Survey of Predict DevOps Readiness based on Machine Learning

[1]**Zahraa Nuri Hasan**, [2]**Ibrahim Ahmed Saleh**

[1]Student, Department of Software, College of Computer & Math., University of Mosul, Iraq

[2]Professor, Department of Software, College of Computer & Math., University of Mosul, Iraq

Abstract - **In the Software Development Life Cycle (SDLC), Development and Operations (DevOps) has given software more reliability, and enable to scalable within a little period. Software development is became is more effective in world today in become a core competency for every business also the machine learning is as obtained interest. As companies increasingly use DevOps practices to enhance efficiency, quality, and timely software delivery, predicting DevOps readiness becomes increasingly vital and important to ensure successful software implementation. the contribution of this paper presents a critical framework for machine learning and its use in predicting DevOps readiness in organizations through team collaboration and workflow monitoring using machine learning models and algorithms that are used for optimization, accuracy, and effective delivery of good results.**

Keywords: DevOps, Machine learning, CI, CD, Pipeline, Ensemble learning, Automation.

I. INTRODUCTION

The software systems have become very widespread and popular and programming these systems depends on many people (team) [1]. Many software companies focus on improving and maintaining software systems because the main goal is to satisfy the largest number of consumers at a lower cost and time [2]. Software reliability is also an important aspect in determining its quality or the quality of the entire product before it is put on the market [3].Therefore, forecasting is considered a very important process for customers and developers because it aims to obtain a clear vision and find future solutions to the problems facing stakeholders in managing large software projects [4]. Advances in the development of artificial intelligence and machine learning technologies have made it easier to achieve positive results and save time and effort [5]. The concept of information systems and software has become very important in order to accelerate the delivery of programs for companies and institutions and give optimal results. Software engineering is a specialization in developing tools and techniques used in creating various and advanced software

systems Enterprise companies are adopting DevOps concepts to speed up deployment, thereby providing both internal and external customers with more builds, more features and better quality faster than ever [6]. The only way to accomplish more and faster builds is to automate the entire process, which is where DevOps comes in, a robust DevOps for Data solution should integrate with virtually all DevOps solutions in the marketplace. A small subset of vendors (i.e. QuerySurge) provide full RESTful and command-line APIs that give you the ability to create and modify source and target test queries, connections to data stores, tests associated with an execution suite, new staging tables from various data connections and customize flow controls based on run results [7].

Agile methodology is a software development methodology, step-by-step development method that focuses on the evolution of user needs. First, the software prototype that users are most concerned about is made and delivered to users. Users find problems in actual scenarios and give feedback. R&D personnel quickly modify and make up for the deficiencies in the requirements. The above process is iterated continuously until the user is satisfied, helps in testing, developing, deploying software and improving ML processes by applying CI\CD pipeline pattern. Agile is suitable for projects with unclear requirements, innovation or the need to seize the market, especially for Internet projects. sometimes, the developers are demonstrate a new software features that also needs to be deployed, so DevOps appeared to be the solution, ML has become a major player in CI/CD processing to overcome challenges and retrain at all stages of the ML cycle automatically through CI/CD pipelines that help in shorten time, enhancing collaboration, and increasing quality and efficiency in work from the beginning until the software delivery stage [8]. DevOps defined as a combination of engineering practices, activities, methodologies and tools that can provide services to organizations better, faster, with high quality and effectiveness, and continuous integration and continuous delivery are among the basic practices that have emerged in the adoption of DevOps. The emergence of agile methodologies with DevOps has contributed to software development and accelerating software delivery with high quality and efficiency, because the DevOps methodology contributes greatly to enhancing cooperation between the

"development" team and the "operations" team in organizations [9]. DevOps refers to a methodology that combines "development" and "operations" into a single set of activities to achieve real goals and greater efficiency. Machine learning has become extremely important in data science in order to solve real-world problems and develop companies. This paper introduces survey for some researchers for DevOps with machine learning algorithms.

As a result of the great technical complexity in creating programs, software operations benefit from machine learning methodologies, as predictive models are used to provide better quality to companies, as these companies work in an agile mode with DevOps rules in order to solve problems and obstacles and increase the performance of methodologies and rapid communication [10]. Machine learning is used in many sectors in our world today and has become an important part in many companies and institutions, but it needs a large amount of data, and this data is constantly changing dynamically through DevOps practices, so ML models must be provided with updated data in order to be deployed in different systems, and continuous delivery is a solution to the problem of deploying ML models easily and without complexity. This is the MLOps process, which includes improving the efficiency of the model and shortening the time, thus accelerating software delivery [11]. The reset of paper, in section 2 definition of DevOps, section 3 illustrated related work for summation of researchers in field of DevOps, finally Section 4 is conclusion of paper.

II. DevOps CONCEPT

DevOps is a software development methodology that emphasizes collaboration between software development and operations in order to operate software systems and accelerate the delivery of software changes. In the context of continuous deployment (CD), it helps create a repeatable and reliable process for frequently releasing software changes in the production environment. Based on agile software development methods, an important principle of DevOps is the automation of build, test, deployment, and operation processes, see figure (1) Therefore, the practice of DevOps in the deployment pipeline involves the automation of the software deployment process, including the automatic configuration of the environment, aiming to minimize the handover debt from the software development team to the operations team. In software development practice, the deployment pipeline is the technical manifestation of the entire software process, including all stages from version control to the end user seeing the software changes. Automation in the deployment pipeline is usually done by the infrastructure team, which will have more advantages [12].
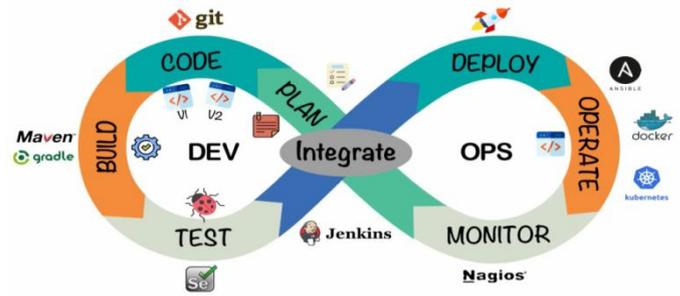

Figure 1: DevOps Life Cycle

By using DevOps approach, the gap between CI\CD is bridged in order to overcome difficulties, provide updates, eliminate manual tasks through automated testing, deliver the product faster, with high quality, because the combination of automation and teamwork will achieve an ideal accomplishment and thus satisfy the consumer [13].

DevOps is a modern approach to software development, it is not like the traditional waterfall model where DevOps can implement any change, test it automatically and deliver it with the help of test automation to the CI/CD pipeline.

Any program that has many features and in order to be published will go through seven stages as in figure (2), where the initial stages are the responsibility of the developers and the final stages are the responsibility of the operators, and the concept of DevOps makes the two teams work in dual mode to accelerate the delivery of the programs.

The idea of automated CI practices in DevOps methodology follows the agile method in software development, in order to identify software bugs before releasing to the production environment [14].
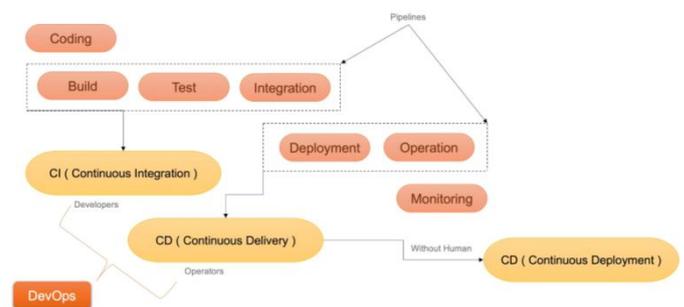

Figure 2: CI/CD relationship with DevOps

Although DevOps practices face many challenges, this approach removes barriers between the software development department and the software operations department, such as shared goals and responsibilities, and enhances efficiency and productivity [15], It emphasizes cooperation between development teams and operating teams in order to release software in the shortest time and ensure its quality and

reliability based on continuous improvement [16]. In a changing and complex environment with large amounts of data, using DevOps methodology with ML approaches and optimization algorithms is important to assess risks based on logging variables and attempt authentication every time in order to maintain data confidentiality for customers [17].

III. RELATED WORKS

Previous research and studies focus on using machine learning methods to predict DevOps readiness. These researches are summarized as follows:

In 2020 Ioannis Karamitsos, Saeed Albarhami and Charalampos Apostolopoulos, applied machine learning to DevOps practices. In this study, scientists introduced two important principles of DevOps, namely CI and CD, into a proposed approach, the MLOps approach, in order to achieve a repetitive automated software release cycle in a shorter time, as well as lower costs and reduce risks, because the manual environment in production and development often fails to adapt to continuous changes. However, it is not easy, as many companies may face major challenges and difficulties at the beginning or middle of operations, such as lack of skills and resistance to change. They used several methodologies such as CRISP, SEMMA and TDSP. The TDSP method was the most suitable. They used the manual ML method and the automated ML method. The automated method led to better code quality and increased productivity, while the manual method led to delays in work and produced high costs [7].

In 2020 Neha Dhaliwal, used several AI algorithms to predict data integrity and accuracy, improve software validation in CI\CD pipelines, predicting defects, detecting anomalies, automating testing and validating software for higher efficiency and accuracy of DevOps data and increased performance and operational efficiency, however, 40% of companies were facing significant challenges due to the presence of more complex software systems, which caused weakness in ensuring software validation and thus disrupting systems. He used neural network algorithms and the accuracy was 94% and 91%. He also used anomaly detection using unsupervised algorithms (Isolation Forest), where 89% of anomalies were detected. Reinforcement learning (Q-Learning) reduces test execution time by 70%. [18].

In (2022) Noor Mohammed Noorani et al, investigated the factors affecting (negatively/positively) DevOps activities, and motivate the implementation of the DevOps approach to the development and expansion of software activities and applied them based on (SWOT-AHP) framework, which was divided into four categories (strength, weakness, opportunities, threats-Analytic Hierarchy Process) and the priorities for each category were classified and determined based on global and local weights in order to meet customer requirements efficiently and effectively, However, there were significant resource limitations and it was not powerful enough to verify the significance of the factors and the survey response rate [10].

In (2022) Hemanth Swamy used machine learning in Microsoft Azure DevOps environment to develop large system log data that is vulnerable to disturbances due to changes in the system log format. DevSecOps is used in every step of the software lifecycle from design to deployment and delivery and automatically maintains security that uses the system security approach in the DevOps process based on cloud-based platforms and ensures network security by preventing unauthorized use, classifying network attacks and using many algorithms in the voting approach. These processes face many challenges and difficulties such as the need for continuous training and expensive processing resources and large and frequently used system logs and the great risks that they face so that the model becomes inaccurate over time. As a result, the researcher used Ensemble Machine Learning (EML) technology and built a cloud DevOps framework to develop products efficiently and with high quality. Therefore, the researcher used three algorithms: logistic regression, which had an accuracy of 80.5%, random forest, which had an accuracy of 83.6%, and decision tree, which had an accuracy of 82.5% finally, the researcher used the Ensemble algorithm, which had an accuracy of 97.15% [16].

In 2022 Mandepudi Nobel Chowdary, et al, used machine learning in prediction, data analysis and training to obtain more accurate results using different algorithms in machine learning, In order to complete software delivery on deadlines, DevOps is combined with machine learning practices for automation and a new approach is formed, MLOps, and training data repeatedly in order to update features with better accuracy and without errors, converting the code and variable parameters to the container image and then loading the new image, i.e. displaying the model for the updated and developed features automatically and predicting the best models, however, it requires the use of many different libraries for prediction. The researchers used a multi-layer neural network and the accuracy was 73% and they trained the data 100 times in order to increase the accuracy [21].

In (2023) Gopalakrishnan Sriraman* and Shriram R. introduce in their paper used several classifiers and supervised machine learning algorithms and divided the data into a training set (80%) and a testing set (20%), Researchers have used machine learning models to predict organizations' readiness to adopt DevOps in order to improve computing and DevOps practices, reduce costs, and increase revenue. However, agile development methodologies have some

drawbacks. Rapid code development may not lead to rapid and frequent code deployment. The classifiers used were logistic regression, support vector machines (SVM), K nearest neighbor (KNN), Naive Bayes classifier (NB), Decision Tree–Entropy (DT), Decision Tree–Gini Index, Random Forest(RF), AdaBoost algorithm, and the proposed A*AdaBoost algorithm. They observed that the accuracy of the prediction results of the proposed A*AdaBoost algorithm is the best and its effectiveness is more compared to the rest of the used algorithms [6].

In (2023) Ahmad Mahdi Salih, et al, applied one of the user acceptance models for technology (UTAUT). This model assumes four independent variables (Performance Expectation (PE), Effort Expectation (EE), Social Influence (SE), and Facilitating Condition (FC) Then they combined these variables with four other proposed variables (perceived DevOps Practices (PDP), Perceived Feasibility (PF), Perceived Organizational Usefulness (POU), and Training) in order to build an improved and developed model in adopting DevOps practices for software development [15].

In (2023) Medisetti Yashwanth Sai Krishna and Suresh Kumar Gawre used a DevOps approach that is the foundation for solving the problem of continuous parameter changes and deploying updates seamlessly using integrated machine learning without the need for physical human intervention, they used a CNN (Convolutional Neural Network) model and updated the parameters via a CI/CD pipeline using Many AutoML tools like (LeNet-5, Alexnet, VGG16) and compared the accuracy each time using manual training method and automatic training method, the accuracy of manual training using LeNet-5 was 64.78%, The accuracy using CI/CD pipeline was 76.54%, the manual training accuracy using Alexnet was 85.67% while the accuracy using CI/CD pipeline was 91.4% , and the manual training accuracy using VGG16 was 71.3% while the accuracy using CI/CD pipeline was 76.4% [11].

In (2023) Sukender Reddy Mallreddy, Yeshwanth Vasa used machine learning models to predict failures in DevOps and cloud computing ecosystems in order to maintain them and reduce potential risks that cause failure of these systems and disasters. Random forest classifiers and neural networks (LSTM model) were chosen and the training and test data were divided into 80% and 20%. In both models, there was a high degree of accuracy, the accuracy was 94%, precision was 93%, and recall was 91% [19].

In (2023) Ahmed Hany Fawzy, et al, used the DevOps Anomaly Detection Framework (DADF) to detect anomalies in DevOps practices based on ML and the accuracy = 96%, precision = 87.5, recall = 100%, and F1-score = 93.3 [20].

In (2024) Heman Swamy, integrated ML methodologies into a DevOps environment in order to assess the risks of security attacks on Blockchain systems based on IP address and user behavior. For this purpose, the researcher used several machine learning algorithms such as Naive Bayes (NB), Random Forest (RF), K-Neighbors (KNN), and Support Vector Machine (SVM). The researcher also used ensemble learning models, and these models improved the accuracy from 87% to 92% [17].

In (2024) Pir Sami , et al, proposed a framework of open source tools that act as a collaborative filtering tool that helps in building an MLOps pipeline that helps organizations deliver new features with high quality and efficiency. The researchers used machine learning algorithms such as (Random Forest, Decision Trees, and K-Nearest Neighbor). Then they used three measures: precision, recall, and F-Measure. The results for the previous algorithms were respectively (0.7055, 0.6318, and 0.6666), (0.6838, 0.5824, 0.6290) and (0.6745, 0.6263, 0.6495) [22].

Table 1: Summary of the literature used in Predict DevOps readiness

Seq.	Author	Technique used	Accuracy
1	Ioannis Karamitsos, Saeed Albarhami and Charalampos Apostolopoulos, 2020	CRISP, SEMMA and TDSP	The automated method led to better code quality
2	Neha Dhaliwal, 2020	Neural Network Isolation Forest Q-Learning	94% 91% 89% 70%
3	Noor Mohammed Noorani et al, 2022	A framework based on (SWOT-AHP)	
4	Hemanth Swamy, 2022	LR RF DT Ensemble algorithm	80.5% 83.6% 82.5% 97.15%

5	Mandepudi Nobel Chowdary, et al, 2022	Multi-layer Neural Network	73%
6	Gopalakrishna Sriraman and Shriram R., 2023	LR SVM KNN	A*Adaboost is better from the rest algorithms by 16.12% for NB, 12.42% for DT-entropy, 10.32% for DT-Gini Index, 8.12% for RF, and 5.24% for Adaboost, the proposed A*AdaBoost algorithm is improved the recall metrics of NB, DT, RF algorithms
7	Ahmad Mahdi Salih et al, 2023	UTAUT Model	For building an improved and developed model
8	Medisetti Yashwanth Sai Krishna and Suresh Kumar Gawre, 2023	(CNN) model LeNet-5 tool, Alexnet tool VGG16 tool using CI/CD pipeline	76.54% 91.4% 76.4%
9	Sukender Reddy Mallreddy, Yeshwanth Vasa, 2023	Random forest neural networks	Accuracy=94%, precision=93%, recall=91%.
10	Ahmed Hany Fawzy, et al, 2023	DADF Framework	Accuracy=96%, precision=87.5, recall = 100%, F1-scor =93.3
11	Heman Swamy, 2024	NB RF KNN SVM	92%
12	Pir Sami, et al, 2024	Random Forest Decision Trees, and K-NN	Precision, recall, and F-Measure. The results for the algorithms were respectively (0.7055,0.6318,0.6666), (0.6838,0.5824,0.6290) (0.6745,0.6263,0.6495)

IV. CONCLUSION

Ultimately, integrating the DevOps approach to software development with machine learning not only delivers better results and enhances collaboration, performance and reliability, but it also helps companies and organizations adapt to the modern marketplace and enhance collaboration, thus leading to rapid growth, development and customer satisfaction. Also when solve problem of "automatic" and "reliable", agile development, the concept of CI and CD that described software development by process from original demand identification to final product deployment to the production environment. The demand flows smoothly between various roles of team in small batches, and small-scale frequent delivery of demand can be completed in a shorter cycle.

The roles of demand analysis, product user experience and interaction design, development, testing, operation and maintenance work closely together, which is less wasteful than traditional waterfall software teams. Through this small-step and fast-running approach, small functions are quickly iterated, verified, and delivered. Through automated tools, testing, deployment, and operation and maintenance are automated, reducing the time it takes for demand to flow in the software life cycle.

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