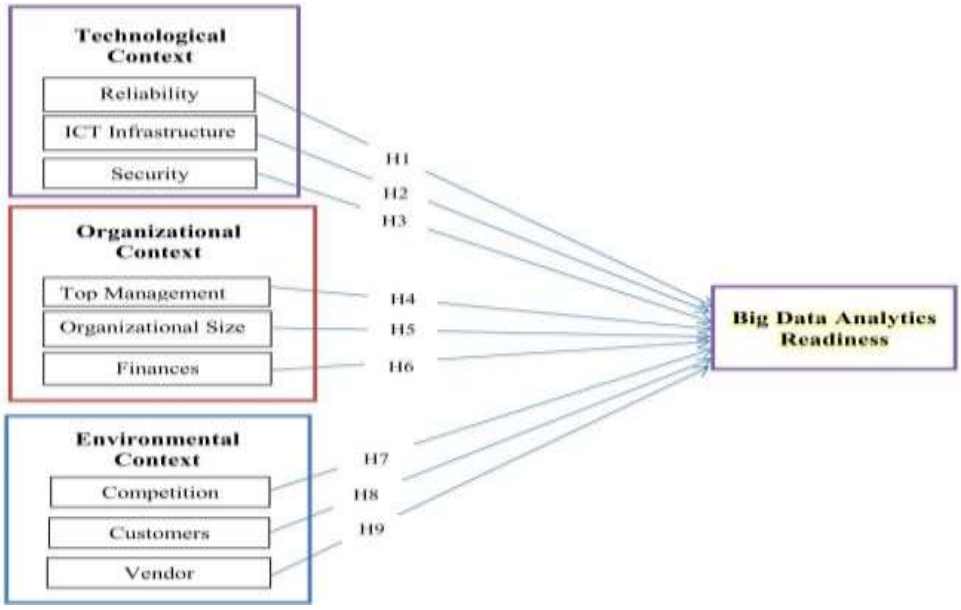

Figure 6: The Theoretical Framework for BDA Readiness by Mokgadi Motau & Kalema (2016)

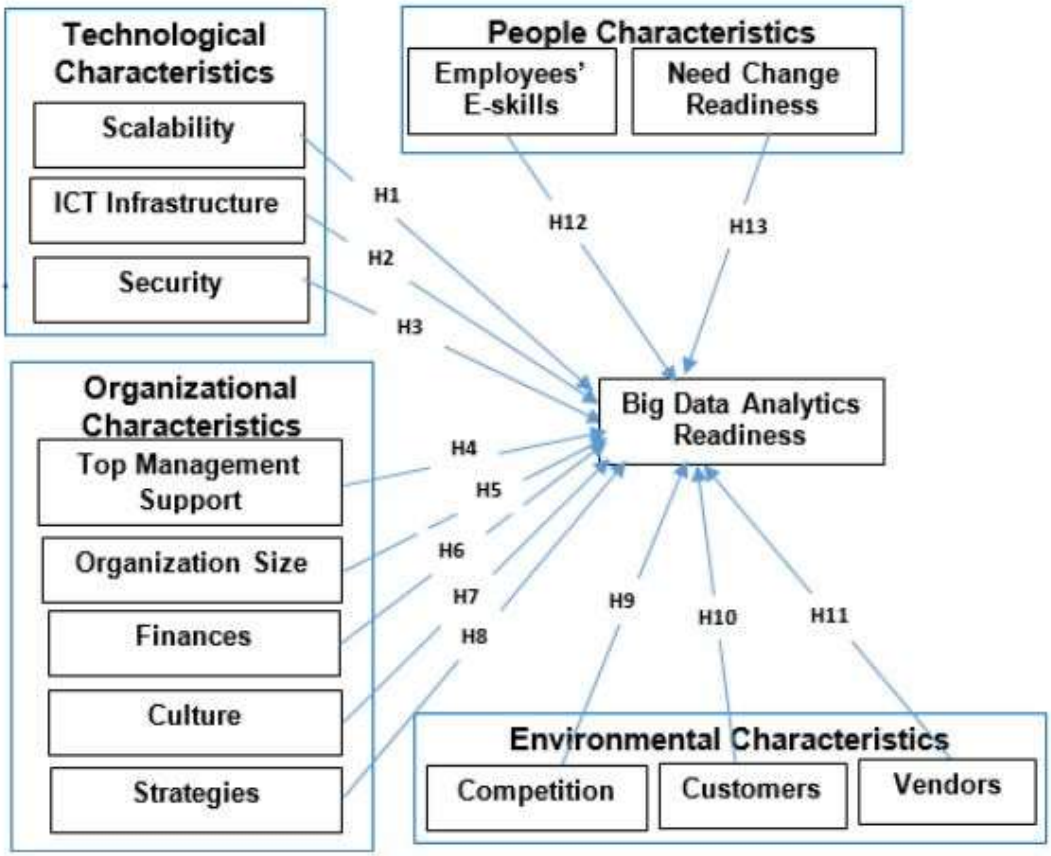

Figure 7: The Theoretical Framework for BDA Readiness by Kalema & Mokgadi (2018)

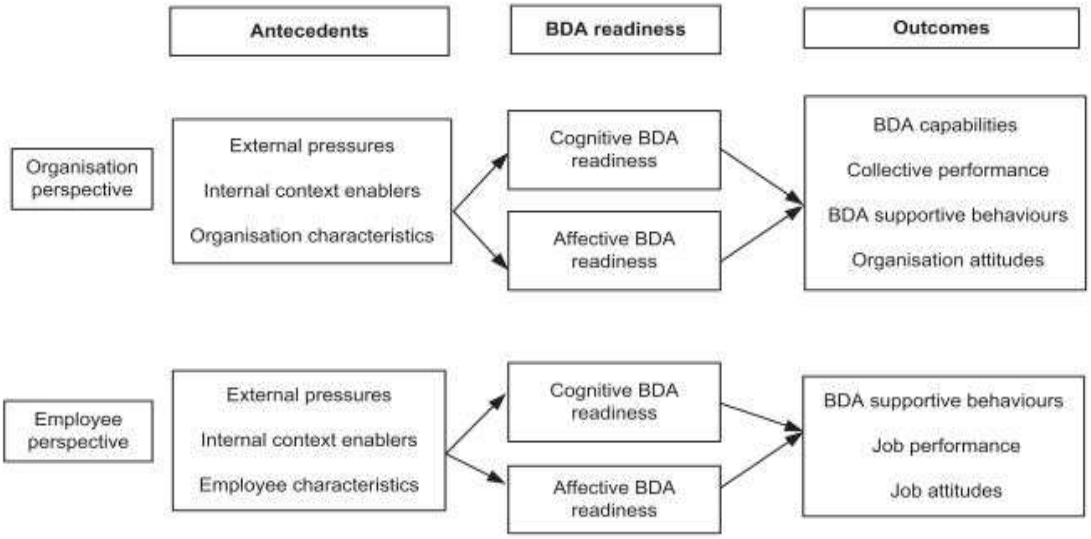

Figure 8: Big Data Readiness Framework by Ali et al. (2016)

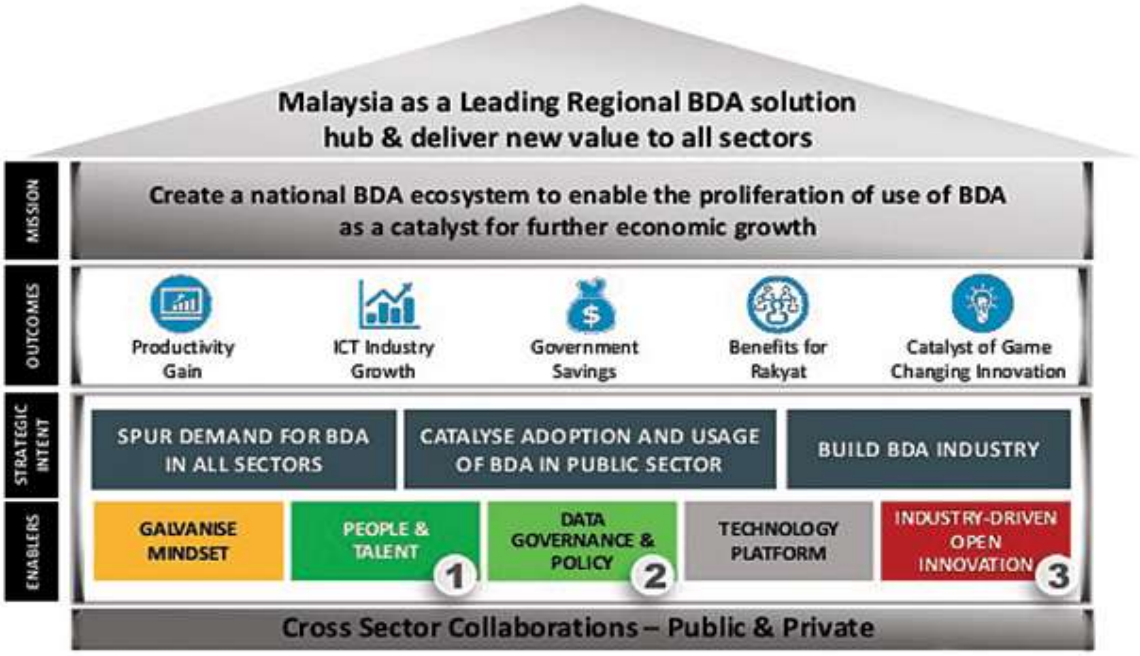

Figure 9: Malaysia's National BDA Initiative Framework by MDEC (2016)

- What are the contributions of the models or concepts for BDA readiness in libraries? (RQ3)
  Based on the four models and concepts of BDA, the contributing factors for BDA readiness in the models exemplified in Figure 6 and Figure 7 have been identified as the most compatible with the current Big Data development activities in the organizations by nine of the twelve reviewed papers. The contributing components are classified into three main factors, which are:

i. Technological Context: all library management system (LMS) now have the ability create and analyze the data for example KOHA Library Management System can analyze all library activity using certain tools and manipulation in the system itself which includes reliability, ICT infrastructure, security, scalability
ii. Organizational Context: even now the management of library was change their overview where every outcome, output and decision must rely on data (generate from the LMS) and even for budgeting also based last year library daily data to defend and get the allocate budget including top management support, organization size, finances, culture, strategies
iii. Environmental Context: each of new task or services in library need a high participant from the employee to learn and know to manage and handle the required system which includes employee skills, and all the staff ready to faces the changed of the working environment changes readiness
iv. People Characteristics: library staff skills and their readiness.

- What are the limitations of the existing models or concepts of BDA for libraries? (RQ4) During the review activity, it was found that the selected assessment models have a few limitations, for example, top management and staff's lack of understanding and knowledge on BDA he in managing the existing data. This can affect the importance of BDA in influencing library services and performance. Furthermore, lack of skills in data analysis and difficulty to change the work culture also affect successful BDA implementations. Moreover, the greater part of the current assessment models are lack of budget for ICT infrastructure development and arrangement for staff training in data analysis.

Table 8.
Big Data Concepts Found From The Literature

No.	Study number	Findings
1	Study 1 Heidron (2011)	i. Reuse of data helps society ii. The data set may be referenced and add value to the credibility of the creator as good or bad. ii. Both libraries are responsible for collecting, maintaining and disclosing social intellectual results, including that information, from librarians with evil backgrounds. v. The library has the expertise and most infrastructures necessary to carry out the task for many data types.
2	Study 2 Gordon-Murnane (2012)	i. The study findings reveal that the skills and skills required for the execution of BDA by libraries have been strongly linked. ii. The correlation was highly significant in all study variables with the exception of two variables, including "big-data concepts" and "different data forms". ii. The analysis also reveals the concept of BDA is well known by many researchers. v. They used a large amount of data, including acquisition, conservation, data curations and analyses, to perform different library operations.

3	Study 3 Reinhalter and Wittmann (2014)	i. The article discusses the development and potential of large-scale data, depicts reforms that stimulate data input and analyze the impact on libraries. ii. With the evolution in libraries, librarians can be experts and authorities in the data age.
4	Study 4 Al-Barashdi H and Al-Karousi R (2018)	i. Big data technology makes handling of huge datasets easier, linking exclusive datasets, real-time identifying trends, predicting results, and advanced risk assessment, as well as testing hypotheses. ii. Both libraries and librarians are totally happy with the large statistics because libraries are record managers and adherents for many years, with no exception to large amounts of data. iii. This is large data technology and the statistics in libraries are huge and complex, the idea is like searching for the "nail in a haystack". iv. Librarians need to know and utilize this knowledge to help their customers choose the correct tool, with the potentials and challenges that are inherent in broad information. v. In the field of big data analytics, academic librarians also play a clear role in helping researchers and other users improve education services and quality.
5	Study 5 Zhan and Widén (2017)	i. This paper aims at defining large data insofar as librarians are capable of handling large data simultaneously. ii. Big data are generally understood in the particular sprint and are not defined in the target area. In both cases, the study was motivated to define large data for libraries iii. The systematic review results demonstrate that the summarized areas of the definitions obtained coincide with the current state of the data library and of the data science research. iv. Each definition has similarities studied. In this process, only more than 50 percent of equations are taken into consideration-to focus on closely linked definitions. When considering digital trends in libraries, big results can be defined as information generated with adequate technology.
6	Study 6 Jharotia (2016)	i. In special, academic and public libraries, data resources are rising. ii. In cataloging, archive, research and reference areas librarians remain particularly suited to the provision of large data services. iii. Large data and library resources to describe key issues and highlight the potential and problems of managing multiple datasets. Librarians may use this information for the development or improvement of data services in their libraries.

7	Study 7 Federer (2016)	i. Researchers in the 21st century frequently use large amounts of digital information, and sometimes they use data that they do not collect but obtain for reuse from public sources. ii. In many fields, researchers need to adhere to new lenders' policies, which allow them to share users' details or to write data management plans, which in the past were not necessary to most researchers. iii. In the light of this rapidly expanding research environment, researchers can help meet their emerging needs. iv. Researchers who need advice on various areas such as data work can support librarians or IPs v. Taking account of how work developed in the Big Data era, and how librarians and others can meet the needs of new researchers. vi. Free available resources can be useful in many life-cycle stages and beneficial to researchers, but can also be useful for librarians with less research experience and who want to develop those skills. These can be useful for scientists.
8	Study 8 Kamupunga[1] and Yang Chunting (2019)	i. Understanding the great value of big data in university libraries is essential in order to take corrective measures to improve the current recommendation system and improve efficiency. ii. The study shows that big data applications are more productive and efficient in libraries to create new knowledge and libraries that use big data analytics. iii. Big data tools and analysis tools require special knowledge and enhance performance in this competitive world.
9	Study 9 Anna, Nove E. Variant and Endang Fitriyah Mannan (2020)	i. Big data are already being implemented in libraries, as is demonstrated by the limited amount of practical BDA library execution. ii. Not many libraries use large data as they lack librarian skills for large data analytics to support innovation and services. iii. In particular, for academic libraries, the use of BDAfor library services is suggested.
10	Study 10 Xu, Du, Wang and Liu. (2017)	i. The data must be analyzed, transformed and presented in order to facilitate the creation of knowledge libraries. ii. User interactions and stored information were considered by the librarians to improve the quality of the library service. iii. The library data stored in libraries directly and on social interaction with library services can be converted into data available that researchers use to better serve their users.
11	Study 11 Xiaodan and Wei (2017)	i. The great future of big database library services. ii. In "building a digital library," the big data match perfectly iii. Big data collections facilitate data collection, review, usage and support in the library iv. The challenge and opportunities Big Data offers libraries to academic groups and libraries

		v. As a library develops innovative resources services, libraries need to maintain monitoring resources so that the resource is genuinely available.
12	Study 12 Chen et al. (2015)	i. The potential applications include enhancing library services or creating totally new services, implementing new library data formats, providing library data analysis data to scientists, data standardization, data modeling, library visualization, and user behavior. ii. Libraries must not only limit themselves to their own information, they can also process and analyze external sources of information. iii. Numerous third-party data sources are available that allow users to extract interesting services. iv. Currently there still are restrictive factors: lack of skilled personnel, periodic poor infrastructure, technical difficulties (such as data formats and instruments).

Conclusion

This article shows that BDA 's concept and deployment are increasing every day. The Big Data landscape has made a significant chance to compete in the organizations. The role of librarians is indeed shifting in this situation and they are actively working as a data analyst, data curator and digital services managers. In this context, librarians are embroiled to gain, curate, interoperate, organize data, provide metadata, preserve data, analyze, and visualize information. As conventional library activities, librarians must to adopt BDA methods in libraries in line with policies and ethics. The data protection and data collection are now pivotal. The skills of managing big data differ significantly from library types. The format, value, volume and organizational culture also hinge on it. The skills and abilities contribute to the sensible realization of big data analytics in libraries.

Libraries should have a reason to be curious about BDA concept, time, effects and planning. The response to this significant venture is essential as the Big Data concept can possibly change a whole library services activity, which is conceptualized in this paper. Because of its excessively compelling and vital capacity, particularly in creating organization cost, Big Data has of late risen as the point of convergence for librarians (Wamba et al., 2015).

Big Data tools makes it simpler for researchers and librarian to manage huge datasets, connect selective datasets, discover user patterns progressively, anticipate results, and receive dynamic hazard scoring, and test theories. Librarians can work with large datasets because libraries and data usage have a long history in being record controllers (new and historical value), with huge data being no exemption. The development of BDA technology and the measurements created in libraries is huge and complex; thusly, drawing new and energizing bits of knowledge from beforehand unmanageable datasets. As a result, librarians should be acquainted with the potential outcomes and difficulties inherent in BDA and utilize that learning to enable their users to choose the correct application.

In addition, librarians have an unmistakable part in BDA to support researchers and various clients improve service performance and quality. Thus, libraries have an essential role of combining government, universities, associations, and the all-inclusive community, since they supervise intellectual assets. However, librarians should learn how data sets should change, and examine them for the purpose of creating new data. Furthermore, they ought to

find measures to make BDA increasingly accommodating, unmistakably conspicuous, and effectively accessible. For example, with the fantastic and new evaluation of BDA data sets, experts and users can examine data in new ways to produce the ideal data. Along these lines, this paper explained the traits of BDA in libraries, directed a review into the managing of BDA in libraries, as laid out by Johnson (2017).

In future studies, the latest Big Data collection systems or technologies should be investigated. The potential areas to be explored may include determining how libraries can benefit from digital content and media material analyses to enhance their information services, and how large data in libraries systematically affect economic value.

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