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| RESEARCH ARTICLE

Automated Cloud Migration Pipelines: Trends, Tools, and Best Practices – A Survey

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| ABSTRACT

The rapid advancement of cloud computing has necessitated efficient and reliable cloud migration strategies, as organizations increasingly transition their data to the cloud. This survey examines the evolving landscape of automated cloud migration, highlighting its benefits, risks, strategies, tools, and emerging trends. This survey examines the evolving landscape of automated cloud migration, highlighting its benefits, risks, strategies, tools, and emerging trends. It discusses migration approaches, rehosting, refactoring, re-platforming, repurchasing, and retaining and explores trends in automated migration, including AI-driven workload assessment, risk optimization, multi-cloud and hybrid adoption, and DevSecOps integration. Essential tools such as Azure Data Migration, AWS Cloud Data Migration, Docker, and Kubernetes are reviewed, along with best practices including CI/CD integration, Infrastructure as Code, agile development, cost modeling, and AI-driven adaptive control to ensure robust, scalable, and efficient migration pipelines. The survey identifies key challenges, including data security and privacy risks, regulatory compliance, operational disruptions, migration costs, complexity of legacy applications, and vendor lock-in. To address these, future research directions are proposed, such as AI-driven security and compliance frameworks, automated cost optimization models, intelligent workload assessment, adaptive multi-cloud strategies, and self-healing migration pipelines. By consolidating current strategies, tools, challenges, and research opportunities, this survey provides a comprehensive reference for organizations planning cloud adoption and establishes a foundation for future innovations in secure, efficient, and cost-effective cloud migration solutions.

| KEYWORDS

Cloud Migration, Automation, Hybrid Cloud, Containerization, AI Optimization, Migration Tools

| ARTICLE INFORMATION

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1. Introduction

Cloud computing is steadily rising to the top. The term is being used in marketing campaigns to attract more people to items because it is the most happening trend [1]. Companies use their data in different ways to meet their business goals, so computing technology must be able to process and store on-demand business data continuously and effectively. Cloud computing is quickly replacing traditional distributed computing as the go-to solution for businesses in need of huge data storage and load balancing [2]. A variety of environments are available for hosting software applications, including private clouds, public clouds, and on-premise solutions. The identification and evaluation of potential migration procedures is critical, as is the migration into the cloud or across these frequently hybrid situations or between providers. The research of migration scenarios was conducted through

expert interviews, focus groups, and observations of migration trends and procedures with leading global cloud solution providers and independent consultants [3].

Cloud computing has lately drawn a lot of interest from researchers in software engineering because it allows application providers to take use of scalable, dependable, and elastic cloud services on multiple levels (infrastructure, platform, and software) [4], [5]. Shifting legacy apps from on-premises servers to rented virtual machines (VMs) in the cloud is a great way to cut down on hardware maintenance expenses, take advantage of auto-scaling in cloud design, and make better use of the highly available cloud service rather than relying on legacy apps' unreliable functionality [6][7]. When resources, like as data or apps, are now housed on-premises, they can be "migrated" to a cloud architecture. By "cloud migration," it mean the process by which a company moves its information technology (IT) assets, including data, apps, and infrastructure, from its current location on-premises to a remote server in the cloud. This is accomplished by taking use of cloud computing's scalability, flexibility, and cost reductions.

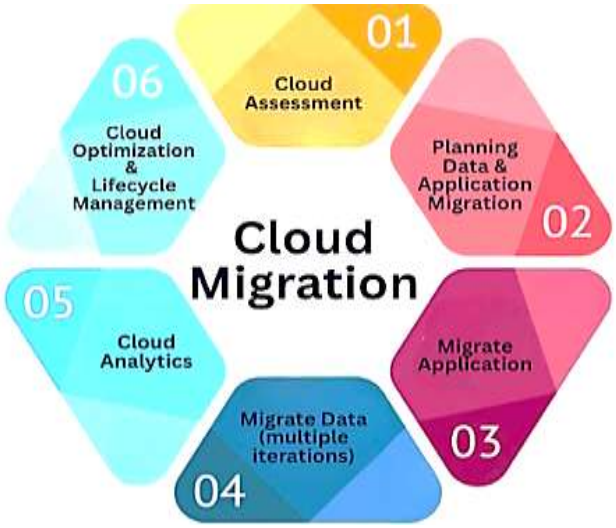

Fig. 1. Cloud Migration

Figure 1 shows the cloud migration process as an ongoing cycle. It starts with Cloud Assessment as it does the assessment of existing workloads, and Planning Data and Application Migration is the next step to prepare resources. Then Migrate Application and Migrate Data (usually in repeated cycles) take care of a smooth transition. Cloud Analytics improves the process, giving insights to continue Cloud Optimization and Lifecycle Management and establish an efficient and optimized migration workflow through an iterative process.

Based on the cloud migration workflow, automated cloud migration pipelines are becoming a major trend to facilitate and expedite the migration process. The pipelines capitalize on automation tools, scripts, artificial intelligence-driven structures, to minimize the amount of manual intervention, reduce error counts, and provide a more uniform execution environment in and across complex cloud environments [8]. With automation, it is possible to perform the assessment on a continuous basis, pre-migration validation and incremental migration of the workloads, applications and databases to keep track of the dependencies and performance. Also, automated pipelines combine testing, the rollback feature, and security audits to ensure data integrity and compliance [9]. With the implementation of these pipelines, organizations are likely to gain access to faster migration cycles, reduced costs to operate, and better reliability, and thus cloud adoption can be more predictable and scalable [10].

1.1 Structure of the paper

The paper is organized as follows: The section II defines cloud migration overview, the section III gives current trends in automated cloud migration, the section IV gives supporting techniques and tools, the section V deals with key challenges and best practices with future directions, the section VI gives a review of related literature, and Section VII concludes the study with summarization.

2. Overview of Cloud Migration

The term "cloud migration" refers to the process by which a company transfers its data to a cloud service, whether it's a public, private, or hybrid cloud [11]. What this means is moving IT assets such as data, apps, and other infrastructure from on-premises systems to an Internet-accessible cloud. Organizations have a number of reasons as to why they prefer cloud migration. Some of the common reasons/benefits/applications include:

- **Cost Savings:** Cloud computing removes the expensive on-premises hardware and software investments made by organizations. This is one of the ways in which organizations can save a substantial sum of money with regard to the costs of infrastructure.
- **Scalability:** Cloud computing offers organizations the flexibility to expand their IT resources up or down according to the organizations need. This would ensure that organizations do not have to install more hardware and software at the times of peak demand.
- **Flexibility:** A public cloud, a private cloud, or a mixed cloud are all types of cloud environments that businesses can choose from with cloud computing.
- **Cloud Computing Advancements:** The systems of cloud computing have experienced a series of innovations over the last few years and are becoming more affordable and accessible to any organization regardless of its size. The recent developments in cloud computing include some of the following:
    - **Serverless Computing:** Employing serverless computing allows businesses to run their apps independently of the underlying infrastructure.
    - **Artificial Intelligence and Machine Learning:** Cloud computing offers organizations access to effective AI and ML that can enable them to derive insights out of their data.
    - **Internet of Things (IoT):** Cloud computing gives organizations the capability of linking and controlling their IoT devices anywhere in the world [12].

2.1 Risks of Cloud Migration

Cloud migration presents many advantages, but it also has several risks that organizations must be made aware of prior to migration. The most frequent risks of cloud migration are some of the following [13]:

- **Data Security:** The cloud-based migration of data may enhance the threat of data attacks, data loss, and hacking. Organizations should make sure that their cloud provider has sufficient security policies that cover their information.
- **Reliance on Third Parties:** Cloud migration is based on the use of a third-party provider of infrastructure, software, and support. Companies have to make sure that the cloud provider is credible and stable.
- **Regulatory Compliance:** There are many regulatory standards that require organizations to adhere to in terms of data privacy, data security, and data protection. The move to cloud may affect the ability of an organization to comply with these regulations and organizations should ensure that their cloud provider abides by these regulations.
- **Migration Costs:** Migration tools, training, and consulting fees caused by cloud migration can be significant upfront expenses. These costs are some of the things that organizations need to take into consideration prior to cloud migration.

2.2 Cloud Migration Strategies

Organizations can also consider various other cloud migration strategies which include:

- **Rehosting:** The rehosting strategy, or so-called lift and shift, entails organizations transferring their applications to the cloud without any alteration being made to the application code[14]. The approach is applicable when the current architecture of the application fit well in the cloud environment.
- **Refactoring:** Refactoring strategy or re-architecting is a process whereby organizations update the application code with cloud-native functionality and capability. The strategy is applicable in case the application code should be modernized.
- **Re-Platforming:** Organizations implement re-platforming strategy where they transform the application infrastructure to exploit the features and capabilities of the cloud environment without changing the application code significantly. Useful in situations with the application code that is suitable to the cloud, but needs minor adjustments.
- **Repurchasing:** The repurchasing strategy involves organizations substituting their current applications with cloud-native applications or software-as-a-service (SaaS). This plan is applicable in cases where the current applications are no longer applicable in the needs of the organization or when alternatives existed in the form of cloud native applications.
- **Retaining:** In the retaining strategy, organizations prefer to retain certain applications or data on-premises and move others to the cloud. The strategy applies in cases where not all applications or data are suitable to be migrated to the cloud because of the technical or regulatory limitations.

3. Trends in Automated Cloud Migration

The term "cloud migration" encompasses the entire procedure via which an enterprise transfers part or all of its data, applications, services, and IT resources from its present data centre to the cloud. Many things need to be considered and rebuilt in order to make the transition from an internal deployment to a cloud platform. Taking a holistic view of the move, cloud migration technology is committed to resolving a plethora of business and technical concerns [15]. The following trends in automated cloud migration:

3.1 AI-Driven Migration and Optimization

Cloud migration is greatly impacted by AI and ML. The goal of implementing these technologies is to improve customer service, forecast and avoid network disruptions, and optimize network performance. To give one concrete example, telecom operators can improve service quality and prevent problems by using AI-driven analytics to gain insights into network usage trends [16][17][18]. In the context of cloud migration, AI also streamlines workload assessment, selects the best migration path, and ensures efficient resource utilization. This leads to faster, safer, and more cost-effective migration pipelines. Moreover, AI enables continuous monitoring of applications after migration, helping organizations maintain performance benchmarks. It also supports predictive cost management by identifying opportunities for savings in real time.

- **Workload Assessment for Migration Planning:** The migration process should not commence until the database workload that has been generated during its utilisation has been thoroughly analyzed and classified. There are a number of factors to consider, such as the data volume and growth rate, the present Key Performance Indicators, the distribution of queries according to difficulty and frequency, and the peak times. It is possible to determine the database burden by taking into account the following factors: data volume, processing time, response time, query frequency, complexity, and workload.
- **Risk Optimization Framework:** The purpose of a risk management framework is to serve as an all-inclusive manual for handling the detected hazards. To assess the potential threats to user privacy and data security posed by cloud computing, one strategy suggests a goal-driven approach. Confidentiality, integrity, availability, mutual auditability, and usability are the six pillars upon which QUIRC rests as a framework for identifying and evaluating security issues in the cloud.

3.2 Multi-Cloud and Hybrid Cloud Adoption

Hybrid cloud uptake more appealing to businesses that use private cloud services in some way. This is because they are already equipped with an internal cloud and can simply make use of what is already available in the public cloud. Figure 2 shows that there are benefits to hybrid cloud computing services for both large organizations, government agencies, and SMEs. Few studies have actually examined hybrid cloud systems, and even fewer have attempted to identify the most significant obstacles to their widespread adoption [19].

- **Interoperability and Integration:** Cloud computing has a lot of benefits for settings that need to be scalable, highly reliable, and easy to set up. The promise of interoperable cloud environments, however, is even more substantial for service providers and their customers. Cloud providers' resources may be constrained, which could be a benefit. Greater resource scalability can be achieved through provider interoperability, which allows for the sharing of unused resources [20]. Cloud service companies may provide specialized, proprietary cloud solutions. This means that cloud consumers are highly likely to develop a dependency essentially a lock-in on a specific vendor. Thanks to cloud interoperability, users have more leeway to switch service providers, which helps prevent vendor lock-in.

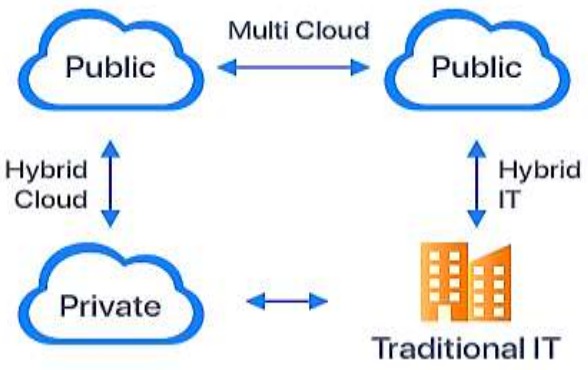

Fig. 2. Multi-Cloud and Hybrid Cloud Adoption

3.3 Integration with DevOps and Security Automation

DevSecOps embeds security practices throughout the software development lifecycle, ensuring that security is a foundational element rather than an afterthought. This approach includes continuous security testing, automated vulnerability scanning, and secure infrastructure as code (IaC), which collectively help identify and mitigate security issues early in the development process. By integrating security continuously, DevSecOps reduces the risk of vulnerabilities being exploited in production environments and enhances the overall resilience of the software DevSecOps builds security into every step of the software development process, making sure that it is not an accident but an essential part of the process. With the use of automated vulnerability

scanning, secure infrastructure as code (IaC), and continuous security testing, this method finds and fixes security flaws before they even happen. Figure 3 shows the automated process that is part of DevSecOps, which aims to prevent vulnerabilities from being exploited in production environments and increase the software's overall resilience [21]

Fig. 3. DevOps Automation

Continuous Security in DevOps Pipelines: A DevSecOps solution satisfies the development operations requirement for security. Aiming to integrate contemporary security principles into the dynamic and rapid DevOps environment, this notion is an endeavor in progress. Encouraging security professionals to be involved from the beginning is an outgrowth of DevOps' goal of increasing collaboration between operators and developers. A comparison of current trends in automated cloud migration is presented in Table I

Table 1: Comparative Analysis of Trends in Trends in Automated Cloud Migration

Trend	Focus	Key Subcomponents	Benefits	Challenges
AI-Driven Migration and Optimization	AI/ML to improve migration efficiency	Workload assessment helps analyze data and queries before migration, while risk frameworks guide the handling of security and privacy issues.	Faster migration, better resource use, and predictive cost savings.	Needs quality workload data and involves complex setup.
Multi-Cloud and Hybrid Cloud Adoption	Combining private and public clouds	Interoperability supports cross-provider resource sharing, and integration helps reduce vendor lock-in.	Flexibility, scalability, and freedom from vendor dependency.	Few empirical studies and technical barriers in integration.
Integration with DevOps and Security Automation	Embedding security in DevOps (DevSecOps)	Continuous testing, vulnerability scanning, and secure IaC embed security across the development lifecycle.	Early risk detection, resilient systems, and ongoing compliance.	Tool integration issues, cultural resistance, and skill shortages.

4. Tools for Automated Cloud Migration

An approach can offer its own tool to handle migration tasks, or it can point developers in the direction of third-party tools that are already out there. In the cloud market, approaches did not offer any tools. Different ways give varying degrees of automation support because it may not be feasible to have tools that can handle the entire migrating process. Figure 4 shows one example of the tool suite in action, which includes Azure Data, CSP, Docker, Kubernetes, and containerization solutions, among others.

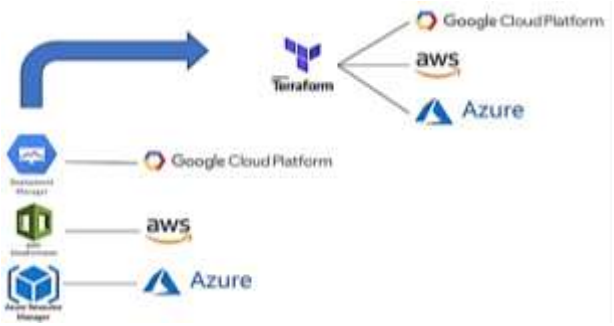

Fig. 4. Tools for Migration in Cloud

4.1 Cloud Service Provider (CSP) Native Tools

Cloud service providers (CSPs) typically state that their capacity is limitless and that they would never turn down a customer's request because they don't have the necessary resources. In order to meet demand during peak hours, CSPs usually acquire physical resources. Consequently, a large quantity of physical resources, termed spare resources go underutilized for the most part. Many modern service providers have taken to renting unused resources at a discount compared to their on-demand prices [22].

- **Azure Data Migration:** Microsoft has enhanced the tool's interaction with their Azure cloud and made it available for free. "Migrating to the cloud doesn't have to be difficult or slow," claimed Microsoft's cloud migration service. Streamline digital transformation and begin enjoying Azure's benefits with all-inclusive cloud migration service. We'll take care of everything from a personalized evaluation to optimizing workloads and continual improvement. Using automated discovery techniques to measure workload and other factors, the cloud migration solutions provide a personalized evaluation prior to the actual migration to the cloud.
- **AWS Cloud Data Migration:** Data can be moved over Amazon's networks, snowball, storage gateways, and technology partners with the help of these technologies that allow for particular acceleration. Amazon has developed a method to determine the anticipated number of days for data transmission, taking into account the fact that enterprise data might range from a few hundred gigabytes to several hundred terabytes. Upon entering the cloud computing market, Amazon immediately began to revolutionize the industry [23].

4.2 Containerization and Orchestration Tools

A container holds packaged self-contained, ready-to-deploy parts of applications and, if necessary, middleware and busi-ness logic (in binaries and libraries) to run the applications.

Tools like Docker are built around container engines where containers act as portable means to package applications.

A container stores application components, including middleware and business logic (in libraries and binaries), in a bundled, self-contained state that is ready to deploy. Docker and similar tools are based on container engines, which allow users to package software in portable containers. Components, their dependencies, and their lifetime can be described in a layered orchestration strategy. After the plan's processes are defined, agents (such as a container engine) in a PaaS cloud can carry them out [24].

- **Docker:** The process of automating application deployment into Containers is made possible by Docker. When running apps in a container, docker provides an additional deployment engine layer on top of the virtualization and execution. Docker, originally developed to give a lightweight and quick environment for efficient code execution, now includes an extra perk that helps streamline the process of getting code from development to testing and finally production.
- **Kubernetes:** Google developed Kubernetes (K8s), an open-source system for orchestrating containers, from its container-oriented cluster management platform Borg. It allows for the automatic deployment of tasks and the management of cluster resources in a highly flexible and scalable manner. Workloads of all kinds, including stateless, stateful, and data-processing ones, can be automatically orchestrated by using this system, which is based on a resource allocation policy that is container-oriented.

5. Best Practices for Automated Migration Pipelines

The most successful automated migration pipelines follow best practices, which include integrating with CI/CD for incremental deployment, using Infrastructure as Code for consistency, and doing a thorough pre-migration review. While cost minimization and post-migration monitoring preserve efficiency and governance, robust data migration, ongoing testing, and a security-first strategy guarantee dependability and compliance. When combined, these strategies make cloud adoption scalable, robust, and affordable.

Data-Driven Learning: AI and ML models can learn from vast datasets, extracting patterns and relationships that may be di‧cult to capture through analytical methods. This enables systems to adapt to complex and non-linear dynamics.

• Real-Time Adaptation: AI algorithms can process data in real-time, allowing for rapid adjustments to control parameters based on changing conditions. This is crucial for applications where quick responses are essential.

• Robustness: AI-driven adaptive control systems can be more robust to disturbances and uncertainties. They can learn to compensate for unexpected changes, ensuring system stability and performance

- **Adopt Infrastructure as Code (IaC):** The term IaC refers to a method of providing both local and remote instances and automatically establishing system dependencies. Continuous deployment cannot be executed without the usage of IaC scripts. Chef and Puppet are two popular IaC technologies that offer ways to set up software deployment infrastructure in the cloud automatically. To manage databases, user accounts on both local and distant computing instances, and to supply cloud-based instances, these technologies are used by IT organizations including Mozilla, Ambit Energy, GitHub, and Netflix. Puppet offers a number of useful resources, such as the "sshkey resource" for managing secure shell (SSH) host keys and the "service resource" for automating the management of software services [25].
- **Requirements Collection Period:** Automating CI/CD workflows is crucial to their success. Manually integrating, testing, and deploying code is inefficient, prone to errors, and inconsistent if not automated. Automation streamlines the application deployment and testing processes. As a result, frequently encountered incomplete or incorrect results as well as the now-famous "works on my machine" issue. Developers would work alone for long stretches of time before integrating their code, which caused integration phases to be tedious, bug-ridden, and project-stalled [26].
- **Agile development:** Cloud users have taken notice of efforts to integrate Agile principles like continuous testing, short releases, and light processes into methods for migrating to the cloud. Is it possible to incorporate Agile principles into legacy modernization processes? That is one such method. It proposes extending the REMICS migration approach to use Scrum [27].
- **Cost Modeling:** The infrastructure cost modelling is at the most advanced stage, and there is some assistance with technology suitability and stakeholder impact analyses. The Energy Modelling efforts are in their infancy, and have yet to incorporate a Responsibility Modelling tool. Nevertheless, a distinct project laid the groundwork for Responsibility Modelling, which incorporates an existing notation [28].

Table 2: Challenges and Future Directions in Cloud Migration

Challenges	Description	Future Research Directions
Data Security & Privacy	Risk of data breaches, unauthorized access, and compliance violations during migration.	Develop AI-driven security frameworks, privacy-preserving migration methods, and automated compliance verification tools.
Regulatory Compliance	Difficulty adhering to local and international regulations (e.g., GDPR, HIPAA) when moving sensitive data.	Research automated regulatory compliance checks and

		cross-border data management strategies.
Migration Costs	High upfront costs for planning, migration, and potential downtime.	Explore cost-optimized AI-driven migration planning and predictive cost modeling.
Vendor Lock-in	A lack of adaptability and interoperability could result from reliance on only a few cloud providers.	Investigate multi-cloud and hybrid solutions with standardized interfaces and portability frameworks.
Complexity of Applications	Legacy or tightly coupled applications are difficult to rehost or refactor.	Develop automated application assessment, refactoring, and containerization techniques.
Operational Disruption	Migration can interrupt business processes or degrade performance.	Study intelligent, adaptive migration pipelines that minimize downtime and ensure performance continuity.
Scalability & Performance Optimization	Maximising efficiency throughout and after the migration.	Research AI-driven workload balancing, dynamic resource allocation, and predictive scaling methods.
Monitoring & Management	Post-migration monitoring and management of cloud resources is challenging.	Explore AI/ML-based monitoring, anomaly detection, and self-healing cloud systems.

This Table II summarizes the key challenges organizations face during cloud migration, such as data security, compliance, and operational disruption. It also highlights potential future research directions, including AI-driven security, cost optimization, automated compliance, and adaptive migration strategies, providing a roadmap for more efficient and secure cloud adoption.

6. Literature Review

This review highlights advances in cloud migration and security, focusing on energy efficiency, trust models, secure protocols, storage optimization, and decision-making algorithms to improve performance, cost-efficiency, and reliability.

Pathania and Mithani (2020) demonstrated how the leading CSPs are always enhancing their cloud architecture to make it more energy efficient. Clients find the process of choosing a cloud service provider to be extremely arduous when migrating from on-premise data center(s) due to the numerous aspects involved, such as the pricing of cloud services and the location of the data centre, among others. A comprehensive database of current energy-efficient clouds together with their sustainability requirements, as well as a range of client inputs, will be used to build a cross-platform advise system that can give clients comprehensive suggestions on their selected cloud service provider. In the event that the customer does not specify a choice, the advise should additionally suggest a suitable cloud provider based on the client's specific workload [29].

Lin et al. (2019) introduced the Cloud Readiness Planning Tool (CRPT), a system that incorporates a Migration Type Classifier that has been trained using a novel active learning strategy to combat "concept drift" and an AI Planner that can autonomously construct plans from domain and problem files using declarative specifications such as desired states and data inputted in a user-friendly manner. They conducted a series of studies using a real-world migration task. The results show that the Migration Type Classifier successfully adapts to changing business needs while achieving high accuracy with low labelling cost [30].

Vo et al. (2019) introduced a new model for trust that allows for a dynamic relationship of trust between services in the cloud. From initial design to final migration across different Cloud providers, show the full security infrastructure life cycle. Evaluate the following aspects of cloud computing: Establishing and maintaining trustworthy relationships is a crucial part of migrating. Secondly, the security architecture can be easily transferred to other cloud providers and can communicate with the secured web application [31].

Karthick et al. (2018) provided a protocol for the secure allocation of resources in order to migrate services without incident. Additionally, investigated two alternate approaches. The first one formally verifies the finished protocol using the Automated Validation of Internet Security Protocols and Applications program. The protocol is secure since it authenticates and maintains confidentiality. Further uses for nonces include replay protection and ensuring freshness. To accomplish the secure transmission in the second method, an automated cryptographic protocol verifier is employed, along with a secure symmetrical session key. Secrets, authentication, and key exchange can all be checked with ProVerif [32].

Hsu et al. (2018) presented a hierarchy system for cloud storage that uses hot-cold data categorization and data transport to automatically assign expected classified data to the suitable storage media according to its temperature. Three important contributions are made by this work. First, let's talk about the practicality: and can save a tonne of money by accurately anticipating which data would have occasional access and then putting them in cold storage. Second, reliability: the proposed solution reduces storage costs while simultaneously increasing the percentage of data access through hot storage, which ensures customer satisfaction. Finally, cloud storage service providers' operational strategies vary, which leads to: flexibility [33].

Narantuya, Zang and Lim (2017) considered a cloud migration solution that allows for the automated migration of many VMs between various cloud infrastructures. Although, while migrating to the cloud, it is important to take into account any dependencies between VMs if a multi-tier web application is built using numerous of them. Failure to do so may result in an exaggerated amount of application downtime subsequent to the migration. The proposed VM grouping approach relies on principal component analysis (PCA) and traffic dependencies to significantly decrease application migration downtime [34].

Saha and Hasan (2017) A cloud migration decision-making algorithm has been created to figure out if it makes sense to run tasks that need a lot of computing power on a cloud computer instead of a mobile device. Furthermore, research comparing mobile and cloud executions has demonstrated that jobs can be completed six to eight times faster when hosted in the cloud as opposed to on-premises [35].

Table III summarizes recent studies on automated testing and software quality assurance, highlighting advances in testing efficiency, multi-platform automation, and quality evaluation. Key challenges include scalability and integration, with future directions focusing on broader platform support and adaptable QA frameworks.

Table 3: Comparative Analysis of Recent Studies on Cloud Migration Approaches

Reference	Study On	Approach	Key Findings	Challenges / Limitations	Future Directions
Pathania & Mithani (2020)	Energy-efficient cloud service provider selection	Cross-platform advisory system using client inputs & sustainability metrics	Provides detailed recommendations for cloud service provider selection based on efficiency and workload	Complexity in handling multiple factors (cost, location, energy metrics)	Enhance automation in advisory system for unbiased recommendations
Lin et al. (2019)	Cloud readiness & migration planning	Utilising an AI Planner and a Migration Type Classifier, the Cloud Readiness Planning Tool (CRPT)	Classifier can adjust to evolving business requirements while maintaining minimal labelling costs and excellent accuracy.	Concept drift in migration tasks	Broaden CRPT to handle diverse cloud environments
Vo et al. (2019)	Trust & security in cloud migration	Dynamic trust model across multiple providers	Trust preserved during migration, portable & interoperable security infrastructure	Ensuring continuous trust adaptation	Strengthen interoperability and cross-cloud trust mechanisms
Karthick et al. (2018)	Secure resource allocation in cloud migration	Resource Allocation Security Protocol with formal verification (AVISPA, ProVerif)	Ensures secrecy, authentication, freshness, replay protection	Relies on protocol correctness & validation tools	Extend to large-scale, multi-cloud environments
Hsu et al. (2018)	Cloud storage optimization	Automated tiering system with hot-cold data classification	Cost savings, improved reliability, flexible strategies	Balancing cost vs. reliability in real-time workloads	Integrate with predictive analytics for dynamic data allocation
Narantuya, Zang & Lim (2017)	Multi-VM migration in cloud	PCA-based VM grouping scheme considering traffic dependencies	Reduced downtime during multi-VM migration	Complex dependency management among VMs	Optimize PCA model and adapt for hybrid/multi-cloud
Saha & Hasan (2017)	Cloud vs. mobile execution of compute-intensive tasks	Cloud migration decision-making algorithm	Cloud reduces task completion time by 6–8x compared to mobile execution	Limited to compute-intensive workloads	Extend algorithm for broader mobile-cloud applications

7. Conclusion and Future Work

Cloud migration continues to be a key enabler of digital transformation, allowing organizations to enhance scalability, agility, and operational efficiency while optimizing costs. The survey presented an overall picture of automated cloud migration pipelines, including AI-based workload evaluation, risk-aware optimization, Docker and Kubernetes-based containerization, and integration of DevSecops. They enhance the faster, reliable, and secure migration processes. Multi-cloud and hybrid approach also expand

resource elasticity, limit dependency on vendors, and enable the integration of heterogeneous environments through smooth sailing. Notwithstanding these improvements, there are still a number of challenges. Data security and privacy risks, regulatory compliance, operational disruptions, complexity of legacy applications, vendor lock-in, and workforce skill gaps continue to impact migration success. Addressing these issues requires both technical innovations and organizational readiness. Integrating AI, predictive analytics, and self-healing mechanisms into intelligent frameworks for end-to-end migration planning, execution, and post-migration monitoring should be the focus of future study. Enhancing interoperability across hybrid and multi-cloud systems, strengthening risk-aware automation, and establishing empirical benchmarks are critical for validating migration strategies in real-world enterprise scenarios. By addressing both technical and organizational challenges, these efforts can guide enterprises toward secure, resilient, and cost-effective cloud adoption, supporting the next generation of digital infrastructure and innovation.

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