Hindawi
Scientific Programming
Volume 2022, Article ID 5241054, 9 pages
https://doi.org/10.1155/2022/5241054

Research Article

Evaluating A's of Big Data for Transformation of Smart Cities

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Received 3 May 2021; Accepted 18 September 2021; Published 8 June 2022

Academic Editor: Zhu Xiao

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Smart devices and things are widely increasing with the passage of time and with the developments of industrial technology. Various smarts devices such as sensors and actuators are interacting with each other for diverse purposes and specific goals. The role of automation can drastically revolutionize to adopt the things, to automate and accurately access, with cost-efficient resources, and save human time and effort. Data plays a vital role in industries and is the fundamental part of organizations. An efficient system is the dire need of the modern industry to efficiently and accurately assess the A's of big data for transformation of smart cities. The existing literature was searched for finding the associated materials and to represent them. The current study considers the A's of big data and with the support of analytic network process (ANP), the same has been evaluated. The approach of ANP works in situation of complexity where decision-making is difficult and challenging. The approach adopted the network hierarchy of goal, criteria, and alternatives for assessing the A's of big data. Various calculations of the process have been carried out for experiments, and the experimental results show the effectiveness of the proposed research in terms of evaluation of A's of big data.

1. Introduction

Data is considered to be one of the significant assets of the organizations in any field. The data plays a crucial role in industries and is the fundamental part of the organizations. Its role is obvious in different fields of life such as education, health, engineering, agriculture, and government. The data is well-thought-out for management and achieving business objectives and eventually for making well-improved decisions according to the information gained from the data [1]. Moreover, a huge amount of data is progressively produced and this trend in growth of the volume of data produced is not changing in the nearby future. It is estimated that 163 zettabytes will be generated by 2025 [2]. The wide-ranging applications of IoT, multimedia data, and social networks generate a huge amount of data [3]. On the other side, most of the data is in an unstructured format which can make its analysis and management a complicated assignment. Big data is gaining considerations of government, academia, and industries for its useful analysis and management and obtaining meaningful insights. The analysis of big data requires examining a huge volume of data for discovering potential patterns and insights into making better decisions [4].

Big data is mainly classified into three broad parts, namely, data that is abundant, data that cannot be classified into a consistent relational database, and data that is produced, taken, and processed promptly. Likewise, various transformations have been done through big data such as transformation of healthcare, engineering, science, business, finance, and, in the end, society. The recent data storage progression and technologies of mining agree to allow preserved rise of data designated by shaping the data held by the organization [5]. Big data has diverse applications in different areas to devise solutions [6, 7]. Various online platforms are extending their spread over long distances providing different social networking approaches. Billions of people everywhere in the world are using social networking sites for uploading videos and photos, updating status, and commenting on daily posts [8]. The relationship of vast growth of social networks has inspired researchers to

examine the contents and analyze user activities [9]. The study was conducted based on systematic review on s-commerce for exploring the s-commerce through collecting, reviewing, and analyzing the materials associated with the research on s-commerce [10].

On the whole, the data is increasing which creates many challenges for researchers and practitioners to deal with. A well-organized system is the necessity of recent industries to professionally and precisely evaluate the A's of big data for transformation of smart cities. The present study considers the A's of big data, and with the support of ANP approach, the same has been assessed. The approach adopted the network hierarchy of goal, criteria, and alternatives for assessing the A's of big data. The experimental results show the effectiveness of the proposed research.

The rest of the paper is organized as follows: Section 2 represents the related work to the proposed study. The research methodology is explained in Section 3 with the details of the ANP approach for assessing the A's of big data for transformation of smart cities. Section 4 represents the results and discussion section of the paper. The paper concludes in Section 5.

2. Related Work

Most of the researchers are trying to shape big data in order to use it for meaningful purpose in a successful and effective way. Sellami et al. [11] proposed an approach which shows scalability to composition of big data services considering not only the quality of reused services but also the quality of consumed data sources. The approach initially proposes a model of quality for big data services-associated information throughout composition with the fuzzy relational concept analysis for building the repository of big data services. The same fuzzy relational concept analysis was used for cluster services and data sources according to different criteria such as their domain, quality level, and the association among them. Finally, the algorithm for selection and composition of high quality and secure big data services were defined. Abkenar et al. [12] demonstrated the analytics of big data meeting social media and presented a detailed review on the approaches of big data analytics in social networks. The study was conducted from 2013 till August 2020 and included 74 papers from the search process. Big data analytics schemes were categorized into two key classifications, the network-oriented and content-oriented approaches. The study has discussed the key ideas, tools, measuring approaches, parameters of evaluation, and so on in detail. Some open challenges and future directions are also discussed.

Shamim et al. [13] analyzed the role of big data in relational and contractual governance in the decision-making performance of big data firms in China. The study has analyzed controlling the role of data-driven culture in association with big data analytics abilities and decision-making. The data was collected from 108 firms of China which were dealing activities associated with big data. With the help of structured equation modelling, the hypothesis was tested. The study has further contributed to knowledge-based dynamic capability views of firms, at variance of big data analytics abilities. Ranjan and Foropon [14] analyzed the applications of big data in the processes of competitive intelligence in organizations through exploring how the big data analytics are dealt by the organization. The study facilitates in providing a context for design of frameworks for the big data model for competitive intelligence in organizations. Kastouni and Ait Lahcen [15] devised a study which focused on the telecommunication project big data analytics. The study also presents beneficial big data analytics use case. Gbadamosi et al. [16] presented a study which incorporates three perspectives of offsite construction such as DFMA, BIM, and big data for proposing a big data design option repository. The approach of the study incorporated the big data design option repository into the offsite construction delivery process.

Calic and Ghasemaghaei [17] hypothesized that firms harness information from big data for improving their corporate social performance and that these enhancements occur by organizational revolution in practice of business, external relations, and workplace organization. The study has reviewed 297 middle- and senior-level managers who were familiar with the use of data in their firms in North America. Arzubiaga et al. [18] proposed an approach for drawing on the socioemotional wealth aspect and its model of FIBER for conceptually investigating its role in family firm decisions for implementing big data. A set of framework and propositions were introduced for likeliness to implement big data in family firms. The authors proposed an approach of risk analysis for the environment of big data that is based on the approach of security analysis called methodology for analysis of risks on information systems facilitated by the technological environment in the cloud [19]. Wilkin et al. [20] presented a study with the aim to develop and test a scale for evaluating availability of big data and role of big data prioritization for more effective use of big data in performance and decision-making. The scale was validated through a survey of 84 managers.

Pellakuri et al. [21] presented an approach based on RHadoop for uploading the data of social media and used the queries of Hive for showing the data. The study then focused on the data that is unstructured for examining the sentiment analysis using RHadoop. Kandt and Batty [22] has discussed the limitations and value of big data for long-term policy of urban planning. For urban analytics, a theoretical perspective is presented which is considered as part of smart urbanism. Based on the empirical studies through big data, the study highlighted epistemological and practical challenges raised from the high-frequency data analysis to strategic determinations and expressed propositions for urban analytics. Pérez-Chacón et al. [23] proposed an algorithm for predicting time series of big data. An efficient pattern sequence-based forecasting algorithm was considered with the contributions to the literature. The approach firstly improves the original algorithm in terms of prediction accuracy, and secondly, it transforms in the context of big data with scalable results.

3. Methodology

The classification of big data is done based on various categories for better acceptance of the features. Various categories such as data sources, data stores, content format,

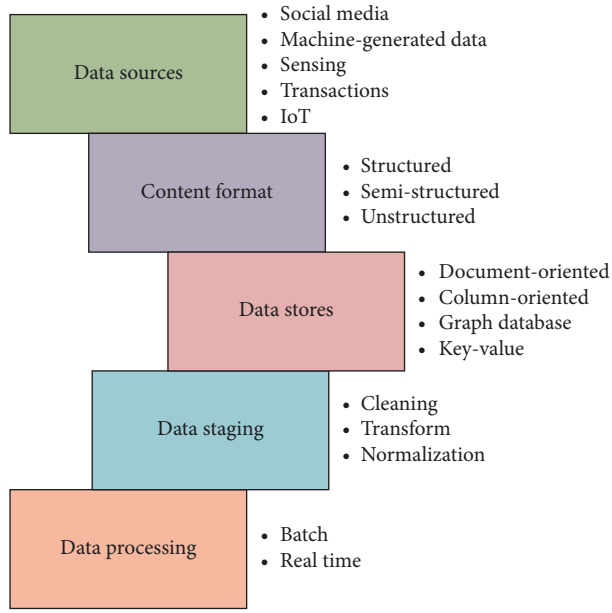

Figure 1: Various categories of data.

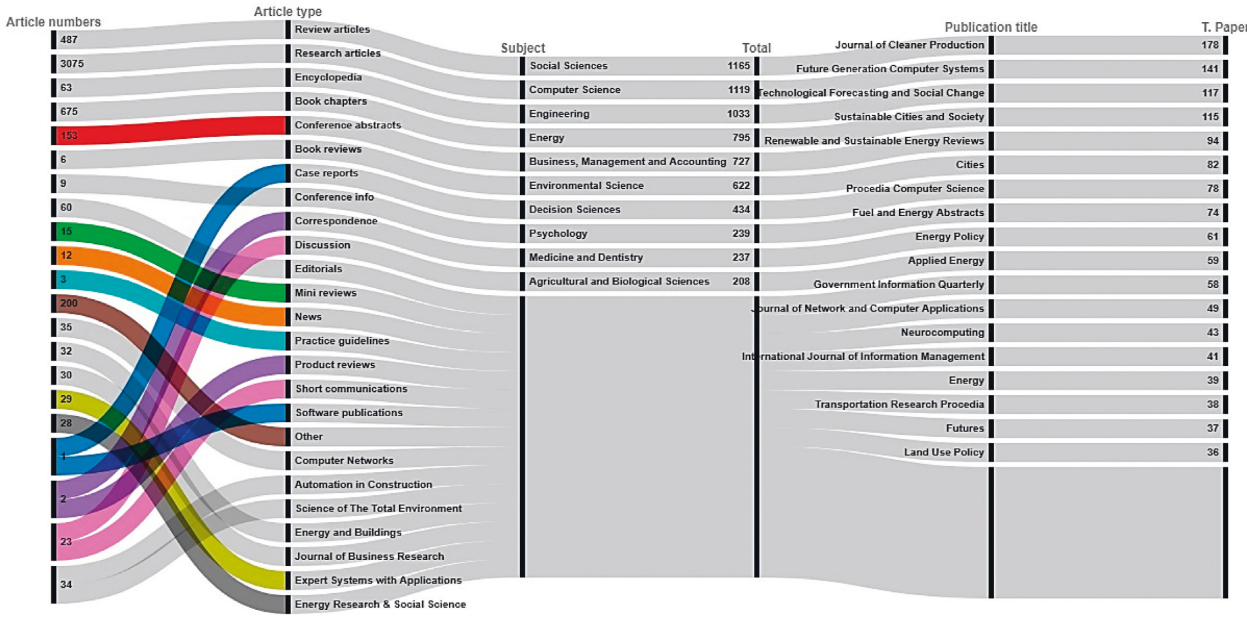

Figure 2: Details of the search process in the ScienceDirect library.

data processing, and data staging are defined. Figure 1 shows the details of various categories of data [3].

Various popular libraries were searched for the process of finding out associated materials to the proposed study. These libraries include ScienceDirect, Springer, IEEE, and ACM. Figure 2 shows the representation of the Science-Direct library for showing the details of the search process.

Some details regarding the number of publications in a given year are given in Figure 3.

Figure 4 depicts the details of the IEEE library for the search process.

The details of the Springer library is shown in Figure 5.

The search process of conference events in the ACM library is depicted in Figure 6.

Furthermore, the other details of the search process in the ACM library are given in Figure 7.

Figure 8 describes the A's of big data. These A's include agility, automation, accessibility, accuracy, and adoption.

The proposed approach has used the application of ANP for evaluation of A's of big data for transformation of smart cities. The approach was adopted to efficiently evaluate the big data according to the defined criteria. The approach has mainly three categories, first to define the goal (assessment), then define the criteria (agility, automation, accessibility,

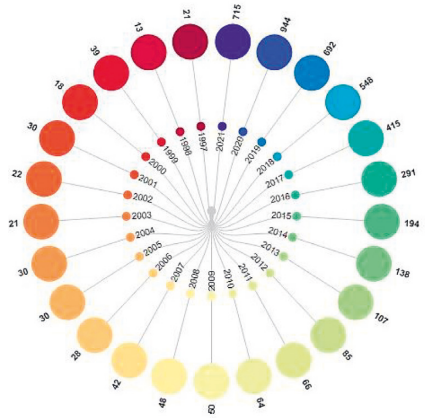

Figure 3: Details of year and number of publications in the ScienceDirect library.

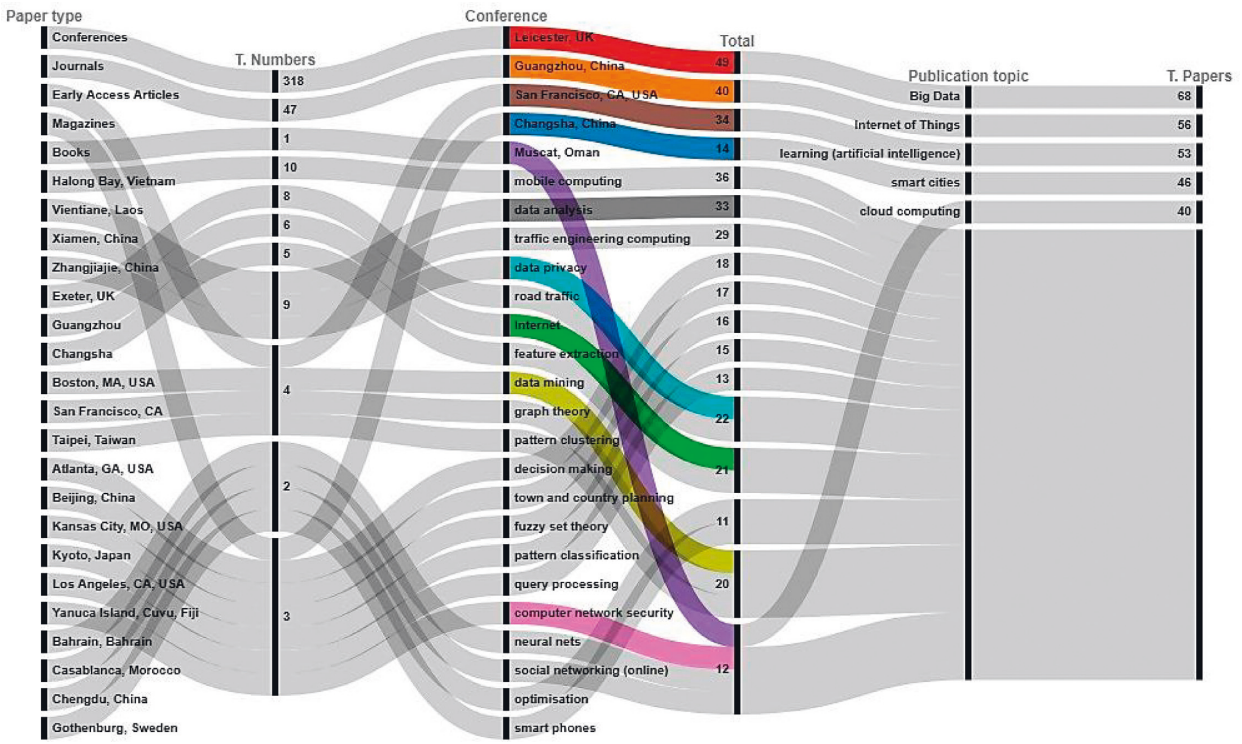

Figure 4: Details of the search process in the IEEE library.

Figure 5: Details of the search process in the Springer library.

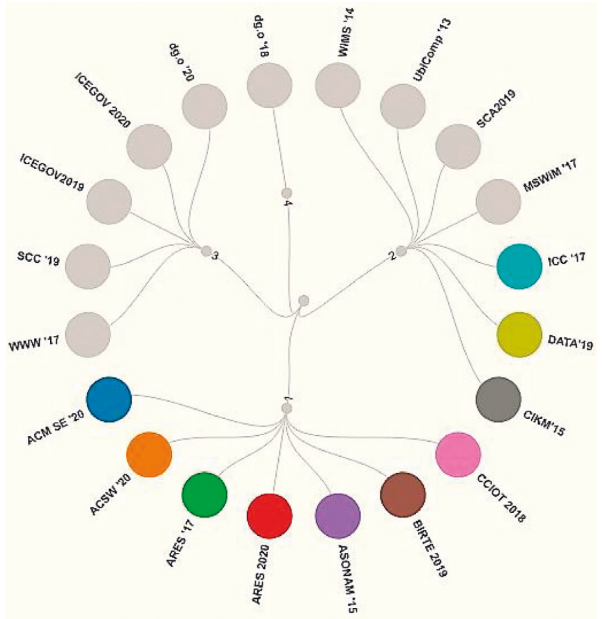

Figure 6: Details of conference events in the ACM library for the search process.

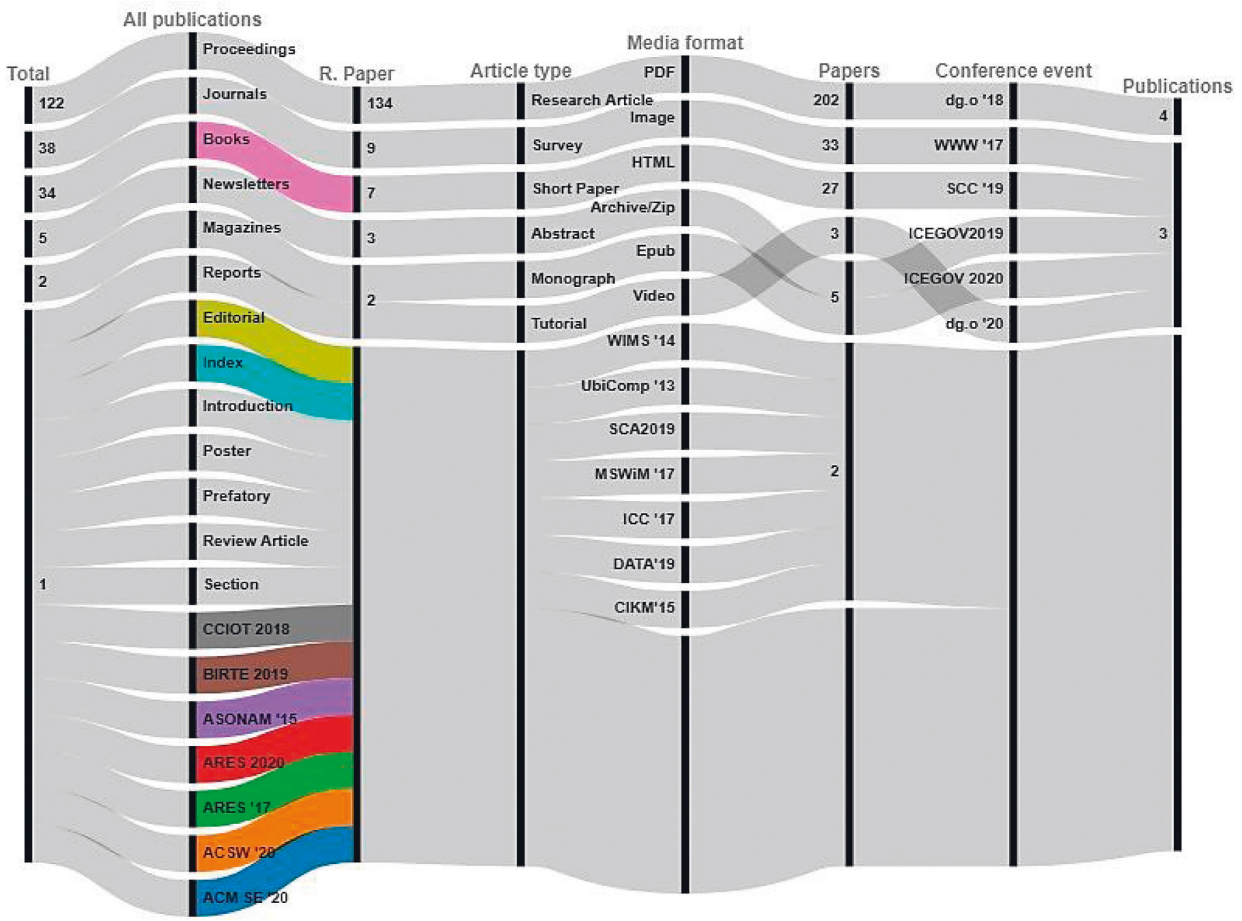

Figure 7: Other details of the search process in the ACM library.

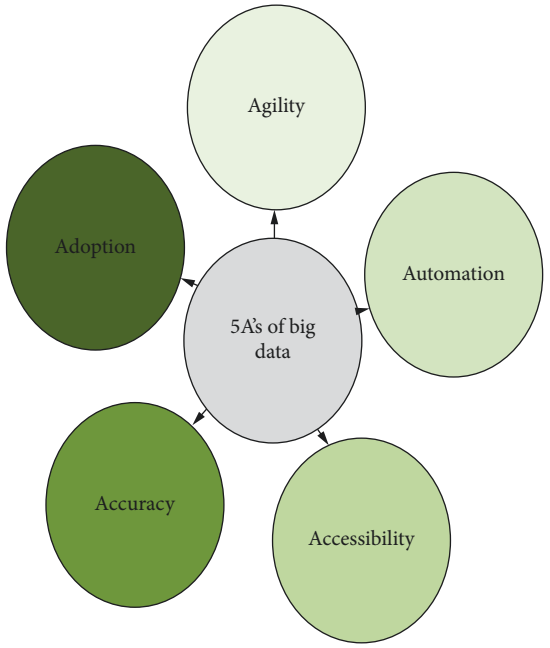

Figure 8: A's of big data.

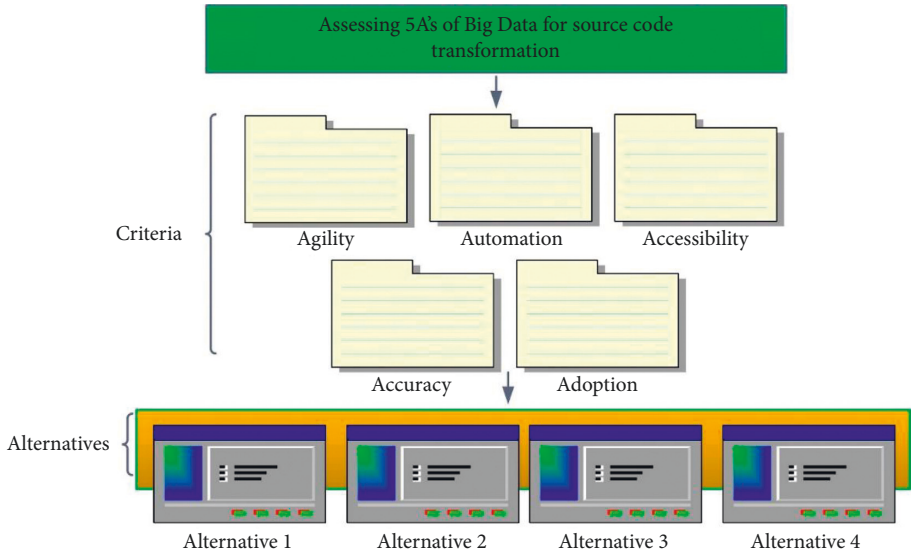

Figure 9: Proposed hierarchy of goal, criteria, and alternatives for A's of big data.

Table 1: Comparison of criteria with respect to "Alternative 1."

	Agility	Automation	Accessibility	Accuracy	Adoption
Agility	1	1/3	1/2	1/2	1/4
Automation	3	1	1/2	1/3	1/2
Accessibility	2	2	1	1/3	1/2
Accuracy	2	3	3	1	1/2
Adoption	4	2	2	2	1

accuracy, and adoption), and finally define the alternatives (four) for evaluation. The ANP approach was implemented for the proposed study in order to assess the criteria for the goal against the available alternatives. The ANP approach works very well in situations where complexity arises and decision-making is difficult and challenging. The approach of ANP has numerous applications [24–27]. Figure 9 presents the proposed hierarchy of goal, criteria, and

Table 2: Normalized table after the process of normalization.

	Agility	Automation	Accessibility	Accuracy	Adoption	EV
Agility	0.08	0.04	0.07	0.12	0.09	0.081
Automation	0.25	0.12	0.07	0.08	0.18	0.141
Accessibility	0.17	0.24	0.14	0.08	0.18	0.162
Accuracy	0.17	0.36	0.43	0.24	0.18	0.275
Adoption	0.33	0.24	0.29	0.48	0.36	0.341

CI = 0.082, where CI is the consistency index.

Table 3: Alternatives with respect to criteria "Agility."

	A1	A2	A3	A4
A1	1	1/2	1/2	1/3
A2	2	1	1/3	1/3
A3	2	3	1	1/2
A4	3	3	2	1

Table 4: Normalized table after normalization process.

	A1	A2	A3	A4	EV
A1	0.13	0.07	0.13	0.15	0.12
A2	0.25	0.13	0.09	0.15	0.16
A3	0.25	0.40	0.26	0.23	0.29
A4	0.38	0.40	0.52	0.46	0.44

CI = 0.062.

Table 5: Weighted supermatrix.

Node label		A's					Alternatives			
		Agility	Automation	Accessibility	Accuracy	Adoption	A1	A2	A3	A4
A's	Agility	000	000	000	000	000	0.081	0.098	0.075	0.085
	Automation	000	000	000	000	000	0.141	0.116	0.164	0.158
	Accessibility	000	000	000	000	000	0.162	0.194	0.170	0.158
	Accuracy	000	000	000	000	000	0.275	0.233	0.266	0.247
	Adoption	000	000	000	000	000	0.341	0.359	0.325	0.352
Alternatives	A1	0.119	0.466	0.104	0.441	0.090	000	000	000	000
	A2	0.156	0.258	0.232	0.256	0.180	000	000	000	000
	A3	0.285	0.181	0.261	0.164	0.449	000	000	000	000
	A4	0.440	0.095	0.402	0.139	0.281	000	000	000	000

Table 6: Limit matrix.

Node label		A's					Alternatives			
		Agility	Automation	Accessibility	Accuracy	Adoption	A1	A2	A3	A4
A's	Agility	0.084	0.084	0.084	0.084	0.084	000	000	000	000
	Automation	0.146	0.146	0.146	0.146	0.146	000	000	000	000
	Accessibility	0.170	0.170	0.170	0.170	0.170	000	000	000	000
	Accuracy	0.256	0.256	0.256	0.256	0.256	000	000	000	000
	Adoption	0.343	0.343	0.343	0.343	0.343	000	000	000	000
Alternatives	A1	000	000	000	000	000	0.240	0.240	0.240	0.240
	A2	000	000	000	000	000	0.218	0.218	0.218	0.218
	A3	000	000	000	000	000	0.291	0.291	0.291	0.291
	A4	000	000	000	000	000	0.251	0.251	0.251	0.251

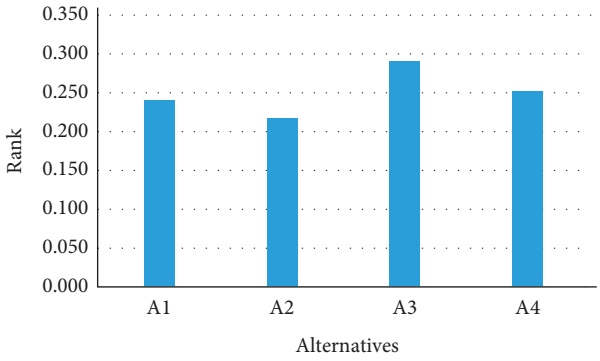

Figure 10: Final assessment score of the alternatives.

alternatives for A's of big data. The approach can decide the best choice among the available alternatives based on the defined criteria.

4. Results and Discussion

Data is well-thought-out to be one of the substantial assets of organizations in any field of life. The data plays a vital role in industries to analyze, manage, and process their business needs. Considering the A's of big data for its normal assessment can save time and resources to easily analyze and process the data. Keeping under review, the ANP approach was adopted in the proposed study under consideration for assessment purposes. The detail of the ANP approach can found in [28]. The whole process of ANP was performed in order to get the assessment measure of the available alternatives against the defined criteria. Table 1 shows the process of comparison of criteria with respect to "Alternative 1."

Pairwise comparison for Table 1 was done, and the normalized table was obtained. Table 2 shows the normalized table.

The same processes have been done for the rest of Alternatives 2, 3, and 4.

Table 3 represents the process of comparison with respect to criteria "Agility."

After pairwise comparison, the normalized table was obtained which is shown in Table 4.

The same processes have been done for rest of the criteria such as "Automation," "Accessibility," "Accuracy," and "Adoption."

Once the pairwise comparisons and normalization process were completed, then all the eigenvalues of each tables were brought into a single matrix called weighted supermatrix. Table 5 represents the weighted supermatrix.

The weighted supermatrix was then converted by taking the power until all the values of each row become the same. This matrix was then converted into the limit matrix for decision-making against the available alternatives. Table 6 depicts the limit matrix for criteria and alternatives.

Figure 10 graphically represents the ranking of available alternatives including A1, A2, A3, and A4. From the figure, it is clearly observed that among the available alternatives, Alternative 3 obtained the high score which is considered as the best choice among the existing choices, followed by Alternative 4, and so on.

5. Conclusion

Data is well-thought-out to be one of the substantial assets of organizations in any field of life. The data plays a key role in industries to analyze, manage, and process their business needs. The role of automation can extremely revolutionize to adopt the things, to automate and accurately access, with cost-efficient resources, and save human time and effort. An efficient and smart system is the dire need of the modern industry to efficiently and accurately assess the A's of big data for transformation of smart cities. Considering the A's of big data for its normal assessment can save time and resources to easily analyze and process the data. The current study analyzed the existing literature and then considers the A's of big data, and with the support of analytic network process, the same has been assessed. The approach adopted the network hierarchy of goal, criteria, and alternatives for assessing the A's of big data. The experimental results obtained from the proposed study show the effectiveness of the proposed research. The approach can easily select the best choice among the available alternatives.

Data Availability

No data was used to support this study.

Conflicts of Interest

The authors declare no conflicts of interest.

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