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Analysis DevOps efficiency and digital transformation of digital economy, cross-border e-commerce, and brand building:

*Note: Evidence GuangDong manufacturing industry in Chinese Guangdong Province

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Abstract. As IT-based DevOps Abilities and Automation testing theory, this study examines factors that encourage and discourage DevOps abilities and automation technology have become a major trend in the development of internet or IT enterprises, The main aim of this paper is to investigate how the use of DevOps has affected the quality of software. Another main aim is to explore and identify ways to continuously increase software quality. One way of finding information on this study is to conduct a literature review. This article uses the ICTAM and TAM theoretical model for analysis. A literature review was developed to gather quantitative data while DevOps Abilities and Quality Assurance experts' interviews were used to determine how DevOps and automation testing can enhance software quality and improve software development efficiency. Interview reviews, Sampling questionaries, hypothesis testing, and regression tests are recommendations. Five semi-structured interviews were conducted with experts and analyzed through the lens of the Interactive Communication Technology Adoption Model (ICTAM) as a guiding framework. Moreover, through a series of data investigation and analysis, DevOps Abilities and Automation testing can help many companies quickly and accurately improve software development efficiency and quality. The results demonstrated that China internet company's DevOps and automation technology helps enterprise's continuous integration and continuous delivery, automation testing and monitor etc. DevOps and CI/CD is one of the best practices for devops teams to implement. The findings is also an agile methodology best practice, as it enables software development teams to focus on meeting business requirements, code quality, and security because deployment steps are automated. Based on DevOps Abilities, Automation testing, CI, CD concepts, many companies can continuously improve their software R&D efficiency and software quality. The research of this paper mainly uses the mixed method of qualitative analysis and quantitative analysis to conduct research and analysis, and uses excel or SPSS 23 software to perform ANOVA analysis on the sample data, Finally, this study contributions concludes the importance of DevOps and Automation testing to China Software company.

Keywords: DevOps Abilities, Automation testing, Communication Technology Adoption Model (ICTAM) and TAM model and CD, mixed method of qualitative and quantitative analysis.

1. Introduction (Heading 1)

Over these decade years, The digital transformation of the software industry in Dongguan City, Guangdong Province, China, and the rapid development of the digital economy. In fact, the DevOps efficiency improvement and digital transformation of software companies are very prominent. This article mainly discusses the DevOps energy efficiency improvement and digital transformation of the software industry in Dongguan City, Guangdong Province, China, as well as its application Automation software theory and ICTAM theory are analyzed and described. Moreover, Organizations are social entities containing multiple people that are goal-directed and are linked to the external environment and software DevOps process. It is defined as a collection of people purposely organized to accomplish a common aim (Daft, 2006). Since its inception, DevOps engineer has a unique combination of skills and expertise that enables collaboration, innovation, and cultural shifts within an organization. DevOps is a process in which, Modern software engineering Culture and Practices to develop software where the development and operation teams work hand in hand as one unit, unlike the traditional ways, furthermore, the CI and CD stand for continuous integration and continuous delivery/continuous deployment. If the software R&D of enterprises wants to improve the efficiency and software quality of R&D, most enterprises will now adopt the DevOps R&D process and technical architecture, involving continuous integration, continuous delivery, automated testing, monitoring, and other aspects (Karamitsos, I., Albarhami, S. and Apostolopoulos, C., 2020). This article will discuss the DevOps architecture and automation. The importance of enterprises and the value of improving efficiency, and discuss and analyze the case of some enterprises. As the software market becomes more competitive, companies devote more time and resources to developing and delivering high-quality software at a quicker pace. Continuous Integration (CI), and Continuous Delivery (CDE) are some of the two continuous practices designed to assist organizations in accelerating the growth and delivery of product features while maintaining efficiency.

As an adaptation of Communication Technology Adoption Model (ICTAM), technology acceptance model (TAM) is introduced by Davis (1985) which is specific for modeling user acceptance of information systems. In an attempt to identify the impact of external factors on internal beliefs concerning to technology acceptance, TAM is introduced. TAM identifies the causal linkages between individual user's attitudes and perceptions toward technology and the actual adoption of technology (King and Gribbins, 2002; Leong et al., 2013). According to TAM model, perceived usefulness and ease of use are the main external variables affecting attitude and intention toward using a technology.

However, Chinese firm's software Developers over the past years have implemented new generation programming languages. DevOps is complemented by a range of agile practices designed to improve cooperation between development and operating teams. implementing such DevOps process and automation testing technology in the organizations is not an easy task, and there exist some challenges that should be considered. These challenges and factors affecting each challenge are discussed in this paper. Briefly, research questions and aims of this study are as follows:

RQ1. What is the impact of the adoption of DevOps and automation testing technology on software quality and delivery efficiency in Chinese Guangdong province engineering companies?

RQ2. Can automated testing on the mobile side, automated testing on the server side, unit testing technology, and DevOps performance improvements help to improve R&D in the Chinese Guangdong province enterprise?

2. Literature Review

2.1. Liturature descriptioins

This study know that the R&D efficiency and quality of software are very important to the success of enterprise software, in which DevOps architecture and automated test R&D are very critical content, this article uses the TAM theoretical model for analysis. We all know that DevOps is a philosophy

and practice focused on agility, collaboration, and automation within IT and development team processes (Erich, F., Amrit, C. and Daneva, M., 2014). Traditionally, software development occurred in silos, with IT and development working independently within their teams and processes. This separation and competing values created an environment rife with miscommunication, poor alignment, and production delays (some have even nicknamed the operations department the "War Room"). DevOps is the response to the "us vs. them" culture of development. The goal of DevOps is to bridge the gap between IT operations and development to improve communication and collaboration, create more seamless processes, and align strategy and objectives for faster and more efficient delivery. This article analyzes and explains DevOps and the importance of automation in the process of enterprise software development, and in the form of electronic questionnaires, 100 observations of sample data from different companies were randomly selected for analysis, and the results were analyzed using a mixed method of quantitative analysis and qualitative analysis. Those aspects can improve the R&D efficiency of enterprise software, reduce the company's R&D costs, and achieve some final results in improving software R&D efficiency and automation. This involves testing a chain of components, sometimes external components too, that together handle a process or business transaction. Integration testing often includes testing the interactions between hardware and software as well as other infrastructural components. About automation testing Level 3: End-to-end testing is, and the name implies, about testing a process from end to end. The scope of end-to-end testing depends on the process, but end-to-end tests often span across multiple technologies (Battina, D.S., 2021). The purpose of end-to-end tests is to ensure that a flow works as intended from the perspective of the user. For this reason, the black box method is often used. The specific test pyramid structure diagram is as follows;

Furthermore, In Chinese software enterprises, many Automation (and the tools that support it) allows developers and IT professionals to combine their efforts into one seamless process and adopt agile practices like continuous integration, continuous delivery, and continuous deployment. In other words, this process enables collaboration throughout the entire development pipeline from concept and builds to deployment and testing. Additionally, DevOps principles prioritize iterative processes that make space for continuous testing and feedback. Again, this practice makes it possible to accelerate the development process, but it also improves the quality and security of the products (Marijan, D., Liaaen, M. and Sen, S., 2018). This article will analyze some cases of software automation improvement and DevOps efficiency improvement of Chinese Internet companies Jingdong Group, Ctrip.COM, and Tencent Group, and discuss how software automation is Improve the efficiency of enterprise software development well (Nurullah, F., Wang, G., Kaburuan, E.R. and Fajar, A.N., 2018). In JD.com, JD.com has developed an automated testing system to help the automated verification work in the software R&D process. R&D and testers only need to perform page-based configuration according to the business to complete the automated process. R&D and testers log in to this A platform for automated testing, create new test plans and test cases that you need to test, and display test cases according to the structure of the directory tree. Each automated test case also has a dependency relationship, so that you can quickly complete an automated test of a business system. Configure the task. This configured automated test task can be reused, or the task can be scheduled to be automatically executed at a certain time, and a test report can be generated and automatically sent to the relevant responsible person (Marijan, D., Liaaen, M. and Sen, S., 2018). This automated testing process of JD has greatly improved the efficiency and quality of research and development. Another case is that the Internet Tencent company in China used Appium, an automated testing framework on the mobile terminal, and packaged it, adding some customized testing and verification functions in the Tencent Group business system. The test is made into a function in the form of a webhook. By the way, Software monitoring is also very important for enterprise automation, including many Internet companies that use log monitoring, service monitoring, and business system monitoring and early warning. This monitoring can help companies monitor their systems in real-time to maintain a healthy state. In the development process of any business system, the DevOps pipeline process can be reused and integrated, which greatly reduces the cost of automated testing on

the mobile terminal and can be quickly applied to the business. system and generate value for the enterprise.

To address these gaps, the present study examines stakeholders' perspectives on blockchain technology adoption in online advertising through semi-structured interviews. Crucially, this study examines adoption from a whole ecosystem perspective, which is essential for gaining a complete understanding of factors encouraging and discourse aging adoption for all stakeholders in online advertising. To this end, it employs Lin's (2003) Interactive Communication Technology Adoption Model (henceforth, ICTAM). Until now, studies that have examined blockchain adoption have done so primarily through the lenses of the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Technology-Organization-Environment (TOE) framework (e.g., Clo hessy & Acton, 2019; Dehghani et al., 2022; Jain et al., 2022; Toufaily et al., 2021).

2.2. Maintaining orgnizational of the paper

The remainder of the paper is organized as follows. Besides, Section 1 presents the introduction; Section 2 presents the literature review ,research questions, Section3 presents the theoretical basis and model , research hypothesis, interviews, variable statements. Section 4 presents the method and data analysis. Finally, Section 5 presents the discussion, limitation, and conclusions.

3. Prepare Your Paper Before Styling

The Theoretical framework of Research model.

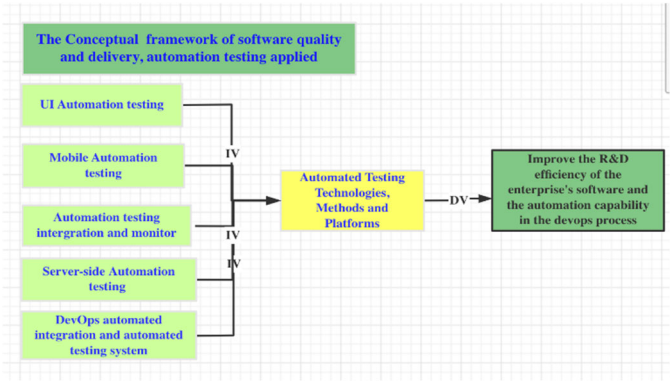

Figure 1. The Conceptual framework of software quality and delivery, automation testing applied. Source: (Author's research model)

Furthermore, Base on above Figure 1's Conceptual framework description and analysis, we can see that the importance of automated testing for software R&D efficiency and quality improvement, but it has the potential to prepare to think critically and solve complex software development management and DevOps process problems, software automation testing, software CICD Process and has more autonomy independence in the automation testing [5 independent variables and 1 dependent variable]. Some Chinese internet corporate software automation testing includes many technologies and processes, such UI automation, mobile automation, server-side automation testing etc.

Hypothesis summary;

According to the above the conceptual framework of the research model, Thus, this study drawing new research model and the relationship between IV and DV. IV also has the following five aspects introduced;

H1: there is a positive relationship between UI automation testing and Improve the R&D efficiency of the enterprise's software and the automation capability in the DevOps process.

H2: there is a positive relationship between Mobile automation testing and Improve the R&D efficiency of the enterprise's software and the automation capability in the DevOps process.

H3: there is a positive relationship between Server-side automation testing and Improve the R&D efficiency of the enterprise's software and the automation capability in the DevOps process.

H4: there is a positive relationship between Automation testing integration and monitor

testing and Improve the R&D efficiency of the enterprise's software and the automation capability in the DevOps process.

H5: there is a positive relationship between DevOps automated integration and automated testing system and Improve the R&D efficiency of the enterprise's software and the automation capability in the DevOps process.

The Independent variables (IV) of Conceptual framework are as follows;

1. DevOps UI automation testing

2. DevOps Mobile automation testing

3. DevOps Server-side automation testing

4. DevOps Automation testing integration and monitor testing

5. DevOps automated integration and automated testing system

The Dependent variable (DV) of Conceptual framework is as follows;

Improve the R&D efficiency of the enterprise's software and automation capability in the DevOps process.

Furthermore, this study uses questionnaires to collect data because there are not many data samples. Electronic questionnaires can quickly collect the company's employee WeChat groups and conduct data analysis. Besides, this study uses a mixed method of qualitative and quantitative research analysis to study the research and development and conclusions of DevOps process and automation testing and automation platform. This study wanted to find out how the industry sees DevOps and Automation technology along with its advantages and limitations. Thus, the results of this study provide a better understanding of DevOps on software quality for both professionals and researchers working in this area. The study shows research was mainly focused in automation, culture, continuous delivery, fast feedback of DevOps. The hypotheses in this research study involved the verification of relationship variables which are DevOps process and software automation testing, software quality. The main objectives of the investigation of this study paper are as follows:

• Research the DevOps UI Automation and Mobile Automation testing for software effective

• Research the DevOps process effectiveness of Chinese GuangDong internet company

• Research the DevOps Server-side automation testing of Chinese GuangDong internet company

• Research the DevOps integration platform of Chinese GuangDong internet company

• Research the DevOps Monitor and automation Monitor of Chinese GuangDong internet company

Interviews

In addition to ANOVA data analysis, this study also conducted interviews with employees of some companies. The interviews of this study took place between February and March 2024. Before the interviews, participants were informed about the study procedure and provided informed consent. All interviews were held online, and video recorded. The interview duration varied between 18 and 92 min, with a median duration of 56.5 min. The interview schedule covered four topics: 1) demographic information, organization and role; 2) DevOps and automation as a technology and the interviewees' DevOps and automation usage; 3) questions for a possible follow-up study; 4) factors influencing DevOps and automation adoption in the interviewee's organization, and in online advertising.

4. Results and data analysis

Additionally, The study mainly uses the mixed method of qualitative analysis and quantitative analysis to conduct research and analysis ,To use the data to analyze the importance of automated testing, we designed a questionnaire, collected a small-scale data sample for analysis, conducted an electronic data questionnaire for 100 samples of several Internet companies, and conducted ANOVA data for the collected data Analysis, to prove the importance of automated testing for enterprise R&D efficiency, this questionnaire has 5 questions, corresponding to the hypothesis verification conditions of 5 IV variables, each question has 1, 2, 3, 4, 5 The score of 5 is the highest, representing the most important, and 1 is the lowest, representing the least important. We collected data from the most 100 observations, then performed ANOVA data analysis on the collected excel data, and obtained theoretical results to support this article. DV variable as well. And the next stage, this study conducted data analysis and statistics with the collected 100 sample observations.

Thus, this study set H_0 *and* H_1Variables: Automation testing (5 IV levels)

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$$

H_1: $\boldsymbol{atleast\ 1\ \mu_i \neq \mu_j\ for\ at\ least\ 1\ (i,j)}$

Set up significant level α=0.05

ANOVA Analysis.

Table 1. ANOVA table of DevOps Satisfaction for different location. Source: (Author's research work)

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Between Groups	2526.582	4	631.6455	31.04154	3.42E-22
Within Groups	7264.378	357	20.3484		

Furthermore, based on the above table 1, we have an information that p-value (3.42 E-22) is less than the significance level. Thus, we reject the Ho. This gives an idea that the DevOps Satisfaction of the automation testing technology in different automation platform are not the same.

Table 2. Summary statistics of DevOps and software development Satisfaction in different software automation testing skills. Source: (Author's research work)

Groups	*Count*	*Sum*	*Average*	*Variance*
UI auto	74	535.84	7.241081	3.727558
Mobile	60	499.02	8.317	14.10177
Server-side	99	705.91	7.130404	7.71553
Integrations	84	985.33	11.73012	34.40074
System	45	650.21	14.44911	57.92905

Furthermore, based on the table 2, Since we reject the Ho, this indicates that there is a significant difference in terms of software development Satisfaction in different automation testing skills. Also, based on summary statistics we can see or there is a higher chance that the automation testing in the automation testing System is comparatively bigger than other automation technologies. This can be further examined by using independent sample T test. On the other hand, DevOps and automation skills helped to bridge the communication gap between developers, managers, quality engineers and operations engineers. This fosters collaboration towards improving the development process and end software product (Toh, M.Z., Sahibuddin, S. and Mahrin, M.N.R., 2019,). Furthermore, the existing different skills can be readily utilized hence increasing the team's reactivity to problems. The above data analysis proves that we can see that the automation testing system is more valuable and less

expensive than other automation technologies for improving the efficiency of enterprise software development.

5. Conclusions

In conclusion, this study aimed to examine the factors that encourage and discourage digital automation testing and DevOps process affects businesses in every market. Either they are driving it or they are being driven by it. Based on the literature review and conceptual framework, there is enough evidence that shows that the software quality and software efficiency is improved when DevOps process and technology is applied. All hypothesis testing were accepted, indicating that the efficiency improvement and automation capabilities of DevOps can help companies improve their R&D and work efficiency and save R&D costs (Luz, W.P., Pinto, G. and Bonifácio, R., 2019). The DevOps process and software automation testing are crucial to improving the efficiency of software R&D in enterprises, any industry is at risk of disruption. As new business models emerge and customer demands keep evolving, enterprises everywhere struggle to stay relevant. They must be ready to adapt the way they do business. Technology is used in new and ever-more complex ways to drive value. On the other hand, these indicates include automation of enterprise systems, cloud-based commerce, and cross-channel user experiences. Enterprises can use automated testing to improve product development speed and efficiency and reduce manual intervention costs and errors. Automated testing improves software development efficiency and quality assurance process through code, and ensures software iteration process and delivery quickly and efficiently (Yarlagadda, R.T., 2018). In the process of automated testing, the automation of the server is mainly based on the protocol of the server, which is relatively simple. Generally, enterprises mainly use it for UI automation and mobile automated testing. Let’s take a look at the front-end automated testing and mobile automated testing (Toh, M.Z., Sahibuddin, S. and Mahrin, M.N.R., 2019,).

In additional, Regarding the front-end technology of automated testing, we generally use the open-source selenium framework, which has many advantages. It includes Selenium is an Open-Source Software, Selenium supports various programming languages to write programs (Test scripts), it has No reliable Technical Support from anybody, it supports Web-based applications only. Difficult to use takes more time to create Test cases (Riungu-Kalliosaari 2016). For mobile automation of software testing, we often use the open-source Appium framework for development and packaging, it is language-agnostic that supports web driver application program interface, allows cross-platform tests. Applications are efficient, accurate, fast, and free from bugs, which saves a lot of time and cost (Riungu-Kalliosaari 2016). Keeping all this in mind learning Appium will be worth it. The Appium framework also includes some of the following advantages. It is free and open-source. It supports both Android and iOS. Automation tests for iOS and Android can be written using the same API. Appium tests can be written using any language. No need to install any extra software on the mobile device to support Appium.

Furthermore, these are lots of hurdles to overcome in bridging the gaps between CI and CDE, and automated testing, but It's worth taking a systematic approach when adopting DevOps automation testing in any business (Bou Ghantous, G. and Gill, A., 2017). According to the above hypothesis testing process, and discussion and analysis, all hypothesis testing verifications are finally accepted, and it proves that automated testing can indeed continuously improve the R&D efficiency of enterprises and the automation capability in the DevOps process. We can see that automated testing has played a very good role in promoting the enterprise's R&D efficiency and DevOps process integration. In short, this study uses the Communication Technology Adoption Model (ICTAM) and TAM model theory to analyze and describe the DevOps energy efficiency improvement, software efficiency R&D, and brand building of technology companies in Guangdong Province, China, and finally draws an analysis conclusion.

To sum up, the study indicates some benefits and challenges involved in adopting DevOps and automation technologies. The benefits include more software frequent releases, improved test

automation, promoting R&D efficiency, software automation monitor, better communication and enhanced occupational welfare with team or company in Chinese Guangdong province.

Finally, a research framework has been proposed by Pham and Ho (2015) to investigate the factors helping the adoption of the DevOps development process, and CICD Process, automation testing. according to the survey, the observations studied in this study is due to the internet company's questionnaires and survey data, so the limitation of this paper is that the number of research samples in this paper is limited to only about 100 samples of the questionnaire. Automated testing is not a 100% guarantee of software quality. Automated testing requires investment in R&D resources and human resources, and continuous maintenance of automated programs is also required. In addition, this is also the gap studied in this paper. During the DevOps process, the efficiency of R&D is generally improved (Perera, P., Bandara, M. and Perera, I., 2016). It is composed of aspects of multiple dimensions, and automated testing is only an important node of it. However, automated testing is not a panacea for improving the R&D efficiency of an enterprise. It's important to note that while automation has many benefits, it also has its limits; it only tests what you tell it to. Another research gap is that the automation capabilities and DevOps processes of each enterprise are also different, so the coverage objects studied in this paper may not be able to cover all Internet companies (Chen, L., 2018). Too small sample data is also a shortcoming of this study. This study makes several theoretical contributions. For one, it supports the findings of previous studies on blockchain technology adoption in other industries, implying that stakeholders in other ecosystems may face similar challenges, and suggests that these findings may be digital transformation to other business contexts. Moreover, it extends these findings by exploring adoption through the lens of the ICTAM (Lin, 2003), whereas other studies have primarily focused on adoption from the perspectives of the UTAUT and TOE frameworks (e.g., Clohessy & Acton, 2019; Dehghani et al., 2022; Jain et al., 2022; Toufaily et al., 2021). Though this may seem obvious, it's important to keep in mind because even after unit, integration, and performance tests have passed, a single end-user can make the whole system crash in seconds. This usually happens if the user does something the developers did not expect as well. Future studies should also test the efficacy of various educational tools for raising the level of awareness regarding issues inherent in the AI and DevOps and CI CD process, Automation testing ecosystem, as well as those educating the public about DevOps technology in Chinese Guangdong province.

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Ethics approval

Ethics approval was not required for this research.

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Competing Interests

The authors declare no conflict of interest. Moreover, the authors have no relevant financial or non-financial interests to disclose.

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