Big Data Analytics and Performance Measurement in Public Sector Organizations

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Abstract
Performance measurement (PM) in public sector organizations plays an important role in measuring progress toward achieving organizational goals, improving performance, and transforming the organization to be more efficient and effective in delivering public services. Over the last two decades many public sector organizations have introduced legislations and frameworks to improve the management of performance. However, public sector organizations are not relying on a universal performance measurement system (PMS) and one recipe to measure performance additionally the increase of performance measurement systems complexity led to an increase in the amount of data to be acquired, processed, and analyzed. Over the last few years, a growing interest in employing big data analytics (BDA) use cases emerged in different public sector domains pursuing the opportunities and potentials of big data analytics to handle the increased amount of structured and unstructured data to support decision-making. A Systematics Literature Review (SLR) is carried out with a combination of text mining techniques and Machine Learning algorithm to automate publication classification was introduced to reduce the burden of study selection process and identifying the most relevant publications to the context of this research.

Keywords
Public Sector, Performance Measurement, Big Data Analytics, Use Cases, Systematic Literature Review

1. Introduction

A Systematic Literature Review (SLR) is a well known research method which researchers and practitioners are using it to keep up with state-of-the-art and to be at the forefront of research as well as when many studies have been published and there are uncertainties about the results. Systematic literature reviews (SLRs) are becoming more demanding given the ever-growing number of publications and the increasing breadth of research questions (Popoff et al. 2020). SLR collects relevant evidence on the given topic that fits the pre-determined eligibility criteria and to have an answer for the formulated research questions. The systematic review should follow a clearly defined protocol or procedure where the criteria is clearly stated before the review is conducted. Systematic reviews often, but not always, use statistical techniques (meta-analysis) to combine results of eligible studies. Meta-Analysis is used to weigh and compare and to identify patterns, disagreements, or relationships that appear in the context of multiple studies that have been selected based on the predefined SLR procedure and the results are obtained by implementing statistical methods.

Today we can capture so much information electronically, we call many things ‘data’ that would not have been called ‘data’ in earlier times – things like names, addresses, birthdates, what one ate for dinner on Saturday, the most recent

book one purchased. Such facts about individual people can be aggregated, analyzed, and used to make a profit, improve health, or influence public policy (Earley et al. 2017). Big Data (BD) is an emerging phenomenon in the recent past years it can be described as vast datasets in terms of size and complexity with numerous data points (more responses or rows) and with higher complexity (more attributes or columns). Big data is a general term referring to the massive amounts of data collected from many sources, including the web and the cloud (Gamage 2016). he also found a leading information technology and research company defined big data as the high volume, high-velocity and or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision-making, and process automation. Most researchers defined big data as a term that describes large volumes of high velocity, complex and variable data that require advanced techniques and technologies to enable the capture, storage, distribution, management, and analysis of the information (Ganesh et al. 2019). For years, the most common and traditional form of data analysis has been grounded in linear and descriptive analytics mostly driven by the need for reporting key performance measures, hypothesis testing, correlation analysis, forecasting and simple statistics. More than 90% of the data available nowadays, has been generated in the last two years with about 2.5 quintillion bytes of data being added up on the existing data everyday (Mohd et al.2016).

Another aspect is how organizations are analyzing and interpreting the huge volumes of structured raw data to unlock their potential data driven benefits. Big Data Analytics (BDA) is increasingly becoming a trending practice, which many organizations are adopting with the purpose of gaining competitive advantages. A lot of research has been conducted in exploring the different kinds of data analytical methods in a wide range of domains and their ability in resolving different kinds of problems. They have also identified and classified analytics methods into three groups, which are descriptive analytics, predictive analytics, and prescriptive analytics. Descriptive analytics answers the questions for the events, which took place in the past "What has happened?", "Why did it happen?", while predictive analytics answers the questions for the future events "What will happen?" and "Why will it happen?" Conversely, prescriptive analytics aims to find the best course of action and answer the questions "What to do?" and "How to do it?" Both descriptive and predictive analytics assist organizations to point out insights from their own data. However, having the insight on what has happened in the past and what will happen in the future is not enough to take advantage of BDA capabilities.

1.1Objectives

This work aims to present the state-of-the-art review that presents a holistic view of the different public sector domains big data analytics use cases in the field of performance measurement by conducting a systematic literature review with support of Machine Learning publication classification model to enhance the efficiency of SLR screening. the results of the SLR should highlight the critical BDA use cases that support public sector organizations to measure & improve performance along with identifying the impact of deploying big data analytical use casus and its potentials in managing and measuring public sector organizations performance.

2. Literature Review

As a new hype in the digital transformation world, Big Data has been highly expanding in many industries. Both the public sector and the private sectors, play an important role to invest in Big Data projects to ensure the benefits for organizations and society, improving the services, and increasing the effectiveness and efficiency (Al-Sai and Abdullah 2019). They also found that public sector organizations should search for their customers' needs and desires. By moving their data collection and analysis from just a product or service orientation to a future-oriented platform and to be able to identify the critical data sources, structure, required skills, and architecture, define the underlying process infrastructure that supports Big Data analysis, define a Big Data strategy, and measure the technologies and applications that support the organization's needs to survive the new digital market. Sivarajah et al. (2017) defined three groups of Big Data analytical methods; descriptive analytics which is the simplest form of BDA method. It involves in summarizing and describing the knowledge patterns using simple statistical measures such as mean, median, mode, standard deviation, variance, and frequency measurement of specific events in BD streams. Second phase belongs to predictive analytics, which is concerned with forecasting and statistical modeling to determine the future possibilities based on supervised, unsupervised, and semi-supervised learning models. Lastly prescriptive analytics, which is performed to determine the cause-and-effect relationship among analytical results and business process optimization policies. Thus, by using prescriptive analytics methodology organizations can optimize their business processes based on results obtained through predictive and descriptive analytics.

Unlike traditional literature review, a meta-analysis adopts the path of science by analyzing differences and areas of similarities, and by integrating results from different studies, in order to derive an objective conclusion in the context

of multiple studies (K. K. Choong 2013). Systematic Literature Review (SLR) can be defined as a set of procedures which allows analyzing systematically an interesting literature locating, appraising, and synthesizing the most relevant publications in a domain area (Gulo et al. 2015). To guarantees SLR methodological accuracy, systematization, exhaustiveness, and reproducibility, researchers follow methodological approach such as the framework of Search, Appraisal, Synthesis, and Analysis (SALSA) to determine the search protocols which the SLR should follow (Mengist et al. 2020). They Also mentioned in their study that most scientific work applied this methodological approach to reduce risks related to publication bias and to increase its acceptability of the work. Furthermore, they added two additional steps (Protocol and Reporting) to the SALSA framework and develop (PSALSAR) framework with the following steps Protocol, Search, Appraisal, Synthesis, Analysis and Report.

Machine learning algorithms, a tool of artificial intelligence, are computational procedures that, among other things, use pattern recognition and inference by learning from previously categorized documents to predict the category a new document belongs to. These algorithms are trained using example data in order to learn the patterns required to conduct the requisite classification. As these are quantitative procedures, it is necessary to generate a feature-set to convert information into an amenable format (i.e., from words to numerical data) (Popoff et al. 2020). They also found that Machine Learning algorithms can improve the efficiency of the SLR process and by reducing the burden/workload on researchers during the study selection process as it reduces the number of abstracts that need to be screened or by replacing the need for a second human screener. Despite existing research on text mining and machine learning for title and abstract screening, the best algorithm remains unclear (Mengist et al. 2020). Although the most commonly used algorithms are support vector machines (SVMs), some researchers suggest that alternative options, such as Naïve Bayes algorithm, may be more favorable (Popoff et al. 2020). Naïve Bayes algorithm is not considered the most precise, otherwise is very simple to work with and to configure (Gulo et al. 2015).

3. Methods

As far as our knowledge and despite the work that have done on PM SLRs such (K. K. Choong 2013, K. K. Choong 2014, Faulkner and Kaufman 2018) and BD & BDA (Sivarajah et al. 2017, Ylijoki and Porras 2016), we couldn't find a systematic literature work that jointly focuses on performance measurement and big data analytics in the public sector domains. One of the reasons mentioned by (Ylijoki and Porras 2016) is that big data is a multi-disciplinary phenomenon. Unlike some other subject areas, big data related articles cannot be found only in certain highly focused forums. Although there are some new journals that focus on big data, various publications in many research domains discuss the topic. Big data is an emerging, multi-disciplinary research area. In this research we adopted (Mengist et al. 2020) framework to be our research methodology with minor adjustments and we identified the key activities for each step as presented in Figure 1. We also introduced a combination of text mining techniques and Machine Learning algorithm to automate publication classification process.

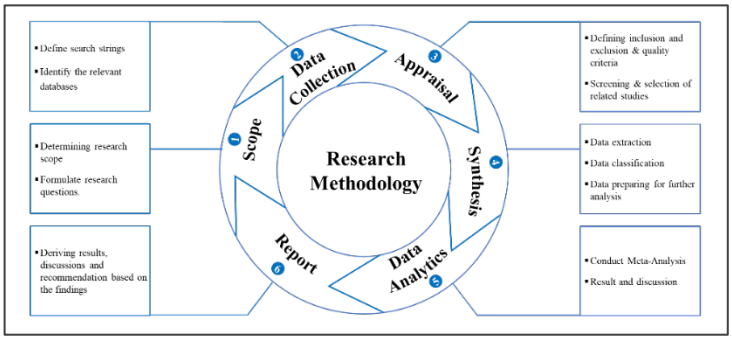

Figure 1. Research methodology

The selection of studies can be automated with the application of search and data reduction algorithms (Thomé et al. 2016). Automatic recommendation of scientific articles consists of many sub-tasks, namely: data collection, text processing, data division, features extraction, feature selection, data representation, classifier training, applying the classification model, and performance evaluation (Gulo et al. 2015). In this research a machine learning analytical model was developed along with the implementation and results validation process, due to the diversity and the wide coverage of research areas and the need to increase the efficiency by reducing the burden/workload throughout publications selection process. In this work a process with six key activities presented in Figure 2 to perform machine

learning predictive model is developed to auto classify publications using Naïve Bayes (NB) algorithm. Naïve Bayes classifiers are known as a simple Bayesian classification algorithm. It has been proven very effective for text categorization (Dai et al. 2007). Naïve Bayes classifiers which are widely used for text classification in machine learning are based on the conditional probability of features belonging to a class, which the features are selected by feature selection methods (Zhang and Gao 2011). We used the Naïve Bayes model denoted as.

$$C_{NB} = argmax_j\, P(c_j) \prod_i P(w_i|c_j) \qquad (Eq1)$$

$$P(c_j) = \frac{|docs_j|}{|Total\ \#documnts|} \qquad (Eq2)$$

$$P(w_i|c_j) = \frac{count(w_i, c_j) + 1}{(\sum_{w \in V} count(w_i, c_j)) + |V|} \qquad (Eq3)$$

Where:

C_{NB}: *The assigned classe for document based on the maximum likelihood of* Naïve Bayes classifier

w_i: *Lits of features i of document D*

c_j: *Predefined classes j*

$docs_j$: *All documents with class*$_j$

V: *The distinct words for all the extracted features*

$P(c_j)$: *Prior information of the appearing probability of class*

$P(w_i|c_j)$: *The conditional probability of feature i occurring in a document of class j*

$count(w_i, c_j)$: *The frequency of word*$_i$ *appearing in a document of class*$_j$

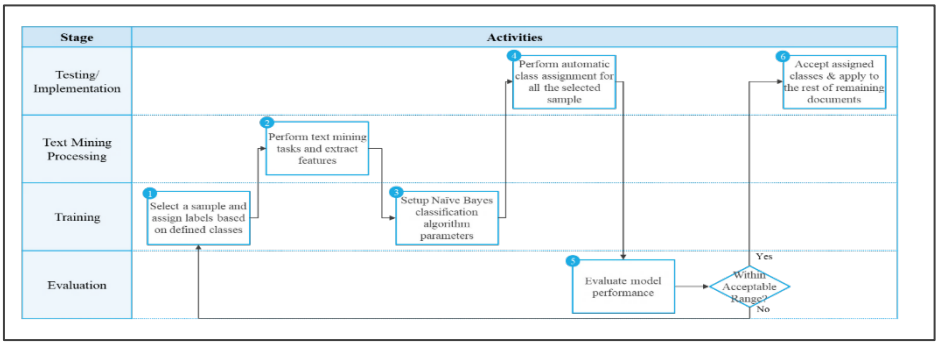

Figure 2. Machine Learning classification model process

4. Data Collection

Data collection step involve determining the needed combination of terms and logical operators to build an appropriate syntax of search strings that meets the scope SLR as well as collect the required data from the identified databases. Mengist et al. (2020) search strategy helps to define appropriate search string and identify the relevant databases to collect the relevant documentation. Consequently, in pursuance achieving our research goal we have formulated three strings combinations for each search area Table 1 in consideration that public sector organizations or use cases are the common aspect to improve performance measurement practices in the public sector as well as leveraging a data driven decision making culture. As results, we were able to gather a total of 23,862 records after searching Scopus and World of Science (WOS) databases. We were able to collect considerably rich publication information from both databases.

Table 1. Collected publication data

Search Area	Search String	Scopus	WOS	Total
BDA & Public Sector Use Cases	("government sector" OR "public sector" OR "public entity" OR "use case" OR "use cases") AND ("big data analytics" OR "big data analysis")	2,970	160	**3,130**
Advanced Data Analytics & Public Sector Use Cases	("government sector" OR "public sector" OR "public entity" OR "use case" OR "use cases") AND ("prescriptive analytics" OR "prescriptive analysis")	91	4	**95**
Performance Measurement & Public Sector Use Cases	("government sector" OR "public sector" OR "public entity" OR "use case" OR "use cases") AND ("organizational performance" OR "organisational performance" OR "organization performance" OR "organisation performance" OR "performance measurement")	19,825	812	**20,637**

To ensure we encounter the most relevant articles to our research we need to define an inclusion and exclusion criteria that will be used to select articles that fulfill our research scope. The defined inclusion and exclusion are presented in

Table 2. Mengist et al. (2020) applied the inclusion and exclusion criteria approach, to select the papers that fulfill the inclusion criteria for their further investigation and content assessments.

Table 2: SLR inclusion and exclusion criteria

#	Criteria	Decision	#	Criteria	Decision
1	Overarching Performance measurement systems should present the used approaches and its associated characteristics and indicators that measure and improve the performance of public sector organizations as a whole.	Include	7	Papers focusing on profitability performance measures	Exclude
2	Papers presenting the key characteristics of big data analytical use cases (data source, used data sets, the used analytical methods...etc.) implemented in the public sector organizations	Include	8	Duplicated publication	Exclude
3	Papers presenting methods, techniques or algorithms that can be used or incorporated with big data prescriptive analytics	Include	9	Documents published before the year 2000 and after 2019	Exclude
4	Papers are presenting use cases were big data analytics can be deployed in the public sector	Include	10	Non-English Publications	Exclude
5	Papers focusing exclusively on technical part of big data technologies infrastructure development and implementation not on the use of data analytics	Exclude	11	Publications categorized as proceedings paper, book, book chapter	Exclude
6	Papers concentrating on managing and measuring performance for a specific organizational perspective or function not on an organizational level	Exclude	12	Publication having missing information	Exclude

For publications selection we stated by conducting manual screening process to exclude publications that did not comply with exclusion criteria #8, #9 #10, #11, and #12 from Table 2 and the number of excluded articles for each criteria is 1,040; 2,986; 411; 2,805; 218 respectively. The total excluded publication from this stage was 7,130 publications considering the overlap between the five criteria. For the remaining 16,732 publications we used Naïve Bayes (NB) algorithm to support in identifying the most relevant literature to the context of this research. A random sample from with a total of 470 publications were selected as the initial training set. Each one of the selected publications were screened by their titles, abstract and keywords attributes and they were labeled either included/excluded based on their relevance to the research context.

Receiver operating characteristic (ROC) analysis is commonly used method to assess the performance of a predictive model. ROC analysis works only for the case when the target variable has exactly two distinct values, such as true and false, or positive and negative (Zhou 2020). We used sensitivity and specificity as our evaluation criteria to decide when to accept model results and implement it on the remaining publications. We defined sensitivity as TP/(TP + FN), where true positive (TP) is when publications labeled as include and predicated as include or having no decision and false negative (FN) is when publications labeled as include and predicated as exclude. Specificity was defined as TN/(TN + FP), where true negative (TN) is where publications labeled as exclude and predicated as exclude, and false positive (FP) is where publications labeled as exclude and predicated as include or identified as having no decision.

We tested and evaluated the predictive model four times each trial took ~ 2 minutes to perform the needed activities to predict publications classes, the fourth trial reached to certain level we feel its satisfactory 98% Sensitivity and 99% Specificity Table 3 shows the number of publications that were labeled and auto classified as well as performance evaluation results for each trail.

Table 3. Machine Learning classification results

		Actual Labels		Predicted Labels		Performance	
Trail	Total Publications	Included	Excluded	Included	Excluded	Sensitivity	Specificity
1	470	45	425	46	424	95.6%	99.3%
2	471	46	425	48	423	95.7%	99.1%
3	483	58	425	59	424	96.6%	99.3%
4	484	59	425	61	423	98.3%	99.3%

The predictive model has been implemented on all the remaining 16,732 publications. As a result, out of the remaining publications 15,277 were classified as excluded and 1,455 included. From the 1,455 publications 57 met our inclusion criteria and they were considered in the synthesis and the meta-analysis. The process of information identification and collection of our eligible publications were synthesized by defined parameters. The used parameters to evaluate and quantify the characteristics of the eligible publications are (Year, Application Domain, Country, BDA Use Cases, Purpose, Analytical Method, Data Sources, Data Sets). Consequently, each publication is examined, and data were collected in a spreadsheet for further analysis and interpolation. We obtained the necessary information to perform the meta-analysis for the eligible publications.

5. Results and Discussion

A metadata data analysis is conducted for the eligible publications starting by analyzing a historical view for the three defined search areas Figure 3. Based on our findings, we can say that performance measurement historically has been attracting researchers' interest for the last two decades. However, a growing interest in big data & prescriptive analytics emerged in public sector studies over the last few years and this confirms the importance and the recent trend of researcher's interest in these topics. Public sector organizations are not relying on a universal performance measurement system to measure and improve public sector performance. We noticed that authors have used different and various approaches in the design and implementation of performance measurement systems which are mainly concerned with Strategy Management, Quality Management, Performance Management, Organizational Excellence, and Business Intelligence.

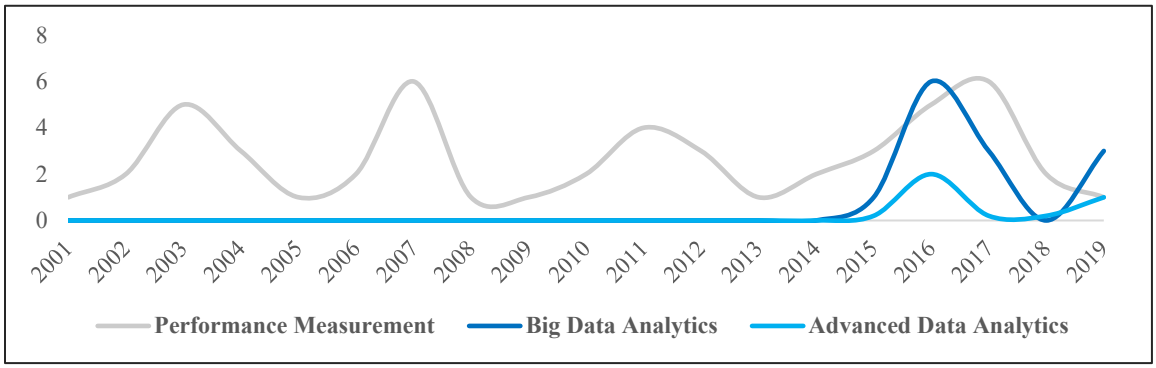

Figure 3: Historical view of publications in the three focus areas

When we looked at public sector organizations practices in the area of big data and big data analytics, we found that researchers and practitioners are acquiring various data sources and data sets in building and utilizing big data analytical use cases, we grouped these big data sources into five main categories namely Internal Systems, Administrative Data, Phone Data, Social Media, and Web Search Queries Figure 4. Internal systems data are the dominate big data analytics data type mentioned by the authors this involve a wide variety of datasets within reach of public sector and nonprofit organizations. We have also noted that big data generated from and across the different social media platforms have attracted author interest due to its numerous opportunities for bringing more insights to decision-makers.

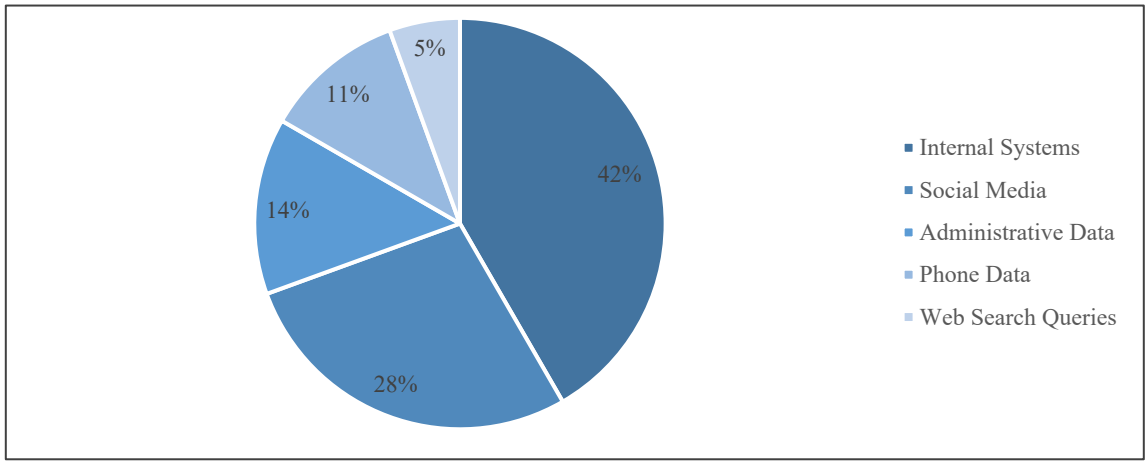

Figure 4: Big Data sources categories

Big data analytics use cases are crucial for all types of organizations, no matter the sector and field they operate. Furthermore, the employment of big data analytics use cases would be useful for efficiency increase and competitive advantage enhancement (Otčenášková et al. 2015). When it comes to the maturity or advancement of public sector organization big data analytics (BDA) use cases based on the implemented analytical methods, we found that historically, researchers have been adopting descriptive and predictive analytics heavily, however there is a growing interest in adopting prescriptive analytics over the last few years. The level of adopting advanced big data analytical methods is still low, since the implementation of prescriptive use cases is still the lowest compared to descriptive and

predictive analytics. Throughout our research we were able to collect a portfolio of 25 big data analytics use case for public sector organizations 8 in healthcare, 5 in tax, 4 in transportation, 2 in employment, 1 in agriculture, 1 in education, 1 in public affairs, 1 in safety and security, 1 in tourism, and 1 in water supply. The purpose, data sources, analytical methods, and the impact for each use case are presented in Table 4. Values having "NS" are not specified.

Table 4. Public sector big data analytics use cases

Domain	Author	Country	Use Case	Purpose	Data Source	Analytical Method	Impact
Healthcare	Gamage (2016)	Australia	Patient Admissions Prediction Tool	Assists with hospital bed management, staff resourcing, and scheduling of elective surgery	NS	Predictive	• Saving A$23 million a year in improved service efficiency if implemented in hospitals across Australia
	Gamage (2016)	Mexico	Disaster Management	Use of mobile phone activity for disaster management	Phone Data	Descriptive	• Enabled tracking of population movements in response to the spread of epidemic disease and provided insight into the impact of policy levers like transportation hub closures, so that the velocity of infection rates was reduced by up to 40 hours.
	Gamage (2016)	Qatar	Personal Electronic Health Record	Use of a clinical information system that will lead to the creation of a personal electronic health record	Internal Systems	Predictive	• Patients' health records are analyzed to assess the probability of particular complications or diseases given their current state of health and their medical histories; and doctors have access to risk profiles that are personalized by collating individuals' data with previous cases
	Gamage (2016)	United Kingdom	Exchange of Best Practices	Integrating and publishing hospital data encouraged and facilitated exchange of best practices among hospitals	Internal Systems	Descriptive	• Improving service efficiency • Cost saving; Infection rates were reduced from around 5000 patients annually to fewer than 1200, resulting in a cost saving of £34 million
	Saxena and Sharma (2016)	Saudi Arabia	Smart Hospital Management System	Detect, locate and monitor patients and track assets and equipment using modern sensor technologies in a real-time environment for e-health systems	NS	Descriptive	• Tapping data from medical prescriptions and patients' reports on a real-time basis by making intelligent decisions about prospective ailments while improvising on the existing cases at the same time
	Rogge et al. (2017)	United States	Monitoring and Tracking Influenza-like Illnesses	Monitoring and tracking influenza-like illnesses of citizens so that earlier detection of influenza epidemics was possible	Web Search Queries	Predictive	• More accurate prediction of the required facilities (for example, hospital beds) and vaccines • Prompt treatment of the patients
	Palanisamy and Thirunavukarasu (2019)	NS	Monitor Patient's Health Condition	Identification of high-risk patient for specialized treatments	Internal Systems	Predictive, Prescriptive	• Track the usage of drugs / Monitor the patient's health condition at any point in time and triggering periodical health alerts
	Palanisamy and Thirunavukarasu (2019)	NS	Patient Treatment Plans	Designing patient specific treatment plans	Internal Systems	Prescriptive	• Implementation of treatment plans and personalized medical care
Tax	Gamage (2016)	Sweden	Streamline Tax	Government used previous year's data combined with user confirmation via text messaging to streamline filing of taxes	Administrative Data	Descriptive	• Streamline filing of taxes
	Gamage (2016)	United States	Tax Fraud Detection	Use of a data analytics program to detect tax fraud	NS	Predictive	• Detect tax fraud by screening the information contained in each tax refund request against billions of personal records from public and commercial databases
	Rogge et al. (2017)	NS	Tax Collection	Creating profiles of people, triangulating information about people, and developing predictive models of 'evasion taxpayers profiles	NS	Predictive	• Detecting and combating fiscal fraud more
	Rogge et al. (2017)	NS	Tax Collection	Creating profiles of people, triangulating information about people, and developing predictive models of 'evasion taxpayers profiles	Internal Systems	Predictive	• Help tax services in detecting and combating fiscal fraud more successfully
	Janssen et al. (2017)	Netherlands	Tax Collection	Use data to improve the assessment of tax filing and collection of taxes	Administrative Data / Social Media	Descriptive	• Guiding inspection decisions and have resulted in higher tax income • Reduce costs and improve compliance
Transportation	Liu and Yen (2016)	Taiwan	Customer Complaint Case Classification	Big data classification and improve the existing manual procedure of complaint case classification	Phone Data / Social Media / Internal Systems	Predictive	• Increased complaint processing speed
	Liu and Yen (2016)	Taiwan	Systematized Complaint Case Assignment	After classifying all complaints, complaint cases should be assigned to or controlled by appropriate human resources to complete the case management within the planned period of time	Phone Data / Social Media / Internal Systems	Prescriptive	• Increased complaint processing speed

Domain	Author	Country	Use Case	Purpose	Data Source	Analytical Method	Impact
	Gamage (2016)	Brazil	Monitoring Traffic and Road Conditions	The solution facilitates a reduction in the time required to identify and resolve traffic problems by 99%, from several hours to several minutes	NS	Descriptive	• Improve road safety • identifying and addressing the situations that cause the most accidents first
	Gamage (2016)	Japan	Intelligent Transport System	Integrate people, roads and vehicles	NS	Descriptive	• Resolve road traffic problems such as traffic congestion, traffic accidents and environmental degradation
Employment	Gamage (2016)	Germany	Assist Unemployed Workers	The Federal Labour Agency in Germany used its multidimensional historical customer data more effectively to assist unemployed workers	Internal Systems	Descriptive	• Reducing costs by approximately US$ 15 billion annually
	Gamage (2016)	Ireland	Rise in Unemployment	Using Social media conversations about work-related anxiety and confusion as an early indicator of a rise in unemployment	Social Media	Predictive	• Provided a three-month early warning indicator of a spike in unemployment
Agriculture	Gamage (2016)	Colombia	Smallholder Agriculture	Adjusting farmers management practices to subtle variations in growing conditions across sites and over time in a given area	NS	Prescriptive	• Optimize crop yields
Education	Rogge et al. (2017)	Italy	Higher education services effectiveness	Measure service effectiveness using social media data in the higher education field	Social Media	Descriptive	• Support the evaluation of public service performance by developing a set of measures, derived from Twitter data, to quantify the effectiveness of higher education services
Public Affairs	Saxena and Sharma (2016)	Oman	Electronic Census of Population	Integration of Big Data to compile information from existing official records were all the ministries and departments would be involved in the recording, sifting, compiling and analysis of the voluminous data	Administrative Data	Descriptive	• Enable electronic census of population
Safety And Security	Van der Voort et al. (2019)	Netherlands	Tracking Criminal Incidents	A dashboard with key information about, among other things, burglaries, robberies, thefts, violence and soft drug production in the city	Administrative Data	Descriptive	• Reduce burglary, robbery and theft • Take more specific and appropriate measures to fight crimes • Evaluate whether the measures taken indeed lowered the crime rate • Early warning: if important developments require action • Enabling decision makers to absorb the information
Tourism	Miah et al. (2017)	Australia	Tourism Demand Prediction	Photos were taken by users along their traveling path using GPS-enabled photo capturing devices that automatically record geographical information	Social Media	Descriptive, Predictive	• Make more informed strategic decisions • Insight into tourists' behavior and preferences • Assist with the forecasting of future and seasonal demands • Estimate the future trends and seasonal effects • Develop targeted marketing materials
Water supply	Gamage (2016)	India	Water Distribution Monitoring Systems	Use of big data and predictive analytics technology to create systems for monitoring water distribution systems	NS	Predictive	• Minimize unaccounted water by detecting large changes in water flow, through real-time monitoring

6. Conclusion

Systematic literature review (SLR) that jointly focuses on performance measurement and big data analytics in public sector studies conducted to achieve the objectives of this work and to address the research objectives. A metadata for 23,862 publications were collected to be included in the screening process. A Machine Learning classification model using Naïve Bayes algorithm was developed to improve the efficiency of the SLR screening. The process of model development, implementation and testing is also documented in this work. Receiver operating characteristic (ROC) analysis was used to evaluate model performance, and the model achieved a score of 98.3% sensitivity and 99.3% specificity

The result of this works shows that public sector organizations' big data sets are collected in three forms structured, semi-structured or unstructured and can be generated from two main origins, inside the organization and outside the organization. There are multiple characteristics of big data, however the primary characteristics of big data are Volume, Variety, and Velocity. Furthermore, the identified big data analytics use cases in public sector organizations are depending on five main data sources in acquiring data sets to be built and implemented. These data sources are grouped into five main categories, and they are as follows Internal Systems, Social Media, Administrative Data, Phone

Data, and Web Search Queries. When it comes to the used analytic methods public sector organizations are adopting, we found that descriptive and predictive analytics are heavily used in measuring performance. However, the level of adopting advanced big data analytical methods such as prescriptive analytics is still low. In this work a portfolio of 25 big data analytics use case for public sector organizations were collated with a demonstration of the purpose, data sources, analytical methods, and the impact for each use case. Furthermore, we found that the employment of big data analytics use cases would have a significant impact on improving public sector performance measurement mainly in improving decision quality, detecting fraud, customers profiling, customize service delivery, support decision making, cost saving, and forecasting of future and demands.

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