

# Data Analytics and BI Framework based on Collective Intelligence and the Industry 4.0

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## ABSTRACT

Now a days, business is subject to frequent changes in operations because of the continuous alignment of changes in strategies and business environment due to rapid changes in human and business resources considering the complexity of businesses. Currently, Business Intelligence is way to handle these frequent changes and risks. In the past BI was so complex thing for business to adopt and only big businesses were able to implement this but now BI is becoming simpler and even web based on cloud, so it is easy even for small and medium business to adopt this to do business in a smart way. The purpose of this literature review is develop a framework of BI and Data Analytics using the collective intelligence, new technologies of the Industry 4.0 paradigm in order to provide a service with low cost and intelligence service for small and medium business which don't have budget to pay an expensive license and hiring an expert to can design the analysis to improve productivity and profitability.

## CCS Concepts

• Information systems → Data analytics.

## Keywords

Business Intelligence; Data Analytics; Collective Intelligence; Industry 4.0; Big Data.

## 1. INTRODUCTION

The importance of the data has done necessary its analysis to support businesses and companies with an acceptable index of productivity and profitability. Even though the data is everywhere and in companies, the adequate management of this data is expensive, which is why a solution that is accessible to small and medium-sized companies that do not have the budget of large companies is required. In addition, with the new technologies that have emerged in recent years, it is necessary to use this so-called Industry 4.0 to overcome this gap.

Now a days, BI is used under the cloud to collect big amount of information from different sources and then make useful analysis from this information and processing [24][32]. On the other hand, Big Data in business intelligence refers to the enterprises which

have incredible amount of data related to their customers and market [18]. Big data technology is very helpful for developing business with new tools and techniques that includes the information, taste, choices, preferences, credit rating of millions of customers [19][26]. Combining this technology with the tools such as data mining are used to filter this raw data into useful information and analysis which can be used in marketing business launching new products and making right business decisions and new business models [15].

The Industry 4.0 is known as the fourth revolution of industry which includes the current trend of automation of everything in business, which includes the use of internet to store information on cloud servers, integrated systems which physically connect thousands of systems with each other and integrate useful information. The fourth revolution implies made the use of new technologies as IoT, Artificial Intelligence, Bigdata, Machine Learning, Cloud Computing, etc. to setup smart industries [12].

## 1.1 Research Problem

There are so much that needs to be done considering the importance of the data analytics on both the technology and economy fields. Most studies conducted are based on the available frameworks for the Big Data analytics while small and medium scale enterprise lack effective frameworks for such. In this work is proposed the framework based on the collective intelligence mining using the selective approach for the business analysis to identify the important innovations associated with the projects or work. Emergent market or business behavior prediction will be difficult since it is mostly based on the individual human processing business analytics. As a result of this factor, reaching a desired global behavior now worsen since the focus of the designing schemes relates to the management of the coordinated problems in an individual level approach.

## 1.2 Related works

The authors [1]'s work, explains the conceptual framework to apply BI in small and medium businesses. These businesses need very comprehensive and effective tools to deal with the large amount of data at this scale in order to create something very useful for their business growth and development [21]. The algorithms and data mining tools are implemented to achieve this purpose. In this context the business needs to apply a high-level BI platform architecture which is also able to further extend with the operations and meet all the requirements for the business, as researched by [17]. Number of enterprises have failed to achieve BI. Many IT enterprises are providing business intelligence and data mining services. [13][17] but costs a lot for small business. The authors [2] propose a conceptual framework about cost efficient BI by datamining. In conclusion, there are few papers focused on cost efficiency of BI implementation, involved in Industry 4.0, for small and medium business.

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### 1.2.1 Industry 4.0 technologies related to Data analytics

The provision of the AaaS in a cloud environment was suggested by the [37] for effective and automatic admission control of Big data [5]. In this paper, a scalable and automatic admission control was proposed to ensure optimization of the profitability. The QoS requirements and Service level agreements must be satisfied and guaranteed. Most capable Small and Medium Enterprises (SMEs) need to pay more for new technologies. The lack of Mobile Business intelligence systems (MBI system) was a common issue in those developing countries. Textual data analysis, principal component analysis, and structural equation modeling are some of those approaches identified by the authors [1]. Cloud storage has a major role in online services and data management. It has been applied to some stages of the data analytics framework. [8] have also highlighted the importance of that relationship and propose the 'cloud federation' as a form of service in helping data storage. This is a form of federation services that will allow different cloud service providers linked with a single virtual storage pool with goal to eliminate the dependency on a single provider to void vendor lock-in issue. From the study by [7], cloud federation approach also deduces merits which include the improvement of the data availability, storage scalability, and performance.

### 1.2.2 Collective Intelligence

Another study by [11] proposed usage of 'crowdsourcing application' to detect damaged roads to generate the required report for analysis and decision making. The collected data helps in guidance for safe driving by giving warning signs against the impending issues on the road by implementing a layered approach using sensors and collecting data from sources such as; the user's-based data, cloud-based data analytics and google maps. This paper works to explore the previous and early works mainly focused on analysis. Decision making is integral in data management and analysis [6]. The authors [4], helped in showing that reducing the risk of personal biases that could impair the process. There are many models and all of them should be evaluated before making the informed decision on the applicable model. In paper [36] the authors consider how the cognitive network should be integrated with intelligence to perceive, analyze, decide and act. In terms of the 'Autonomous Nodes' cooperative collective behavior has been found to play an important role. A relevant point in this paper found to be related with the [20],[36] and [37] study is that of the cooperative decision-making mechanism for multi-autonomous nodes and thus ensuring it is presented to the cognitive network. This is because the link helps manage the pointer that emphasizes the inability of a single AN to meet the QoS and network performance object (NPO). Digital Technology trend is now moving faster than expected which makes other fields scope hard and complex to adapt. Following this concept, [29] by mining of server registries, compliance repositories helps to collect a set of servers with the respective access rights for the team members. The collected data will then be uploaded based on a preferred crowd outsourcing principle. It was revealed this approach helps with the improvement of the role discovery process and accelerates security service infrastructure.

### 1.2.3 Data Analytics frameworks

In a study titled "Building use Cases with activity reference framework for big data analytics" by [16], application of the Big Data analytics was explored. This approach has been noted to influence the exponential growth rate noted within different organizations recently which intrigues major business

organizations to invest in Big Data technologies [22][27]. Despite investment by companies, the right framework that helps keep the common reference is still missing, which makes achieving the proper business values and providing right answers related to Big Data Analytics (BDA) is somewhat difficult to process. This paper focuses on using vendor-neutral and technology agnostic BDA activity reference framework to help close the gap.

In another published study by [34], it was introduced that there is a reusable form of a framework for the analytic governance to accelerate the use of data across the organization. This is tagged the Analytic Governance Framework (AGF) and it highlighted how it tends to impact as guiding principle which helps in the realization of the manager's work, analytic practitioners and data management practitioner. The important unique aspect of the principle is that relating to the facilitation of the communication and coordination on the basic project data which helps in better efficiency. Finally, there is no open framework that can integrate the dashboard together. The authors [14] provides one framework that can combine data from several sources and encompasses two separate configurations which are the; generic meta information and individual services. This will help in configuration of the dashboard needed for the interface.

## 2. PROPOSAL

As demonstrated in the current literature review, there are no research papers that support small and medium-sized companies that need to perform data analytics to improve their productivity, profitability or simply reflect their status in business terms with low budget. In addition, this type of company does not have analytical experts, so paying a high cost of business intelligence software licenses is a waste of resources.

On the other hand, although it is true that collective intelligence has been used in several aspects for decision making, no works have been found that use it to create a data analytics framework or dynamic template generator.

Faced with these gaps, it is proposed to combine collective intelligence with the new technologies that make up Industry 4.0.

### 2.1 Conceptual Framework

The graphical model provides the functions of the proposed framework. Here the decision-making process is carried out by two major technologies. One is data analytics. And another one is collective intelligence. In the data analytics it has four sub factors like Data type, Analysis type, and cost and framework type.

In below, the conceptual map of data analytical framework is delivered based on the collective intelligence. This will be used to make the simulation quality. Here the variables are separated in two ways such as dependent variable and independent variables. The data analytics contains factors like descriptive, predictive, and prescriptive. It is having some structures for the data analysis. They are structured, unstructured, open data and private data. And for the simulation quality, more methods are added to the conceptual map. The methods are based one Industry 4.0 technologies. They are cloud computing, big data analytics, cognitive computing, and machine learning. And the Industry 4.0 had some factors for the data analytics. They are descriptive, diagnostic, and prescriptive.

In business, efficient decision making improves the performance of the business [9]. The proposed research mainly focuses to demonstrate similar models. Here there are four sub-factors are identified. And they are described in this section. Data is

commonly classified into four types. The best model must capable of analyzing all the different model. In the previous works, most of the models are capable to analyze all kind of data. Generally, the business data analyzed in three different methods. And they are Descriptive, Predictive and prescriptive. Related to the cost here there are two subsystems (SLA and QoS).

This industry 4.0 technologies in this framework will be used for making smart decisions, interacting with the industrial data process, and making better analysis based on data. These are the main things which are helpful to produce the company. If the

company's production rate is high, then the development or growth of the company is also very high. Because of that, it is necessary to use the industry 4.0 combining with collective intelligence. Moreover, the cost will be analyzed based on SLA and QoS, trying to improve cost for SMEs. The important concepts of the industry 4.0 which are helpful for the develop this framework will be data from ERP, IOT, IoT, Datawarehouse. The technologies involved are AI, Cloud Computing, Cyber physical systems, real time data processing, machine learning and Big Data. These are the different concepts in the industry 4.0 which making different smart decisions [30].

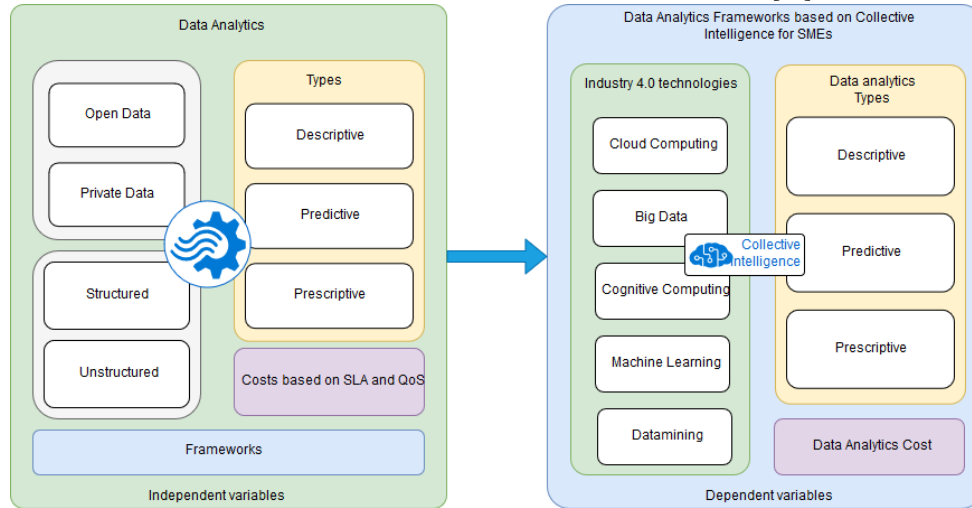


Figure 1. Conceptual model framework.

## 2.2 Theoretical Framework

Factors	Sub-factors	Variables	Zhang B	Zhao	Zhang M.	Yamada	Chang	Kalema	Vucovic	Lau	
Data Analytics	Types of data	Open Data	X	X	X	X	X	X		X	
		Private Data	X	X	X	X		X	X	X	
		Structured	X	X	X	X		X	X	X	
		Unstructured	X		X		X			X	
	Type of analysis	Descriptive		X	X	X	X			X	
		Predictive	X	X	X		X	X	X	X	
		Prescriptive	X		X		X			X	
	Costs	SLA		X	X						
		QoS			X						
	Frameworks	BI					X	X		X	
Real time			X						X		
Governance					X						
As a service			X								
Data Analytics Framework	Industry 4.0	Bigdata	X	X		X				X	
		Cloud Computing		X							
		Machine learning	X								
		Datamining				X					
	Collective Intelligence	Cognitive Intelligence			X				X		
		Decision-making		X	X		X	X	X		
		Security								X	
		BI									
	Costs	Analysis	X	X						X	
		SMEs							X		
Low cost		X	X		X	X	X	X			
Licence											

Figure 2. Comparative Analysis of Related Models [35][39][36][34][4][1][29][16].

The Figure 2 shows the matrix that details the factors, sub-factors and variables that give context to this theoretical framework.

In the above-given table, the comparison of various model's results is given. It provides an overview of the different models [25]. Here the models proposed by [16], [36], and [39] contain clear procedures on Data analysis and analytical frameworks. It also talks about the different variables Data type, different frameworks, Industry 4.0 and Collective intelligence etc.

## 2.3 Data Analysis and BI Framework based on Collective Intelligence

The basic approach behind the proposal is to cut the losses of small and medium businesses that can't afford to hire someone that will give them a data analytics application for better overall efficiency and productivity based on collaboration. SMEs rely on the cost-efficiency model as their resources are constraint as oppose to large enterprises. Figure 3 is an illustration of data analysis and BI framework based on Collective Intelligence which incorporates all the necessary components and technologies for

functioning [23]. The SME users are in control of their business profile. In Cloud computing, the information is stored online with the ability of privacy. In Smart analysis assistant, the analytics portion comes into play. In Collective Intelligence, the framework incorporates both the analytics and storage involved. The Smart Analysis Assistant is the most crucial one as it involves reports which reduces the cost for Small and Medium size enterprises. In Business profile and registration, it enables to input or edit the business general information, details and even their capacity.

The big data is used to process a huge volume or amount of unstructured data. The use of big data in decision making is more important than the traditional small data. Some of the advantages of using Big Data in Decision making are understanding the journeys of customers, reduction in cost and time, supply chain optimization and simulation, competitive intelligence, real-time decision-making process, and prediction of future outcomes [10]. In Big Data, more data sources are collected and developed. The data mining process is done on the developed data sources. Then, the data analysis is done followed by the analytics. After that, the better decision is made according to the collected information in Big Data.

Collective intelligence is used to find the solution to a problem as a group [28][33]. There are a greater number of people needs to solve that difficult problem. It can be solved by the giving ideas from the persons in the group [38]. Then, analyze those ideas and solves that problem in an efficient manner. Collective intelligence is one of the valuable marketing tools. If any small problems

occurred in the collection of data in the network means, then it will be solved by the systems in the network. If the problems are in an unstructured manner means, then it needs the human to solve those problems in the network. These unstructured data set problems are solved by the use of the concept of collective intelligence. This collective intelligence will produce more idea related to data analytics. Then, plan according to the problem and will find the correct solution.

Machine learning concepts also helpful for the decision-making process [31]. For using the machine learning technique to support the decision making we need to follow some steps. First, we need to develop the machine learning model. Machine learning model development is not an easy thing. To develop this model, we need to collect the business domain data. We need to combine all the data. Then the data cleaning process carried out. Then the data is converted into the Machine learning features. After doing all these things the system is capable to assist in decision making process. In the developed system the required details are collected by the technologies like industry 4.0 and the collected data processed by the data analysis, collective intelligence and machine learning etc. and finally the system brings the facts. These facts are highly helpful for the managers.

The SMEs users will can easily use this framework as it is easy, and the interface is understandable. It differs from others because it uses collective intelligence and Industry 4.0 technologies, to improve the data analysis and reduce costs.

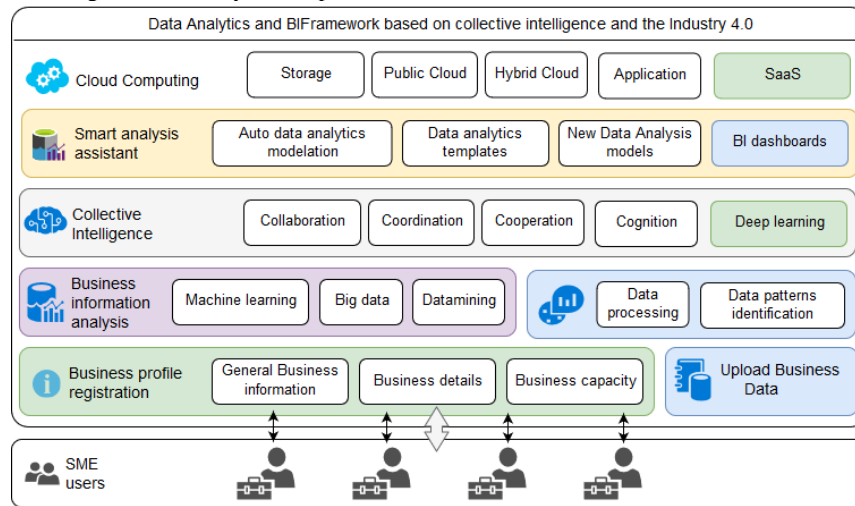


Figure 3. Data analysis and BI framework based on collective intelligence.

### 3. DISCUSSION

Generally, the accuracy of decision-making process mainly relies on the data used for that. The proposed research framework will works based on the various business data analytics from users. It facilitates various feature and function to assist the decision making. It can analyze different types of data by different process. These processes are increasing the effectiveness of the system.

Here the data are collected and processed by the collective intelligence concepts. Here the different kind of data is analyzed by the big data analysis and machine learning concepts. The size of data is too big, then the accuracy of the results also too good. Then the various data analytics concepts also used. Based on the need the model uses the descriptive technique, predictive technique, and prescriptive technique. It gives higher flexibility.

Also, the data analytics costs also low. All these features and technologies make the proposed model as more reliable.

### 4. CONCLUSIONS

The present job is developed an Analysis Data Framework based on Collective Intelligence and new technologies in order to provide a smart analytics assistant in business. In the framework there are three major technologies are used [35]. These three technologies are founded from the literature research conducted in the previous process. Industry 4.0 concepts helps to improve the performance of the business. It reduces the complications involved in the current manufacturing process. Also, it ensures the sustainability in growth. Cloud computing and data analysis also the major factors in the proposed system. These things improve the process decision making. Collective intelligence changes the conventional data analysis process. It increases the effectiveness

of the current system. Also, the proposed system mainly concentrates on the cost also. Here the framework is developed for support the medium and small-scale companies during the decision making. The use of different technologies also improves the decision-making capability and accuracy.

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