Data Science Methods in Project Financing Involvement

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***Abstract*—Changes in the economy require innovative approaches to data analysis. Most data today is poorly structured or unstructured, large in size, Data Science methods are becoming the tool that facilitates efficient data processing. Big data in finance today requires improvement and refinement of practical aspects of implementation because, in most cases, the traditional approach dominates. Given the constant development of information technology and its application in all areas, Data Science Methods prioritize organizing the process of finding sources of project funding. The study considers the possibilities of using Data Science Methods in project financing involvement, developed a model for decision-making on project financing. The volume of project financing and their structure by different sectors of the economy are studied separately.**

Keywords—Data Science, project financing, decision-making, finance

I. Introduction

Large amounts of ever-growing data characterize the digital age. The total volume of data in the world doubles every 18 months, and over 90% of the data that exist today were created in the last two years [6]. For the most part, such data are poorly structured or unstructured.

Data science is an umbrella term for an interdisciplinary field that uses scientific methods, processes, algorithms, and systems to extract knowledge and insights from data in various forms like data mining and machine learning [9, p. 19]. Big data analysis mainly includes Linear regression, Logistic regression, Classification and Regression Trees, K-Nearest Neighbors, K-Means Clustering, Neural networks, which cannot be implemented without the use of Data Mining methods. Data science in finance is mainly used in cases when performing Financial distress modeling, Financial fraud modeling, Stock market prediction and Quantitative modeling, and Auditing [9, p. 22]. However, these methods are practically not used to analyze and structure project financing. Increasingly, these methods are used in economics. In particular, L. Chagovets, S. Prokopovych, and V. Kholod investigate regional economic development by applying Data science methods [p. 43-56]. Financial markets also produce significant amounts of data, so using Data Science methods to process them is especially relevant today.

Applying Big data in finance today requires improvement and refinement of practical aspects of implementation because, in most cases, the traditional approach dominates [1]. The main task of the study is to identify and prove the benefits of using Data Science Methods when making decisions about investing and financing projects.

II. Analysis of Recent Research and Publications

I. S. Lazarenko, S. V. Saloid, S. O. Tulchynska, S. O. Kyrychenko, R. V. Tulchinskiy consider and prove the need to study Data Science as a separate discipline by students of economic specialties [11, p. 132-144]. They argue it by changes in the economy and the multiplicative amount of data, the type, and nature of these data. The authors note that the specificity of economic professions requires acquiring skills in the work with Big data. The economists of the future should be a specialist in the main subject area and a specialist in Big Data and Data Mining [11, p. 132].

D. Krukovets reviews the main streams of Data Science algorithm usage at central banks [10, p. 13-24], focusing on macroeconomic and financial forecasting, text analysis (newspapers, social networks, and various types of reports), and other techniques based on or connected to Big Data. A. Perić, N. Polić, E. Kozarević say that the power of analytics is becoming valuable to finance departments, as the information on company performance is integrated with budgeting, forecasting, and general financial information [16, p. 1078-1090]. It makes increasing the interest in cloud technology, Big data trends, and data analytics. All these are the subjects in Data Science. A new approach to financial research is called Financial data science. C. Brooks, A. G. F. Hoepner, D. McMillan, A. Vivian, C. W. Simen talk about its origin and introductory provisions [4, p. 1627-1636]. They define financial data science "as an interdisciplinary process of scientific inquiry, which is rigorously and repeatedly exploring and explaining the variance in all relevant data sets to advance financial decision making" [4, p. 1629].

Data science in finance is often used to predict indicators and not make decisions about the optimal value [1]. Therefore, this area of research becomes especially relevant in the languages of the variability of the business environment and the volatility of the requirements of business entities to sources of project funding. We believe that Data science can be extended to predict the reliability of credit applicants' tendency to delay payments or risk of defaulting [9, p. 24]. More accurate forecasting of interest rates can affect investment decisions during project financing. Also, Data science can help optimize project budgeting since data analytics tools allow a project manager to combine diverse financial and non-financial data and make more effective decisions about project financing and manage project financial risks. Risk management is a crucial area of big data analytics, especially after the recent financial crisis [23].

Systematization of Data Science methods is done by V. V. Liubchenko, N. O. Komleva, S. L. Zinovatna, K. O.

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Pysarenko [12, p. 80-90]. In particular, Data Science methods include Data Preprocessing (Data Cleansing, Data transformation, Feature Engineering), Data Modeling (Generative modeling, Predictive Modeling), Data Visualization (Data Presentation, Interactive Visualization). Each of these areas of Big Data research involves using different methods and approaches to mathematical and statistical analysis, information technology, and subject-oriented knowledge. Big data analysis is an essential aspect of using Data Science methods in identifying fakes, false, and data that are not directly related to the problem to be solved [3, p. 91-95].

III. DATA SCIENCE IN PROJECT FINANCING

In general, the concept of "data science in project financing" can be shown as an intersection of the main areas of research (Figure 1).

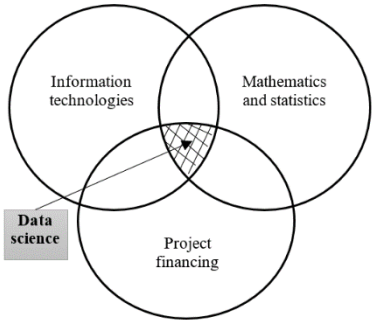

Fig. 1. The hierarchy of alternatives and criteria

The scheme visualizes the general theoretical approach to the understanding of data science as to science at the intersection of several branches of knowledge: information technologies, mathematics, and statistics, and also subject area. In our study, the subject area is project financing. The study of the data of the subject area should be a methodological concept of decision-making to project financing involvement.

Approaches to data analysis using Data Science methods proposed by I. V. Ponomarenko and I. I. Vinnikov for Internet marketing [18, p. 63-67] can be used when making decisions on project financing involvement. The intensity of the introduction of innovative digital technologies affects the development of individual businesses. Therefore, their application when choosing a project financing scheme will allow both to optimize the decision-making process and to form a competitive position of a project product on the market. In current conditions, due to the accumulation of large amounts of information, the availability of powerful computer equipment, and appropriate software, there is an opportunity to implement Data Science approaches in the field of project financing.

Big Data in finance has three features: large size, high dimension, and complex structure [8, p. 3]. Big data in finance starts from analyzing large-size data such as trades and quotes [8, p. 14]. Approaches to Big Data processing are increasingly the object of scientific research, in particular related research [13, 21, 22, 23]. Given the constant development of information technology and its application in all areas, Data Science Methods prioritize organizing the process of finding sources of project funding. Data Science Methods will allow us to track all available opportunities to raise financial resources in real-time, allowing us to compare the criteria for requirements, cost, availability, identification of identical proposals, and more. Thus, GV Makarova, IO Ushakova consider the possibility of creating an algorithm for selecting business partners using the methods of Data Science [14, p. 69-74].

The concept of "project financing," as well as the dynamics and structural project financing, explores M. K. Mohammadia [15, p. 24-33], focusing on the Arab countries. Problems and prospects of using data science in domestic financial and economic research are considered by A. Yu. Polchanov and O. Yu. Polchanov [17, p. 161-169]. The authors identified problems using data science in financial research. A separate group of studies is those aimed at comparing corporate and project financing. In particular, [20] compare Project Finance loans with Corporate Finance loans across forty countries and show, first, that in countries where laws protecting against managerial self-dealing are weak, Project Finance is more likely. Also, the researched topic is partially revealed by O. Astanakulov, who considers the functional algorithm for evaluating and modeling using the Data Science methodology for national projects and government programs [2, p. 51-59].

IV. THE CURRENT STATE OF PROJECT FINANCING

Project financing - the provision of financial resources for the implementation of the project, based on the viability of the project itself, the source of repayment of obligations arising from such financing is the cash flows generated as a result of the project. The basis of project financing is forming such a financing scheme that will provide the optimal level of risk and profitability of the project for all stakeholders.

Information on project financing in different world regions can be found in Project Finance Outlook [19] and the Global Project Finance Review [7]. The amount of debt project financing during 2019-2020 decreased significantly, explained mainly by the impact of the COVID-19 pandemic. The overall decrease in debt project financing in the global economy during 2019-2020 is 10.55%. However, in the global regions of the world economy, the dynamics of debt project financing during the analyzed period were completely different (Table 1).

TABLE I. GLOBAL PROJECT FINANCE LOANS

Region	1/1/2020-12/31/2020		1/1/2019 - 12/31/2019		Growth in 2019-2020	
	US$mil	*%*	*US$mil*	*%*	*US$mil*	*%*
Global	277,613.4	100.00	310,346.8	100.00	-32,733.4	-10.55
Americas	88,337.7	31.82	94,589.8	30.48	-6,252.1	-6.61
EMEA	125,643.6	45.26	125,500.5	40.44	143.1	0.11
Asia Pacific & Japan	63,632.0	22.92	90,256.5	29.08	-26,624.5	-29.50

The EMEA region (Europe, Middle East, and Africa) had almost no changes in debt project financing. At the same time, the most significant negative impact on the development of debt project financing occurred in the region of Asia Pacific & Japan, where volumes decreased by almost 30%. It can be explained mainly by the negative impact of the COVID-19 pandemic. The US market has also shrunk, reflected in a reduction in the debt project financing of more than 6%.

Table 2 presents the structure of debt project financing by sectors of the economy in 2019-2020 and the change in debt project financing.

TABLE II. GLOBAL PROJECT FINANCE LOANS BY SECTOR

Sector	Global		Americas		Asia Pacific & Japan	
	2020	*2019*	*2020*	*2019*	*2020*	*2019*
Power	47.82	42.32	56.22	53.33	46.31	42.38
Oil & Gas	23.14	20.87	22.39	27.67	20.97	7.84
Transportation	12.27	17.65	13.80	8.84	19.14	26.38
Telecommunications	4.70	2.03	0.50	0.00	0.12	0.06
Industry	3.82	1.70	1.60	1.89	0.17	1.15
Mining	2.28	3.19	0.55	5.01	7.01	0.20
Petrochemicals	1.89	5.58	3.62	0.74	2.00	11.34
Leisure & Property	1.58	3.69	1.04	1.68	2.94	7.07
Waste & Recycling	1.29	0.15	0.00	0.00	0.00	0.00
Water & Sewerage	1.19	2.82	0.28	0.79	1.34	3.48
Agriculture & Forestry	0.02	0.00	0.00	0.00	0.00	0.00

Highest declines in debt financing in the Americas region occurred in the Mining (-89.82%, -4,258.4 US$mil) and Water & Sewerage (-67.45%, -505.5 US$mil) sectors. The overall decrease in the Americas region (-6.61%, -6,252.1 US$mil) decreased -24.44% (-6,398.4 US$mil) of debt project financing of the Oil & Gas sector. This sector accumulated about 25% of debt project financing in 2019-2020, and significant changes in this sector have led to a general decrease throughout the region.

The most significant decrease in debt project financing was in the Asia Pacific & Japan region (-29.50%). The overall decrease in debt project financing (-29.50%, -26,624.5 US $ mil) in the Asia Pacific & Japan region was due to a decrease in -48.86% (-11,632.7 US $ mil) in the debt project financing of the Transportation sector and a reduction of -87.55% (-8,964.5 US $ mil) and -22.96% (-8,780.4 US $ mil) of debt project financing of the Petrochemicals and Power sectors, respectively. The share of all three sectors in the debt project financing market in 2019-2020 decreased significantly. However, the most significant structural changes occurred for the Petrochemicals sector, whose share decreased from 11.34% (third sector in terms of debt project market weight) in 2019 to 2.00% (sixth sector in terms of debt project finance market) in 2020.

V. CONSTRUCTION OF PROJECT FINANCING SCHEME BASED ON DATA SCIENCE METHODS

Project financing scheme - a set of organizational, financial characteristics, the definition of subjects, objects of the process, sources of financial resources for project implementation, risk allocation methods, and participation in the distribution of project profits. Since the project financing scheme reflects the mandatory parameters that comprehensively reflect the project financing, the formation of the project financing scheme is mandatory for any project.

The main parameters (P) of any project financing scheme can be classified into seven groups (Table 3).

All these parameters of the project financing scheme belong to unstructured or poorly structured data. Because any project is innovative, and its characteristics are different from other projects. The constraints for each project are unique. Existing databases to use such parameters either do not exist or the data of such databases need to be further analyzed for different results. In addition, all projects are implemented in a dynamic environment, in conditions of uncertainty, and therefore such databases must be dynamically updated.

Input data for project financing scheme are formed from both internal and external sources. Such data acquire the status of resource constraints of the project.

TABLE III. ELEMENTS OF THE PROJECT FINANCING SCHEME

Symbol	Parameter name	Element of the project financing scheme
P_1	characteristics of investors	creditors who provide financial resources on loan terms or invest in debt securities; shareholders (participants) who invest in corporate rights
P_2	process object	project as a separate independent organizational unit; project as part of the activities of an individual business entity
P_3	sources of project funding	own sources; liabilities
P_4	terms of financial resources involvement	amount; terms (security, repayment of the principal amount and payment for the use of resources, grace periods); rates of payment for the use of financial resources; effective interest rate
P_5	sources of debt repayment	cash flows exclusively from the project implementation; cash flows from the business entity (for which the project is implemented) and from the project implementation
P_6	investor risk management methods	types of security
P_7	terms of investors' contributions	share price, share in the share capital, types of shares (ordinary or preferred).

In addition, additional input data for the formation of the parameters of the project financing scheme are KPI (key performance indicators) of the project because they affect the individual parameters of such a scheme.

Also, part of the input data for forming the parameters of project financing schemes is obtained at the development stage, as project financing provides financial resources for all activities in the project schedule. Therefore, all calendar planning data and some other structural planning data (including all data generated as a result of budgeting) can be included in the input data of the project financing scheme.

Based on the formed databases of parameters of the scheme of project financing, an array of schemes of the project financing ($S_{1...n}$) is carried out. However, the peculiarity of project financing is that at the first stage of project financing, several schemes are mainly formed, from which one is selected. Criteria (C) for the selection of project financing schemes are: 1) the probability of implementation of the financing scheme (C_1); 2) the impact of the funding scheme on project effectiveness (C_2); 3) level of risks (C_3); 4) reliability of funds from investors (C_4); 5) compliance with the financing scheme with the general strategy of enterprise development (C_5).

VI. DECISION-MAKING ON PROJECT FINANCING INVOLVEMENT

The final management decision to select a single project financing scheme (MD) is binary (Boolean): 1) approval and further implementation of the project financing scheme; 2) refusal to implement the scheme (all schemes) of project financing. Schematically, the hierarchical structure of decision-making on project funding involvement is presented in Figure 2.

The model of decision-making on the choice of project financing scheme takes the form:

$$Dt = (P, S, C), \quad (1)$$

where P – descriptive analysis and description of initial data for parameters of the project financing scheme; S – comparative analysis and description of project financing scheme; C – compliance analysis with the criteria of project financing scheme; Dt – evaluation analysis of project financing scheme and predicting the likelihood and effectiveness of project financing scheme or impossibility of project financing.

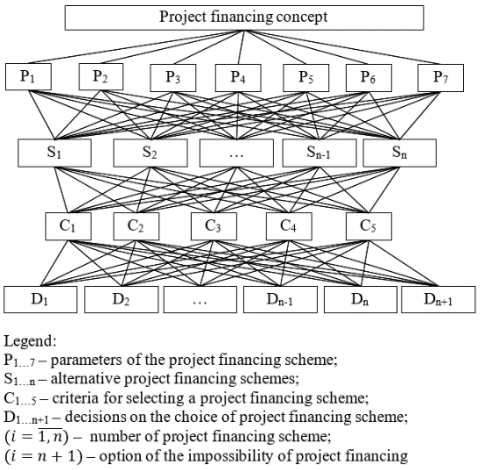

Fig. 2. The hierarchical structure of decision-making on project financing involvement

Applying the proposed hierarchical scheme and decision-making model for project financing involvement is based on Data Science methods, taking into account the nature and type of input data. Its practical application will increase the efficiency of decision-making processes to project financing involvement according to various criteria that are the highest priority for the entity.

VII. CONCLUSIONS

The primary attention is paid to studying the essence and place of Data Science in project financing involvement. Given that most data today is poorly structured or unstructured, large in size, Data Science methods are becoming the tool that facilitates efficient data processing. The study formed a model for deciding on a project financing scheme, which involves the analysis of Big Data based on Data Science approaches. The project financing analysis makes it possible to identify changes in the structure of such financing both by sources and sectors of the economy. The choice of project financing scheme is characterized by taking into account a set of parameters and criteria. Input data on project financing parameters today are large arrays of poorly structured and unstructured data that require innovative approaches to their processing in order to make effective decisions based on them.

In further research, it is advisable to pay attention to the formation of dynamic information databases on the parameters of project financing and perform practical testing of the developed decision-making model for the selection of project financing schemes based on Data Science approaches.

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