2020 IEEE International Conference on Progress in Informatics and Computing (PIC) | 978-1-7281-7086-2/20/$31.00 ©2020 IEEE | DOI: 10.1109/PIC50277.2020.9350787

# Project Portfolio Management Studies Based on Machine Learning and Critical Success Factors

Augusto Hayashida Marchinares [1,*], Igor Aguilar-Alonso [1,2]

*1. Facultad de Ingeniería de Sistemas e Informática, Universidad Nacional Mayor de San Marcos, Lima, Perú*

*2. Escuela Profesional de Ingeniería de Sistemas, Universidad Nacional Tecnológica de Lima Sur, Lima, Perú*

augusto.hayashida@unmsm.edu.pe, iaguilar@untels.edu.pe, iaguilara@unmsm.edu.pe

**corresponding author*

***Abstract*—Project Portfolio Management is very important for the growth of companies, because it favors to plan several possibilities in each scenario. The purpose of the Project Portfolio Management is to manage all resources in order to plan and execute successful projects and achieve the strategic objectives of the organizations. In the Project Portfolio Management, a lot of data is generated daily, which is important for the planning of new projects in companies; consequently, this need arises to create models that help to process and interpret this data. In this context, Machine Learning as an expression of Artificial Intelligence, is presented as an alternative and technological enabler that allows a system, by itself and in an automated way, to learn to discover patterns, trends and relationships in data, it is presented as an engine of digital transformation of business, which is being adopted by many organizations and its demand is growing. Therefore, this paper aims to compile and review the proposals made for the implementation of Machine Learning and critical success factors to improve Project Management, based on a literature review and an analysis of the current state of the art of Machine Learning. 122 articles were found and 21 articles were selected that are related to the research questions. As a final result, 7 ML methods and 18 critical success factors for PPM have been identified.**

***Keywords— Machine Learning, Deep Learning, Project Portfolio Management, Models, Critical Success Factors***

## I. INTRODUCTION

Today, Project Portfolio Management (PPM) is very important for the growth of companies, this allows planning a series of possibilities in a given scenario. The purpose of the PPM is to adequately manage all available resources to be able to select, plan and execute successful projects, it also allows to reduce costs, improve the quality of service provision, increase benefits, minimize risks and create value in organizations to achieve their strategic objectives.

Motoa, indicated that projects are of great importance for society and for organizations and today it is important the concept that resources are limited [1].

Without projects, societies do not develop and organizations become obsolete and unable to survive in an environment of competition [2]. We must start to think about what we call successful projects, and the conditions that facilitate project success.

Professionals use risk management based on the common assumption that risk management adds value to projects, and this is not necessarily the case, what is sought in project management is to increase profits and minimize risks [3]. However, achieving this requires increasing project management capabilities. Many times in project measurement they only look at the iron triangle (time, cost and scope - TCA), a product of the inexperience of project managers, but also it is difficult to measure medium and long-term variables related to the success of the Project [4]. To understand which conditions facilitate the success of projects and identify which are the causes that lead to a project failure, it involves analyzing the internal and external contexts in which they are executed [5]. In this sense, there are both academic and corporate studies for the use of methodologies, frameworks and good practices at the strategic level of PPM, some more oriented to the efficiency and effectiveness of the project manager's knowledge and others to the use of new technologies that promote innovation, which allow to carry out this transformation of project management [6].

According to [7], they indicate that the PPM is a permanent process that evaluates, prioritizes and monitors projects in the Project Portfolio Management Office (PPMO). The pressure to increase the profits of organizations depends on various internal and external factors. For this reason, it is necessary to create a very close link between strategic planning and project processes.

Large industries, such as financial services, health and government, are the ones who have been dabbling in technologies such as Machine Learning (ML). ML, as an expression of Artificial Intelligence, is an analytical function that already determines multiple aspects of our life, as an engine for the digital transformation of the business and provides value proposals [8]. The benefits of adopting ML are based on the reduction of planning costs, selection of correct and efficiently assigned projects, ML allows a system, in an automated way, to learn to discover trends and patterns, as well as the relationship between data [9].

It should be considered that the Digital Competitiveness Index in Peru is low compared to other countries. This is demonstrated by its position in the IMD 2018 World Digital Competitiveness ranking [10], Peru is in a position N ° 54 out of 62 participants worldwide. Likewise, according to the 2019 World Economic Forum, Peru is in the last position in the ranking in ICT adoption in South America and in 98th place worldwide [11]. According to the 2016 annual economic survey by the National Institute of Statistics and Informatics (INEI) [12], it is indicated that only 58% of companies have management systems, allowing them to have a continuous improvement of their policies, procedures and organizational processes.

**978-1-7281-7086-2/20/$31.00 ©2020 IEEE**

Furthermore, according to PMI's Pulse of the Profession [13], they state that the most critical is the money that continues to be wasted when there is no good project management. Statistics indicate that US $ 122 million is wasted for each investment of US $ 1 billion, all of this is conditioned by poor project performance, the same source indicates that projects are 2.5 times more successful when using proven project management practices. Thus, tools that improve said management become relevant, a good option is ML, an effective project management leads to more successes, reducing risks and increasing the possibility of success in the strategies of organizations. In 2013 [14], it showed a project success rate of 39%, that is, meeting the time and requirements specifications. It also indicates that 43% of the projects conclude, but with delays or cost overruns and not necessarily complying with the requirements and specifications; and that 18% fail completely.

The ML provides an opportunity for economic growth for Peru. The main source of productivity growth that an economy has is adopting new technologies. In this regard, the difference between the United States and Peru is striking, while in the former Total Factor Productivity (TFP) grew steadily since 1980, in Peru it decreased by 40% [15].

Therefore, ML is presented as a technological enabler for companies and PPM, which 2.5 trillion bytes are globally generated daily [16]. Consequently, for many industries in the world, ML is becoming a factor that triggers deep innovation [17], generates new business opportunities and defines new business parameters, focusing mainly on PPM.

The objective of this article is to present the results of studies for PPM that use ML methods and their Critical Success Factors (CSF). In addition, the motivation to carry out this research is to know the ML models implemented in the academic and business fields, in order to know the latest models developed and help us with our proposal to improve project management in an organization.

Therefore, it has been necessary to apply the literature review, as a methodology for obtaining results, reviewing bibliography related to the studies of projects implemented by other authors that use ML, as well as studies related to the CSF for the PPM.

## II. Methodology

To carry out the review we use the guide established by Kitchenham [18], which consists of three important phases:

1) *Review Planning:* In this phase it is necessary to confirm the need to carry out the review, considering the research questions.
2) *Review Implementation:* In this phase, the primary studies are selected, according to the inclusion and exclusion criteria.
3) *Review Results:* In this phase the statistics and analysis of the selected articles are displayed.

### A. Review Planning

For the review, the following repositories of indexed scientific articles were consulted: Scopus, Springer Link, ScienceDirect, IEEE Xplore, and ACM. The research questions for the information search are the following:

*Q1: What Machine Learning methods are applied in Project Portfolio Management?*

*Q2: Which are critical success factors for Project Portfolio Management?*

### B. Review Implementation

The search process began by applying the following search strings in the repositories of indexed scientific journals, as well as indicated in Table I, to obtain potential articles.

TABLE I. Literature Search String

| Question | Search String |
|---|---|
| Q1 | MODEL AND (MANAGEMENT AND BUILD OR DESIGN OR IMPLEMENT) AND "MACHINE LEARNING" AND "PROJECT MANAGEMENT" |
| Q2 | (FACTORS OR CASES) AND OF SUCCESS AND PROJECT PORTFOLIO MANAGEMENT |

The results obtained from potential articles were filtered using the following inclusion and exclusion criteria, indicates in Table II.

TABLE II. Inclusion and Exclusion Criteria

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Articles related to research questions. | Studies that do not meet the inclusion criteria. |
| Studies from 2014 to 2020.<br>Studies related to Machine Learning models and frameworks.<br>Studies related to critical success factors for PPM. | Posters, editorials, letters, misprints, thesis and books. |
| Articles in journals or congresses. | |

To filter the articles, we took into account the process indicated in Fig. 1, considering the inclusion and exclusion criteria:

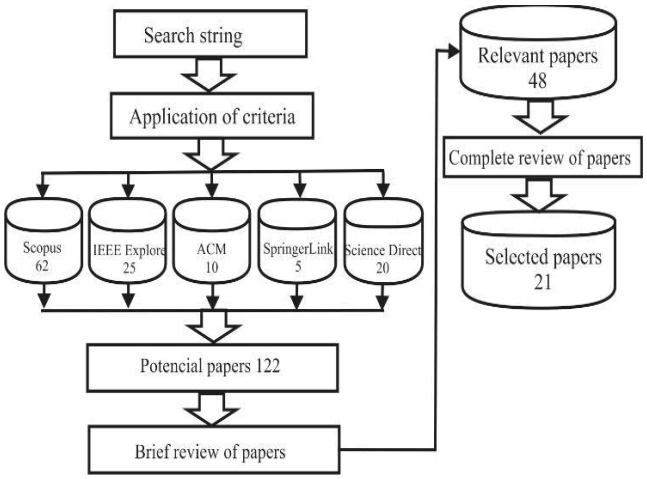


Fig. 1. Search process for selected articles.

After obtaining the relevant articles, a full review of the articles was performed. Finally, a small group of articles were selected to answer the research questions. Likewise, several articles were excluded because they did not meet the specified criteria

### C. Review Results

In the review process, 122 potential articles were identified, after a brief review of the articles, 48 relevant articles were identified and finally, after a deep review, 21 articles were selected (12 related to ML for project management and 9 articles related to CSF for PPM), as detailed in Table III.

TABLE III. POTENTIAL, FILTERED AND SELECTED ARTICLES

| Repositories | Potential articles | Relevant articles | Selected articles | % |
|---|---|---|---|---|
| Scopus | 62 | 24 | 11 | 52% |
| Springer link | 5 | 2 | 2 | 10% |
| Science Direct | 20 | 6 | 3 | 14% |
| IEEE Explore | 25 | 15 | 4 | 19% |
| ACM | 10 | 1 | 1 | 5% |
| TOTAL | 122 | 48 | 21 | 100% |

## III. RESULTS FOUND

The results found are described below:

### A. Found results of ML methods for PPM

According to Koulinas [19], it is expressed in a very didactic way, the recently proposed studies that use ML strategies, it is indicated in the article that it would be quite interesting to develop even more approaches of neural networks for various projects and their programming problems, and also, metaheuristics based on the hybrid nature enhanced by a Reinforcement Learning (RL) process.

Ruchi & Srinath [20], in their article they present the proposed architectural design and explanation of the related concept for efficient management of business projects in the current data scenario. On the basis that data mining and ML help to obtain valuable information about a company and its growth through data exploration, Project management helps cross-functional teams be more effective. Additionally, companies are using project management to develop their future leaders. The article presents the use of ML methods such as a) Support Vector Machine (SVM), b) Decision tree (DT), c) Multivariate regression analysis (MVR).

Agreeing to Bisong [21], in the article it is mentioned build automation as an integral part of Continuous Integration (CI) software development practice. At CI, developers are encouraged to join early and often. However, deployment times can be a problem when integrations are frequent. This research focuses on finding a balance between frequent integration and developer productivity. As a result, the following ML methods were used a) Linear Regression (LR), b) SVM and c) Artificial Neural Networks (ANN).

According to Hammad [22], the article tells us about estimating software effort as a primary mission in the software development process, covered by project managers. Cost estimation is used in the planning stage of software business management. The article presents ML methods to build software stress estimation models from software characteristics. These methods are: a) ANN, b) SVM and c) LR, they are evaluated on a public data set with real software efforts. The results showed that the ML approach can be reliable in predicting the future effort of a software system.

Agreeing to González [23]. He tells us about DT sets which is a very popular and successful method in ML. In this article, it is necessary to identify which ML methods are appropriate for a specific problem. The aim of the research is to help professionals choose the best overall technique according to the characteristics of their problem and their workflow. It mentions the following methods a) DT, b) MVR and c) ANN.

Concurring to Auch [24], it is explained how automation and ML are gaining popularity. To extract knowledge from existing software projects often, similarity analyzes are performed using different methodologies, data, and metadata. This article focuses on existing approaches to analysis based on similarities, categorizations, and relevance in software applications. It mentions the following ML methods used a) SVM, b) DT and c) ANN.

According to Dwivedi [25], it tells us about how Software Engineering Project Management is a key factor in determining success. The first thing to do is to estimate the time that should be devoted to the software development process. This article makes a comparative study of the different ML methods, which is a) LR, b) MVR, and c) ANN to calculate the time it takes to produce software.

Agreeing to Belharet [26], it points out that AI and ML are just beginning to be known in project management. This article shows the impacts of artificial intelligence on projects and how they will reshape project management in the future. Prevailing PMO models are juxtaposed to the potential impacts of AI. In this article the authors discuss how the worlds of AI and PM will intersect and show which PM processes will be affected first and which will be difficult to automate. ML methods are mentioned in the article: a) SVM and b) ANN.

According to Sabahi & Parast [27], they show recent studies on project management that have demonstrated the important role of people's business orientation in the performance of projects. In this study, an ML approach is proposed to predict the performance of people's projects based on people's business orientation and attitude. The study indicates that a range of ML methods including a) SVM, b) ANN, and c) MVR was used.

Corresponding to Jeong [28], in his article, delivery times for ship manufacturing in the naval industry were predicted, using ML technology to propose a new management method. Various ML methods were applied. Lead time prediction models based on analytical cases were created using various ML methods to investigate whether a specific algorithm is good for all data in the process. Among such ML methods that were used a) MVR, b) ANN and c) DT, which are known to be suitable for numerical prediction.

Matching to Pospieszny [29], this article addresses how ML methods are used in the field of software estimation, the

objective of which is to address the deficiencies of traditional estimation techniques and increase the success rates of projects, it is proposed effective and practical ML implementation and maintenance approaches. Through intelligent data preparation, a set averaging of three ML methods was achieved: a) SVM, b) ANN and c) LR.

Concurring to Dastile [30], this article reviews the ML models scoring and statistics. It also proposes a guiding framework for ML. The following ML methods are included: a) Naïve Bayes (NB), b) DT, c) SVM and d) ANN.

### *B. Results found of CSF for PPM*

According to Tobal [5], in his research he concludes that he has identified 2 critical factors that are most cited in the literature. These identified factors are: a) top management support; and b) a project manager dedicated to the project.

During Mansell's study [31], he has identified 6 CSF for projects. 4 factors have been identified from the results of a survey and 2 critical factors have been identified from a development model of the Impact-Value Chain (IVC). The factors identified are: a) strong leadership, b) clarity of IVC project success definition, c) prioritizing goals aligned to strategic vision, d) select targets relevant to the project, e) aligned business priorities, and f) reporting and communication.

Agreeing to Aini [32], the article tells us about the management of an ERP system implementation project. CSF become something interesting to identify the development of the system. This study shows that the CSF of this type of project are influenced by: a) individual impact, b) project management, and c) information quality.

Concurring to Sanchez [33], it is explained the successful development of information systems projects as a source of competitive advantage for organizations. In this article it is proposed as CSF of project management based on: a) project management, b) cost and time, c) project size (Hs) and d) team size.

According to Uriel & Amnon [34], it is described results that examine the relationship between knowledge management (KM) and the success of the project and if KM can contribute to the success of the project. Client participation also emerged as a key factor in the success of the project. Additionally, the budget, schedule and scope management. Therefore, the author provides us with three CSF: a) knowledge sharing, b) customer involvement and c) golden triangle.

Matching to Petro & Gardiner [35], it is shown the factors that make possible the success of the Project portfolio and the effectiveness in management in the project-based organization. The results of the investigation indicated that a) project management, as well as b) committee level of involvement and c) client satisfaction.

Corresponding to Ogbeifun [36], The project's CSF are determining elements of the project's outcome. This article reveals that project managers in higher education institutions expanded the project's CSF beyond the iron triangle. This is because capital assets are critical in developing suitable academic environments for teaching. Therefore, the CSF considered in the article are: a) cost and time, b) knowledge sharing, c) client satisfaction and d) project to desired quality.

Concurring to Kock [37], it is shown us that the application of Project Portfolio Management Information Systems (PPMIS) is generally positively associated with portfolio management processes quality and the success of the project portfolio. The article indicates that the success of the project depends on the following: a) project portfolio management information systems, b) project portfolio Management formalization c) risk management formalization, which can help project managers to find the causes of project problems and take appropriate action.

According to Mohagheghi & Jorgensen [38], it is aimed to reduce the waste of resources on failed software projects through a better understanding of the CSF and challenges. As a result, it was obtained that: a) customer Involvement, b) client satisfaction, c) project priority and d) the application of agile practices (AP) were the main CSF.

## IV. Analysis of Results

Based on the results found in the literature review, the following analysis is available:

### *A. Analysis of the ML methods identified for PPM*

The analysis of the results obtained from the literary review of the ML studies is carried out, as indicated in Table IV.

TABLE IV. ML Methods identified for PPM

| N° | Reference | Machine Learning Methods | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | ***RL*** | ***SVM*** | ***DT*** | ***MVR*** | ***ANN*** | ***NB*** | ***LR*** |
| 1 | [19] | X | | | | | | |
| 2 | [20] | | X | X | X | | | |
| 3 | [21] | | X | | | X | | X |
| 4 | [22] | | X | | | X | | X |
| 5 | [23] | | | X | X | X | | |
| 6 | [24] | | X | X | | X | | |
| 7 | [25] | | | | X | X | | X |
| 8 | [26] | | X | | | X | | |
| 9 | [27] | | X | | X | X | | |
| 10 | [28] | | | X | X | X | | |
| 11 | [29] | | X | | | X | | |
| 12 | [30] | | X | X | | X | X | |
| | Total | 1 | 8 | 5 | 5 | 10 | 1 | 3 |
| | % | 3% | 25% | 15% | 15% | 30% | 3% | 9% |

When analyzing the results found based on the existing ML Methods for PPM, it can be seen that the authors of the reviewed articles mostly apply the ANN and SVM method and two articles perform a model based on RL and NB. Therefore, we can take the revised models as a reference and select specific components, in order to propose a ML model. From a percentual point of view, the ANN methods are the most used with 30%

and the SVM method with 25%, then DT and MVR with 15%, LR with 9% and finally RL and NB with 3%.

Responding to research question 1, we conclude that from the analysis carried out, 7 traditional ML methods have been identified to help PPM. The methods found are the following: SVM, ANN, DT, MVR, RL, NB and LR.

### B. Analysis of the CSF identified for the PPM

Next, the analysis of the results obtained from the literary review of the CSF is carried out, as indicated in Table V.

TABLE V. CRITICAL SUCCESS FACTORS IDENTIFIED FOR THE PPM

| N° | Reference | Critical Success Factors | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Top Management support/Project management* | *Dedicated project manager* | *Strong leadership/Committee level of involvement* | *Clarity of project* | *Prioritizing of goals/Project Priority* | *Targets relevant/Projects to desired quality* | *Aligned business priorities/PPM formalization* | *Reporting and communication/Knowledge Sharing* | *Individual impact* | *Information quality* | *Golden Triangle* | *Project size (Hs)* | *Team size* | *Customer Involvement* | *Client satisfaction* | *PPM information systems* | *Risk management formalization* | *Agile practices* |
| 1 | [5] | X | X | | | | | | | | | | | | | | | | |
| 2 | [31] | | | X | X | X | X | X | X | | | | | | | | | | |
| 3 | [32] | X | | | | | | | | X | X | | | | | | | | |
| 4 | [33] | X | | | | | | | | | | X | X | X | | | | | |
| 5 | [34] | | | | | | | | X | | | X | | | X | | | | |
| 6 | [35] | X | | X | | | | | | | | | | | | X | | | |
| 7 | [36] | | | | | | X | | X | | | X | | | | X | | | |
| 8 | [37] | | | | | | | X | | | | | | | | | X | X | |
| 9 | [38] | | | | | X | | | | | | | | | X | X | | | X |
| TOTAL | | 4 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 1 |
| % | | 13% | 3% | 6% | 3% | 6% | 6% | 6% | 9% | 3% | 3% | 9% | 3% | 3% | 6% | 9% | 3% | 3% | 3% |

Analyzing the above table, it is observed that a total of 18 factors have been identified in the 9 articles analyzed. When making the crossing between factors and articles, there is a correspondence of 32 cells marked with "X".

The most outstanding factor among all, is represented with 13%, corresponds to top management support and project management. Then, represented with 9% each, it corresponds to the following factors: reporting and communication and knowledge sharing, golden triangle, and client satisfaction. With a 6% representation to each of the following factors: strong leadership and committee level of involvement, prioritizing of goals and project priority, targets relevant and projects to desired quality, aligned business priorities and PPM formalization, customer involvement. Finally, the other factors represent 3% each of them.

Responding to research question 2, we conclude that from the analysis carried out, 18 CSF have been identified that influence PPM. The CSF identified are the following: Top Management support and Project management, dedicated project manager, strong leadership and committee level of involvement, clarity of project, prioritizing of goals and project priority, targets relevant and projects to desired quality, aligned business priorities and PPM formalization, reporting and communication and knowledge sharing, individual impact, information quality, golden triangle, project size, team size, customer involvement, client satisfaction, PPM information systems, risk management formalization, agile practices.

## V. CONCLUSIONS

The article concludes with the following:

- As a result of the research process, a total of 122 articles were found, and finally 21 articles were selected, which are related to the research questions. 12 articles related to ML and 9 articles related to CSF to improve PPM.
- In the selected articles, 7 ML methods were identified. In the analysis carried out, the methods that are most repeated in the articles analyzed are ANN with 30%, and SVM with 25%.
- In relation to the PPM CSF, 18 factors have been identified and the factors that are repeated the most in the articles analyzed are support for senior management and project management with 13%; followed by reporting and communication and knowledge sharing, golden triangle and customer satisfaction, represented by 9% each.

## REFERENCES


[1] G. Motoa, "Project success assessment, a literature review," no. February, 2018.

[2] A. J. Shenhar, D. Dvir, O. Levy, and A. C. Maltz, "Project success: A multidimensional strategic concept," *Long Range Plann.*, vol. 34,

no. 6, pp. 699–725, 2001.
[3] P. Willumsen, J. Oehmen, V. Stingl, and J. Geraldi, "Value creation through project risk management," *Int. J. Proj. Manag.*, vol. 37, no. 5, pp. 731–749, 2019.
[4] R. Müller and J. R. Turner, "Matching the project manager's leadership style to project type," *Int. J. Proj. Manag.*, vol. 25, no. 1, pp. 21–32, 2007.
[5] F. Tobal Berssaneti and M. Monteiro Carvalho, "Identification of variables that impact project success in Brazilian companies," *Int. J. Proj. Manag.*, vol. 33, no. 3, pp. 638–649, 2014.
[6] C. Matt, T. Hess, and A. Benlian, "Digital Transformation Strategies," no. October 2016, 2015.
[7] I. A. Alonso, J. C. Verdún, and E. T. Caro, "The Importance of IT Strategic Demand Management in Achieving the Objectives of the Strategic Business Planning," in *2008 International Conference on Computer Science and Software Engineering*, 2008, vol. 2, pp. 235–238.
[8] G. Mccarthy, "Transforming business using digital innovations : the application of AI , blockchain , cloud and data analytics Transforming Business Using Digital Innovations : The Application of AI , Blockchain , Cloud and Data Analytics," no. May, 2020.
[9] A. Talavera and A. Luna, "Machine learning: A contribution to operational research," *Rev. Iberoam. Tecnol. del Aprendiz.*, vol. 15, no. 2, pp. 70–75, 2020.
[10] IMD, "Competitividad Digital Mundial," vol. 162, no. 20, pp. 99–100, 2018.
[11] K. Schwab and World Economic Forum - WEF, *Insight Report - World Economic Forum*. 2019.
[12] INEI, "TIC Peru 2015 INEI," 2018.
[13] Project Management Institute, "PMI's Pulse of the profession VIII encuesta mundial sobre dirección de proyectos," p. 36, 2016.
[14] S. G. International, "The Chaos Manifesto," *Chaos Manif.*, vol. 2, p. 52, 2013.
[15] R. Albrieu, M. Rapetti, C. Brest, and A. Sorrentino, "Inteligencia artificial y crecimiento económico Oportunidades y desafíos para Costa Rica," *Intel. Artif. y Crecim. Económico en América Lat. Buenos Aires CIPPEC*, p. 20, 2019.
[16] Kor, "Machine learning," pp. 3–5, 2016.
[17] P. K. Chan and S. J. Stolfo, "Toward Scalable Learning with Non-uniform Class and Cost Distributions : A Case Study in Credit Card Fraud Detection 1 Introduction," *n Proc. Fourth In- ternational Conf. Knowl. Discov. Data Min.*, pp. 164–168, 1998.
[18] B. Kitchenham, "Systematic literature reviews in software engineering ," vol. 51, no. 1, pp. 7–15, 2009.
[19] G. Koulinas, A. Xanthopoulos, A. Kiatipis, and D. Koulouriotis, "A summary of using reinforcement learning strategies for treating project and production management problems," *2018 13th Int. Conf. Digit. Inf. Manag. ICDIM 2018*, pp. 33–38, 2018.
[20] S. Ruchi and P. Srinath, "Big Data Platform for Enterprise project management digitization using Machine learning," *Proc. 2nd Int. Conf. Electron. Commun. Aerosp. Technol. ICECA 2018*, no. Iceca 2018, pp. 1479–1484, 2018.
[21] E. Bisong, E. Tran, and O. Baysal, "Built to last or built too fast? Evaluating prediction models for build times," *IEEE Int. Work. Conf. Min. Softw. Repos.*, pp. 487–490, 2017.
[22] M. Hammad and A. Alqaddoumi, "Features-level software effort estimation using machine learning algorithms," *2018 Int. Conf. Innov. Intell. Informatics, Comput. Technol. 3ICT 2018*, pp. 1–3, 2018.
[23] S. González, S. García, J. Del Ser, L. Rokach, and F. Herrera, "A practical tutorial on bagging and boosting based ensembles for machine learning: Algorithms, software tools, performance study, practical perspectives and opportunities," *Inf. Fusion*, vol. 64, pp. 205–237, 2020.
[24] M. Auch, M. Weber, P. Mandl, and C. Wolff, "Similarity-based analyses on software applications: A systematic literature review," *J. Syst. Softw.*, vol. 168, p. 110669, 2020.
[25] D. Dwivedi, A. Sharma, and A. Shukla, "Software Development Life Time Prediction Using Machine Learning Approach and There Comparison," *SSRN Electron. J.*, 2020.
[26] A. Belharet, U. Bharathan, B. Dzingina, N. Madhavan, C. Mathur, and Y. Toti, "Report on the Impact of Artificial Intelligence on Project Management 1," pp. 1–53, 2020.
[27] S. Sabahi and M. M. Parast, "The impact of entrepreneurship orientation on project performance: A machine learning approach," *Int. J. Prod. Econ.*, vol. 226, no. December 2019, p. 107621, 2020.
[28] J. H. Jeong, J. H. Woo, and J. G. Park, "Machine Learning Methodology for Management of Shipbuilding Master Data," *Int. J. Nav. Archit. Ocean Eng.*, vol. 12, pp. 428–439, 2020.
[29] P. Pospieszny, B. Czarnacka-Chrobot, and A. Kobylinski, "An effective approach for software project effort and duration estimation with machine learning algorithms," *J. Syst. Softw.*, vol. 137, pp. 184–196, 2018.
[30] X. Dastile, T. Celik, and M. Potsane, "Statistical and machine learning models in credit scoring: A systematic literature survey," *Appl. Soft Comput. J.*, vol. 91, p. 106263, 2020.
[31] P. Mansell, S. P. Philbin, and T. Broyd, "Development of a New Business Model to Measure Organizational and Project-Level SDG Impact—Case Study of a Water Utility Company," *Sustainability*, vol. 12, no. 16, p. 6413, 2020.
[32] S. Aini, M. Lubis, R. W. Witjaksono, and A. Hanifatul Azizah, "Analysis of Critical Success Factors on ERP Implementation in PT. Toyota Astra Motor Using Extended Information System Success Model," pp. 370–375, 2020.
[33] O. P. Sanchez, M. A. Terlizzi, and H. R. de O. C. de Moraes, "Cost and time project management success factors for information systems development projects," *Int. J. Proj. Manag.*, vol. 35, no. 8, pp. 1608–1626, 2017.
[34] I. Uriel and G. Amnon, "Function of Organizational Knowledge Management," *IEEE Int. Conf. Ind. Eng. Eng. Manag.*, vol. 1, pp. 340–356, 2018.
[35] Y. Petro and P. Gardiner, "An investigation of the influence of organizational design on project portfolio success, effectiveness and business efficiency for project-based organizations," *Int. J. Proj. Manag.*, vol. 33, no. 8, pp. 1717–1729, 2015.
[36] E. Ogbeifun, C. Mbohwa, and J. H. C. Pretorius, "Project success factors: The opinion of facilities managers," *IEEE Int. Conf. Ind. Eng. Eng. Manag.*, vol. 2016-Decem, pp. 1176–1179, 2016.
[37] A. Kock, B. Schulz, J. Kopmann, and H. G. Gemünden, "Project portfolio management information systems' positive influence on performance – the importance of process maturity," *Int. J. Proj. Manag.*, vol. 38, no. 4, pp. 229–241, 2020.
[38] P. Mohagheghi and M. Jorgensen, "What contributes to the success of IT projects? Success factors, challenges and lessons learned from an empirical study of software projects in the norwegian public sector," *Proc. - 2017 IEEE/ACM 39th Int. Conf. Softw. Eng. Companion, ICSE-C 2017*, pp. 371–373, 2017.